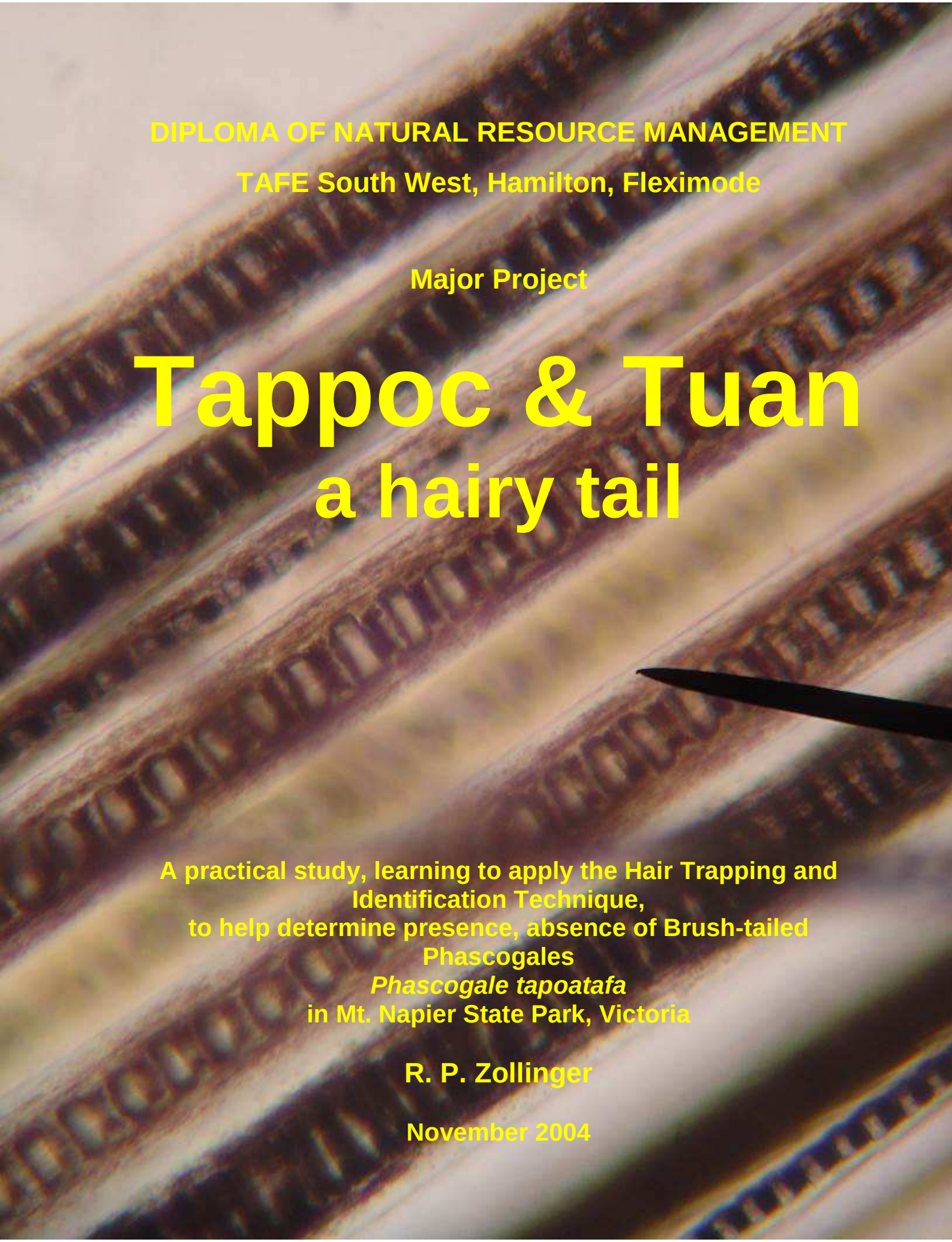

DIPLOMA OF NATURAL RESOURCE MANAGEMENT

TAFE South West, Hamilton, Fleximode

Major Project

Tappoc & Tuan
a hairy tail

A practical study, learning to apply the Hair Trapping and Identification Technique,
to help determine presence, absence of Brush-tailed Phascogales
Phascogale tapoatafa
in Mt. Napier State Park, Victoria

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CONTENTS

Cover Photo: The medulla structure of a hair sample as seen through the light microscope.

ABSTRACT

The main aim of the project was to learn apply the technique of hair identification to establish if Brush-tailed Phascogales, *Phascogale tapoatafa*, are still present in Mt. Napier State Park since last record in 1980.

Hair samples were collected using 100 Hair tubes placed along five transects across Mt. Napier State Park between April and May 2004. A second trapping exercise between September and October 2004 using another 60 hair tubes along three transects was conducted, but these results could not be included in the paper due to time restraints.

The Hair ID CD ROM, produced by CSIRO developed by Brunner, Triggs and Ecobite Pty. Ltd., was used to conduct identification of hair samples collected.

Unfortunately no conclusive evidence of the Brush tailed Phascogale was found in the hair samples collected during the first trapping exercise.
Never the less other significant findings such as the presence of the Fat-tailed Dunnart, *Sminthopsis crassicaudata*, were of great interest.

INTRODUCTION

The Brush-tailed Phascogale or Tuan, *Phascogale tapoatafa,* is a medium-sized, strongly arboreal, marsupial (family Dasyuridae) found in dry sclerophyll forests and open woodlands that contain hollow-bearing trees.

Brush-tailed Phascogales are best described as having a body length of 150-260mm, a tail length of 160-230mm and a weight of 110-310g. The head, back and flanks are covered by deep grizzled grey fur, which is generally cream to white underneath. It has large naked ears and a conspicuous black “bottle-brush” tail with hair up to 40mm long.

It lives on a diet of large arthropods such as moths, cockroaches, beetles, cenipedes, spiders, ants. Other insects, nectar, small reptiles, mammals and birds are also part of the diet.

The Brush-tailed Phascogale is monoestrous, meaning that all males die after the short annual breeding season from mid May to early July, when 11-12 month of age. Females sometimes live for over two years but a single breeding season is the norm (Cuttle 1983).
Female Phascogales forage over home ranges of 30 to 60 ha and does not overlap territories of unrelated females, while males forage over areas greater than 100ha overlapping territories of other male and females (Traill & Coates 1993).

The Brush-tailed Phascogale is classified as vulnerable in Victoria and is listed as threatened under schedule 2 of the Flora and Fauna guarantee Act, 1988.

The survey of Brush-tailed Phascogales is difficult using traditional survey methods, due to low population density, nocturnal habits and generally cryptic behavior.

The study was conducted within Mt Napier State Park, a conical shaped extinct volcano rising to about 442 meters above sea level, located in the south west of Victoria, 16 km south-east of Hamilton within the Shire of Southern Grampians.

The last recorded sighting of a Brush-tailed Phascogal at Mt Napier was made by a member of the Hamilton Field Naturalist's Club in 1980.
(Bird pers.Comm. 2004)

One of the key aims of this study was to investigate presence absence of Brush-tailed Phascogales as well as other species within Mt Napier State Park by using the Hair trapping and ID technique.

The other key aim was to learn and develop skills in the hair identification technique, first developed for Australian mammals by Brunner and Coman in 1974, in accordance to analyse hair samples collected using hair tubes and funnels.

In order to gain data about presence, absence of species, 100 Hair traps were laid between April and May 2004 along five transect lines to collect hair samples.

The traditional methods of identifying hair uses light microscopy to determine the morphological characteristics, typical for each individual species, in connection with a Hair ID CD ROM database produced by CSIRO, developed by Brunner, Trix and Ecobite Pty. Ltd.

A second trapping session, based on findings during the first trapping, was conducted between September and October 2004 using 60 Hair traps along three transect lines. One in a section of the park previously not covered and two in the transect line yielding the most diverse species range.
Due to time restraints the results of the second trapping attempt could not be included in these paper.

Photo: Brush-tailed Phascogale. Photo, courtesy of Andrew Arnold, DSE

THE STUDY AREA

Geology

Mt Napier is an extinct volcano located in one of the largest geological units in Victoria the Newer Volcanic Province, a region extending from north of Melbourne to west of Portland. Refer to Figure 1.

There were about 355 to 400 eruption points identified in the Newer Volcanic Province of which the more resent eruption points occur within the south-west of the province. The distribution of the volcanoes (generally becoming younger toward the south and west) suggest a Hot Spot volcanism as the continent drifted from Antarctica and moved steadily northwards (Rosengren 1994).

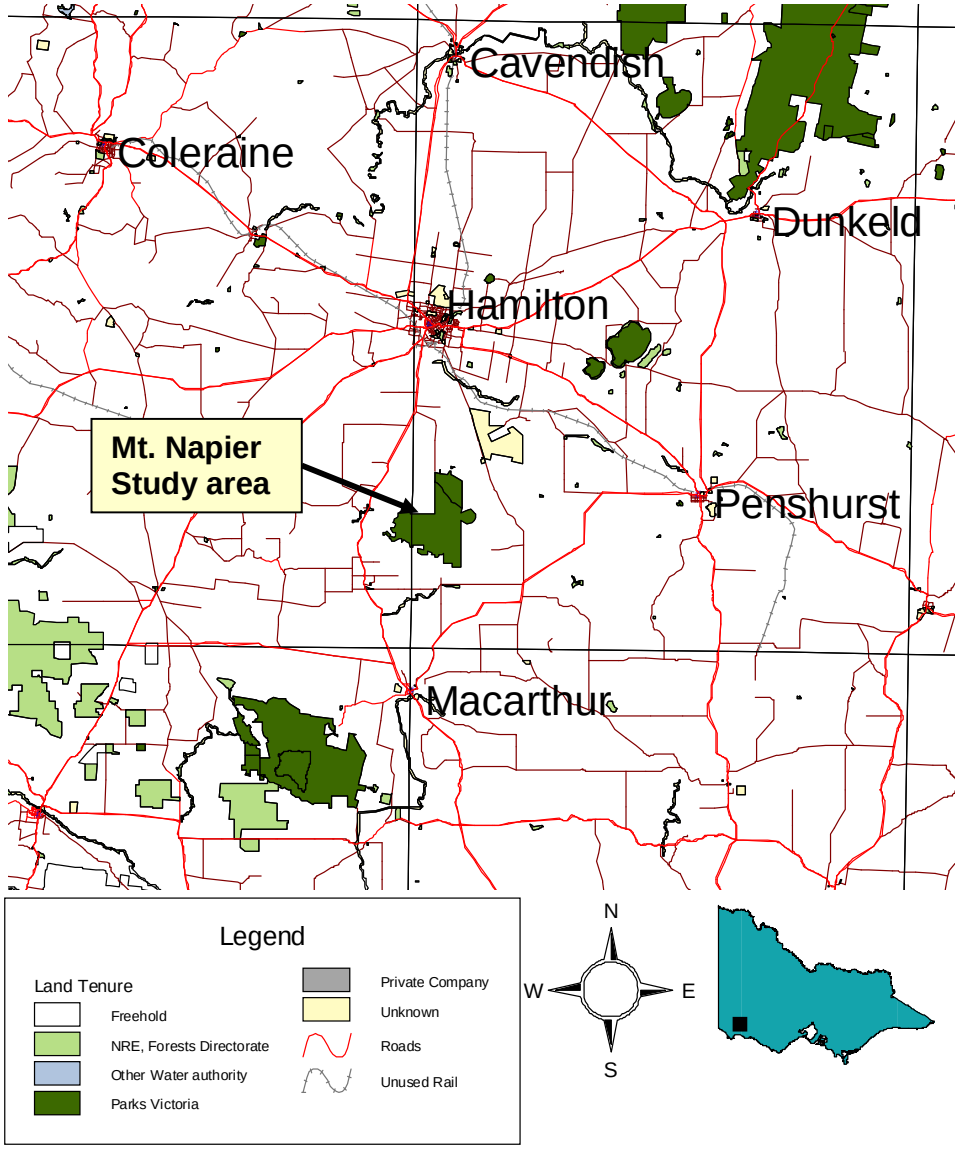


Figure 1: The study area and location

Mt Napier is a conical shaped cinder cone formed in two final stages of eruption and is one of the more recently active volcanoes in Victoria. It rises some 182 meters from the undulating plains to an elevation of about 442 meters above sea level.
A crater and multiple points of eruption mark the summit of this symmetrical cone.
Resent isotope readings (1997) indicate that Mt Napier erupted about 32 000 years ago, rather than the 8000 years previously suggested (Grimes pers. comm. 2004)
During eruption, Mt Napier superimposed igneous rocks such as basalt, scoria and tuff over older Pliocene basalt (3.9 million years) which in turn overlies Cainozoic marine sediments.
This older lava field lies across an ancient river valley, thought to be the original course of the Wannon River.
Turbulent lava barriers (stony rises), tumuli (blisters), channels, craters, spatter cones and cinder cones form the raw landscape.
The main flow of the molten lava moved some 24 kilometers south-west from Mt. Napier down along Harmans Valley toward Wallacedale, creating a unique volcanic landscape along its way including the Byaduk Caves.
A minor flow went north-east, obstructing another drainage line and forming Buckley Swamp.
Clustered around the mountain are at least 30 other eruption points which may have developed when the main vent blocked (Ollier & Joyce 1964).

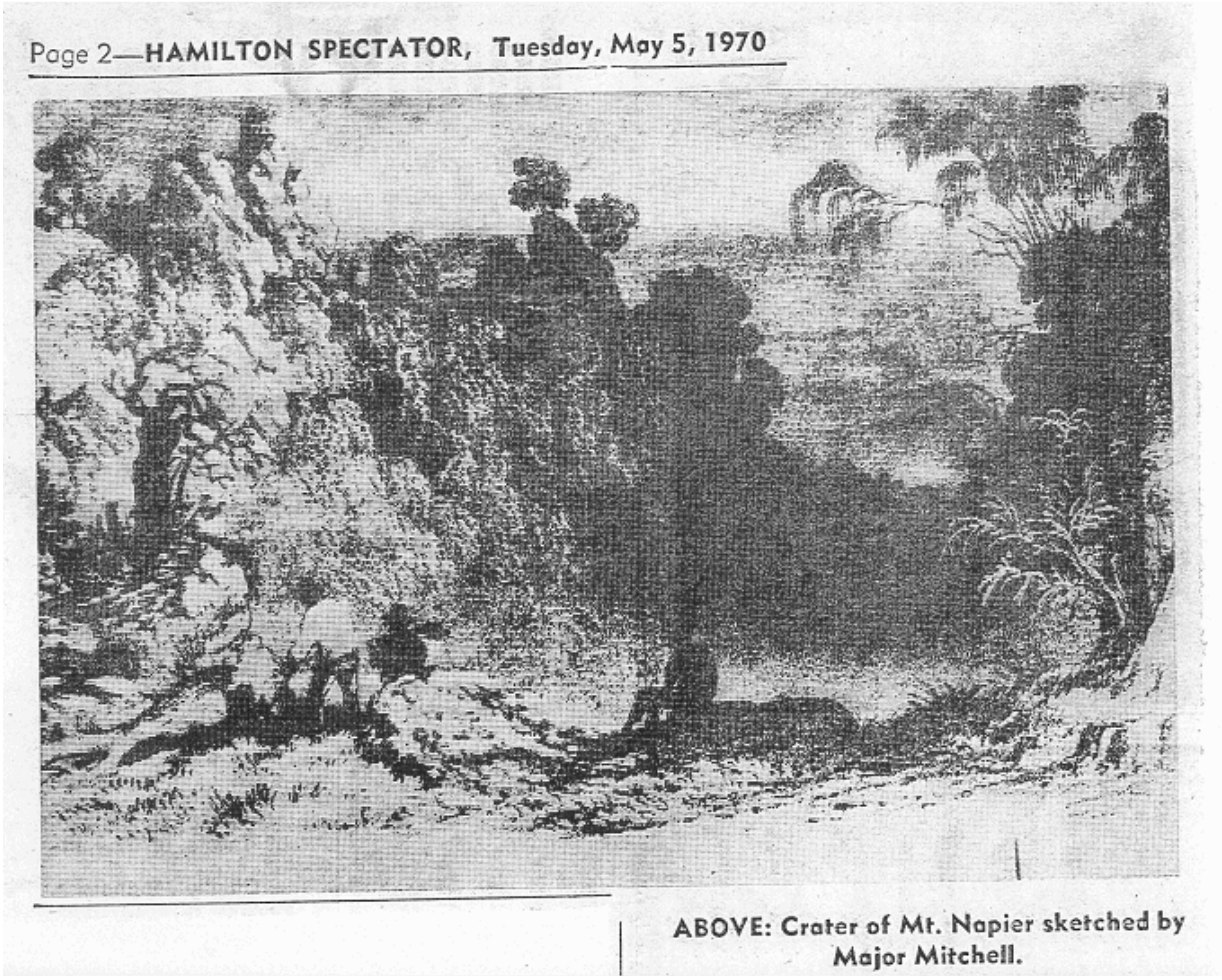
Photo: Mt Napier as viewed from Buckley Swamp Road

History

Mt.Napier formed part of the country of the Djab Wurrung tribe. The Djab wurung clan that belonged to Mt. Napier were the Tapukunditj which was one of at least 41 Djab wurrung clans. The traditional Djab wurrung name for Mt. Napier is Tappoc meaning the head. (Mt Eccles NP & Mt Napier SP Management Plan, DCNR 1993)

Major Thomas Mitchell and party climbed the mount for the very first time on September 4th 1836 during the expedition of “Australia Felix”. Mt Napier was named after Admiral Sir Charles Napier with whom Major Mitchell was associated in the Peninsula War of 1808 to 1814.
An extract from Mitchell’s journal, published in 1838 states:

“On reaching the summit I found myself on the narrow edge of a circular crater, composed wholly of lava and scoriae. Trees and bushes grew everywhere luxuriantly, except where the sharp rocks shot up almost perpendicularly. The igneous character of these was so obvious, that one of the men thrust his hand into a chasm to ascertain whether it was warm” (Willis 1963).
Refer to figure 2


Page 2—HAMILTON SPECTATOR, Tuesday, May 5, 1970

ABOVE: Crater of Mt. Napier sketched by Major Mitchell.

Figure 2: Summit of Mt Napier as seen by Major Mitchell in 1836.

After Major Mitchell's initial survey, Mount Napier was first used as a trigonometrical vantage point for the official triangulation of western Victoria in April 1869.
Appendix II, pictures a copy of the original sketch showing the triangulation station.

The scenic interest of Mt Napier was first realized on government level in June 1873 as a notice of intention to reserve the cone but nothing came of this move.

In 1914, residents of the Buckley Swamp district raised funds to build a cairn on the summit to commemorate Major Mitchell's discovery of the mount.
Appendix III**,** is showing a photograph of the memorial built in 1916.

It was not until September 1921, when by order of Council, 344 acres comprising the whole peak and part of the Manna Gum woodland around its northern flank was appointed a "public reserve" and a committee of management was appointed.

During 1923 to 1933 the reserve was rented for grazing by an adjoining landholder.

Boundary disputes with property holders over alleged activities to cut timber within the reserve led to a new survey in September 1933.

The committee of management lapsed in August 1943 and has never been appointed there after.

Fires devastated the whole area around Mt Napier including the cone in early January 1944.

Further Fires in 1965 devastated over 1000 acres and during the 1960s and 70s small deliberately lit fires regularly burnt the woodland around Mt Napier.
Appendix IV**,** pictures a copy of an article printed in the Hamilton Spectator in November 1965.

In 1966 an attempt to declare Mt Napier a wildlife and native plant sanctuary was requested but noting came of it.

In 1971 a submission to reserve an area of about 2500 acres including Mt. Napier as a National Park was prepared.
Appendix V, pictures a copy of a news paper article featuring the proposed public reserve.

In April 1972, 3500 acres were burnt, killing many Koalas and other wildlife.

In 1975 the last remaining grazing licenses were removed from Mt Napier.

For the first time, in 1981, 40 Koalas from French Island were released in Mt Napier. The Koala population has since grown and have reached a crisis point where they are having a devastating impact on the Manna Gum woodland of Mt. Napier.

In 1982 the Hamilton Field Naturalist Club commenced revegetation on the summit slopes using seeds collected on site in an attempt to restore the summit to its original vegetation cover.

In 1987, over a century after it was first recognised for its scenic value, Mt Napier was finally declared a State Park covering an area around the mount of about 2800 hectares.

In June 1993 a draft management plan for Mt Eccles National Park and Mt Napier State Park was submitted.

(Willis 1963, Mt Eccles NP & Mt Napier SP Management Plan, DCNR 1993)

Photo: Summit of Mount Napier with the remains of the Major Michel memorial tower.

Flora

The vegetation around Mt Napier is dominated by a Manna Gum *Eucalyptus viminalis*, woodland together with Blackwood *Accacia melanoxylon*. There are lesser numbers of Cherry Ballart *Exocarpus cupressiformis* , Tree Everlasting *Ozothamus ferrugineus* and Sweet Bursaria *Bursaria spinosa*.
Small patches of grassland occur in the southern part of Mt. Napier State Park. Dominated by Poa Tussock *Poa labillardieri*, Austral Bracken *Pteridium esculentum*, Variable Groundsel *Senecio latus* and Bidgee-widgee *Acaena novae-zelandiae*.

According to the Department of Sustainability and Environment (DSE) using the data from the Flora Information System 2003, 70 flora species are listed for the Mt. Napier area of which 14 are mosses, 3 are ferns, 17 are monocotyledons and 36 dicotyledons. Refer to Appendix VI Subset flora species list.

Thought, the plant species list for Mt Napier, compiled by C. Beauglehole and J. Willis for a report outlining a proposal for a National Park in the Mount Napier Area in 1971, listed 103 flora species. That list comprised of 6 Fern species and 97 vascular plant species including one orchid and 33 exotic plants.

Photo: Tree Everlasting
Ozothamus ferrugineus

Photo: Native Ivy-leaf Viola
possible *Viola hederacea*

Photo : Poa tussok grassland, *Poa labillardieri,* on top of Mt. Napier.

Fauna

The current list for mammals recorded around Mt Napier, according to the Department of Sustainability and Environment (DSE) using the data from the Atlas of Victorian Wildlife 2003, lists 16 mammal species including 8 bat species.
Species such as the Tiger Quoll *Dasyurus maculatus*, Brush-tailed Phascogale *Phascogale tapoatafa* and the Southern Brown Bandicoot *Isoodon obesulus* are believed to occur in Mt. Napier.
Koalas in Mt Napier seam to be on the increase but do not appear as numerous as in Mt Eccles National Park.

Wild Goats, foxes, rabbits and feral cats make up the majority of introduced mammals.

Sub-fossil mammal deposits found in the Byaduk Caves provide an index of the mammals of fairly recent times. 25 sub-fossil mammal species have been recorded including the Eastern Barred Bandicoot *Perameles gunnii* and the Brush-tailed Rock-*wallaby Petrogale penicillata*,(Wakefield, 1964).

The current list for birds recorded around Mt Napier, according to the Department of Sustainability and Environment (DSE) using the data from the Atlas of Victorian Wildlife 2003, lists 48 bird species.
Refer to Appendix VII Subset fauna species list.

Thought the bird species list for Mt Napier area, compilled by M. Gunn, B. Birrell, L. Elmore and C. Beauglehole for a report outlining a proposal for a National Park in the Mount Napier Area in 1971, lists 90 bird species including 6 introduced species.

Little research has been done on reptile and amphibians, the odd Tiger Snake, Brown Snake, Blue Tongue lizard and skinks have been reported.

Photo: One of the many Koalas

Photo: Wedge-Tailed Eagle Nest high in the crown of a Manna Gum.

Photo: Common Blue-tongue *Tiliqua scincoides*

Previous studies

After the initial survey and notes by Major Mitchell, not many fauna and Flora surveys were undertaken at and around Mt Napier until the late 1950s early 1960s by naturalists Cliff Beauglehole and Lionel Elmore.
Following that initial survey, the Hamilton Field Naturalists Club, in preparation for the submission to make Mt Napier a National Park extended the flora and fauna lists during the 1970s and 1980s.

More recently a fauna survey in 2000, conducted by DSE (Department of Sustainability and Environment) in conjunction with the Brush-tailed Phascogale Recovery team, was inconclusive. The trapping results were very poor (no animals at all) using over 70 Elliot traps which were suspended in trees and spaced at about 200m, parallel to access tracks over three trapping nights (Arnold pers. Comm. 2004).

METHOD

Home made hair tube

Cylindrical hair tubes are made of a piece of PVC (poly vinyl chloride) piping of varying diameter cut into suitable length.
The length and diameter varies according to the size of animal being targeted.
They are usually closed on one end, but may be left open on both ends.
The bait is placed in the closed end of the tube or in the center if both ends are open, wrapped as a muslin-covered ball.
Adhesive material is placed on the upper inner surface of the open end(s).
The tube can be placed on the ground or fastened to the lower branches of trees.
To prevent the tubes from being moved by animals it is necessary to secure them to the ground with a U-shaped strong wire.
For this study a double open-ended cylindrical tube with a diameter of 45mm was placed on tree, a method recommended by ARI (Arthur Rylah Institute) used to target Brush-tailed Phascogales.
Refer to figure 3.

Figure 3: Home made cylindrical hair tube as used in the survey

Commercial Hair funnel

The hair funnel trap is a half-cone shaped housing fitted with a wafer that is coated with a glue formulation covering all of the upper rounded part of the funnel.
Bait is placed at the end of the funnel.
Because of its wide opening and narrow end, hairs from large and small animals can be obtained.
The hair funnel can be secured to the ground with tent pegs or fixed to a trees using a simple platform or by utilizing a branch of the tree.
Refer to figure 4.

Figure 4: Commercial Hair Funnels as used in the survey.

Field Layout

For the trapping of hair (part of animal) a research permit under the Wildlife Act 1975 and the National Parks Act 1975 was obtained to undertake research in Mount Napier State Park.
Refer to Appendix VIII Copy of Research permit.

The study used 50 of each kind of hair traps totaling 100 hair tubes.
The cylindrical (45mm diameter) hair tubes, open at both ends with bait placed in the middle, were used on trees and the hair funnels were used on the ground.

To increase the chances of attracting as many different animals as possible, two different bait mixtures were used.
The first consisted of the traditional Peanut Butter, Honey and Rolled Oat mixture and the second of a Sardine, Fish Oil, Flower and Rolled Oat mixture.
The two bait mixtures were alternatively placed either in the tree or on the ground.
A Honey water mixture (10% honey, 90% water) was used to spray a trail of liquid along the tree from the ground to the hair tube to increase chance of animals finding the tube.

Five transect lines were selected to be studied, considering several different factors for their selection.
These include distance from access track, distance from cleared land, type of vegetation and type of topography.
Each transect line had 10 trapping stations consisting of two hair traps, one on the ground and one in the nearest tree.
Every transect line covered about 500 meters in a more or less straight line heading away from any access track with trapping stations spaced at 50 meter intervals and starting at least 50 meters away from access track.

Flagging tape labeled with trapping station and transects number marked each trap site.
Compass bearing and GPS (Global Positioning System) readings were taken at every trapping station as well as general notes about vegetation, topography or habitat were recorded,

Hair tubes were left in the bush for about four weeks between 25th April 2004 to 22nd May 2004.

After collection the adhesive material of each trap was carefully examined and any hair captured analyzed using the Hair Identification technique and the Hair ID software.
Data for each transects was entered onto Excel spread sheet for data processing and analysis.

Location and geographic maps were produced using Arc-View, a program based on GIS (Geographic Information System) data and grid references using a GPS (Global Positioning System).

Photo: Hair samples collected on a wafer during the survey

HAIR ANALYSIS

The method used in this study is Hair tube sampling, one of the least intrusive fauna survey methods known and proven efficient.

Descriptions as stated in Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

Hair analysis provides a quick, non-intrusive and cost-effective method of undertaking mammal fauna surveys work.
Hair collected from tubes are undamaged and therefore much easier to identify than those collected from scats or pellets.
The tubes reveal the position of animals whos hair have been collected.
However, the location of the tube in an environment can influence the species identified and in some cases it may not detect all species present in a study area, and not all species can be reliably identified from hair analysis.

Hair tubes are simple devices that have gained wide acceptance as a tool for fauna survey work.
In general terms, hair tubes are tubes of various shapes and usually have one end closed. Adhesive material is placed on the upper inner surface of the open end, and bait is placed in the closed end of the tube. Animals pushing into the tube to investigate the bait leave hairs attached to the adhesive material, which can later be removed for analysis.

Limitation

Successful identification of hair relies on access to accurate reference information about the structure and appearance of mammalian hair.
Hairs of closely related species can be difficult to distinguish. In such cases, species identification may only be possible by reference to known species distributions that have been determined by other survey methods.
Identification of hair is complicated due to variability of structure and appearance of hair from different parts of a single mammal, and even within a single hair.
Hair analysis can only be used to indicate presence or absence of a species in a survey area. It can give only limited information on abundance.
In common with all survey methods, survey results based only on hair analysis may be skewed by the collection technique.
Species are overlooked due to; the location of the trap in the environment; species that will not enter hair tubes or species that are not captured by local predators when using scats for identification purpose.

Accuracy and Reliability
Description as stated in Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

A reliability assessment of mammalian hair identification was conducted by Lobert and Lumsden (1991).
This study measured the accuracy and reliability of identifying hair, using samples of 37 known mammal species in a series of tests.

At the end of the study the “reliability categories” were as follow:

Reliable (taxa correctly identified in 100% of cases),
Possible (taxa correctly identified between 75 and 100% of cases),and
Unreliable (taxa correctly identified in less than 75% of cases).

Importantly, many of the threatened fauna were in the reliable category, e.g. Spotted-tailed Quoll, Brush-tailed Phascogale (some of which can be difficult to detect with conventional survey techniques).
The unreliable group included Antechinus to species level and Sminthopsis species.

Woolley and Valente found the “Antechinus” group most difficult to identify. Differences were seen in the structure of the medulla of the over-hair and in the position of the constriction in the guard hairs and over-hairs.

HOW HAIR ID WORKS

Hair ID database

In 2002 Barbara Triggs and Hans Brunner in cooperation with Ecobyte Pty Ltd and CSIRO Publishing produced the first ever Hair ID software for Australian mammals.

The hair ID software significantly extends the range of reference information for Australian mammals and was used in the project as the key tool for hair identification.

The Hair ID database has been designed around identification keys adapted from those developed by Brunner and Coman (1974). Species have been keyed into the database based on their known hair characteristics. To allow for the variations in hair, species have been entered into the database in two ways for each of the diagnostic characteristics the most commonly occurring form of the characteristics and all the known variations of the characteristics.
Currently the database in Hair ID contains information on 110 species. The criteria for the selection of these species is that they are either commonly occurring in unidentified samples, or are rare and important species that should not be overlooked

Equipment

Recommended equipment as per Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

- A light microscope capable of 100x to 400x magnification for viewing the hair and prepared slides.
- Glass slides and coverslips.
- A thin metal slide with a series of small holes for making the cross-sections. The slide is a stainless steel microscope slide (76 x25 x 0.5mm) with two to six holes each of 0.8mm diameter along the center.
- Dull rayon yarn (330 denier) for packing hair when making cross-sections.
- Cotton or nylon thread to help in preparing cross-section.
- Glycerol for mounting of hair on slides.
- Razor blades for trimming hair preparing cross-sections.
- ACROPOL CA 146 or poly vinyl acetate (PVA) glue for preparing scale casts of hair and a brush for spreading glue.
- Citro Clean or similar solvent for removing hairs from adhesive tape used in hair tubes.
- Scissors, tweezers and needle for handling hairs.
- Computer capable to run Hair ID CD ROM.

Equipment used for the study is illustrated in figure 5.

Figure 5: Equipment used for hair analysis

Types of Hair

Definitions taken from Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

Vibrissae:

These are large, stiff hairs that are primarily sensory in function. They are referred to as whiskers. Vibrissae hair samples are of no value for species identification as their basic structure is very similar for all mammals.

Bristle hairs:

These hairs usually have a very narrow medulla or no medulla at all, are oval to circular in cross-section, and commonly have a flagged or frayed tip. (e.g. certain breeds of domestic pig or human hair)

Over-hair:

Usually they are circular in cross-section and have little diagnostic value. As a rule, over-hair are more densely pigmented than the other hair type immediately surrounding them.

Guard hair:

These are the larger or coarser hairs forming the main pelage, including a type often described as shield hairs. The largest of the guard hairs, termed the primary guard hairs, are of paramount importance in hair identification, it is these hairs which generally exhibit the most diagnostically useful features.

Under-hairs:

These are shorter and finer than the guard hairs on any given area of the pelage and are commonly wavy. Like the guard hairs they range in size down to extremely fine hair. Under-hairs are generally of little diagnostic value.

Structure of hair

Description taken from Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

Typical hairs are made up of three layers of keratin material.
All three layers consist of dead cells and all are of a cellular appearance when inspected in detail. The shape, arrangement and size of all three layers are very important in hair identification. However, some hair are non-medullated for example wool of sheep.
Once hair has protruded above the skin, it no longer exists of living cells and its original structure will not change except by physical means.
The typical internal structure of hair can be easier observed in cross-section and longitudinal-section.
Refer to figure 6.

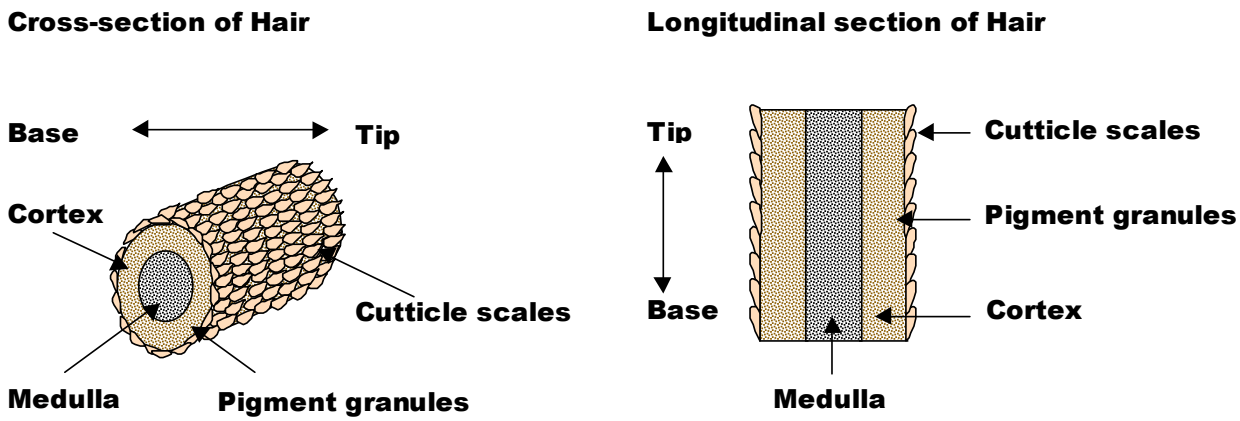


Figure 6: Illustration of cross and longitudinal section.

Medulla

The Medulla is the central portion of most hairs, and is a hollow space filled with air and shrunken cells.
In many medullae, the air space is partly filled with pigment granules. Therefore, the structure of the medulla can most easily be assessed in this region.

Pigment granules

Color in hair results from the effect of light on pigment, and from the structure of hair, which permits describing them as red, yellow, black, or graduations of these colors. White areas of hairs and some grey areas are unpigmented.

Cuticle scales

The cuticle scales or outer layer of a hair consists of a single layer of generally transparent overlapping scales.

Cortex

Like the medulla, the cortex of the hair consists of dead cells packed into a rigid hyaline mass.

Diagnosis of hair
Description taken from Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

Hair can be identified by studying their appearance, size, shape and structure.
Various Regions of a hair can be identified between a shield and a non-shield hair.
There are four main tools to help identify an unknown hair.

Diagnostics of Hair Profile

Hair profile is a term used to group a number of characteristics of hair related to its size, shape and appearance.
Size of hair (maximum length and diameter of the hair)
Shape of the hair (presence absence of shield region, waviness, constrictions)
Type of hair (guard hair, over-hair and under-hair)
Color of the hair (presence absence of pigmentation and color bands)

Diagnosis of medulla

The shape of the medulla along the length of the hair, and the diverse arrangements of the cells and air spaces within, is used to classify medullae according to their appearance. It is possible to recognize and define four major structural groups of medulla: unbroken, broken, ladder and miscellaneous.
Each of these can be further subdivided, giving a total of 12 distinct types.
Refer to figure 7.

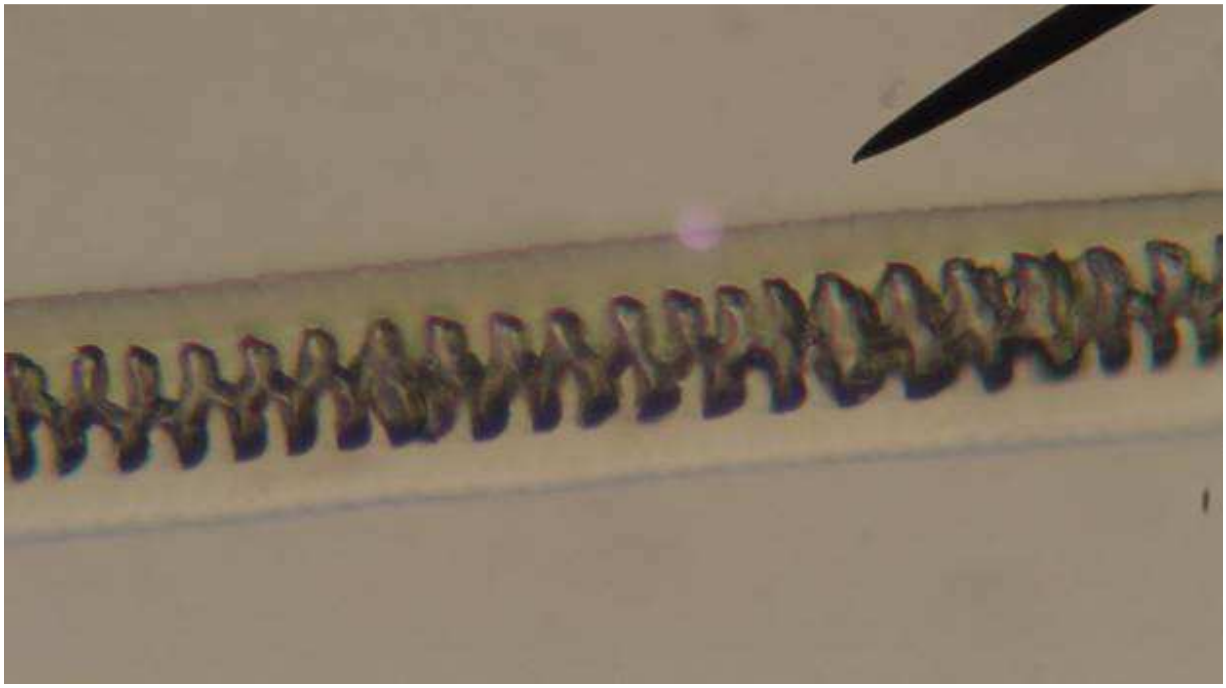


Figure 7: Example of the medulla through light microscope

Diagnosis of cross-section

There are marked differences in the cross-section shape of different hair.
The cross-section is the single most important feature of the hair identification system used in Hair ID. Generally, the most useful cross-section is found at the widest point on the primary guard hair.
Refer to figure 8.

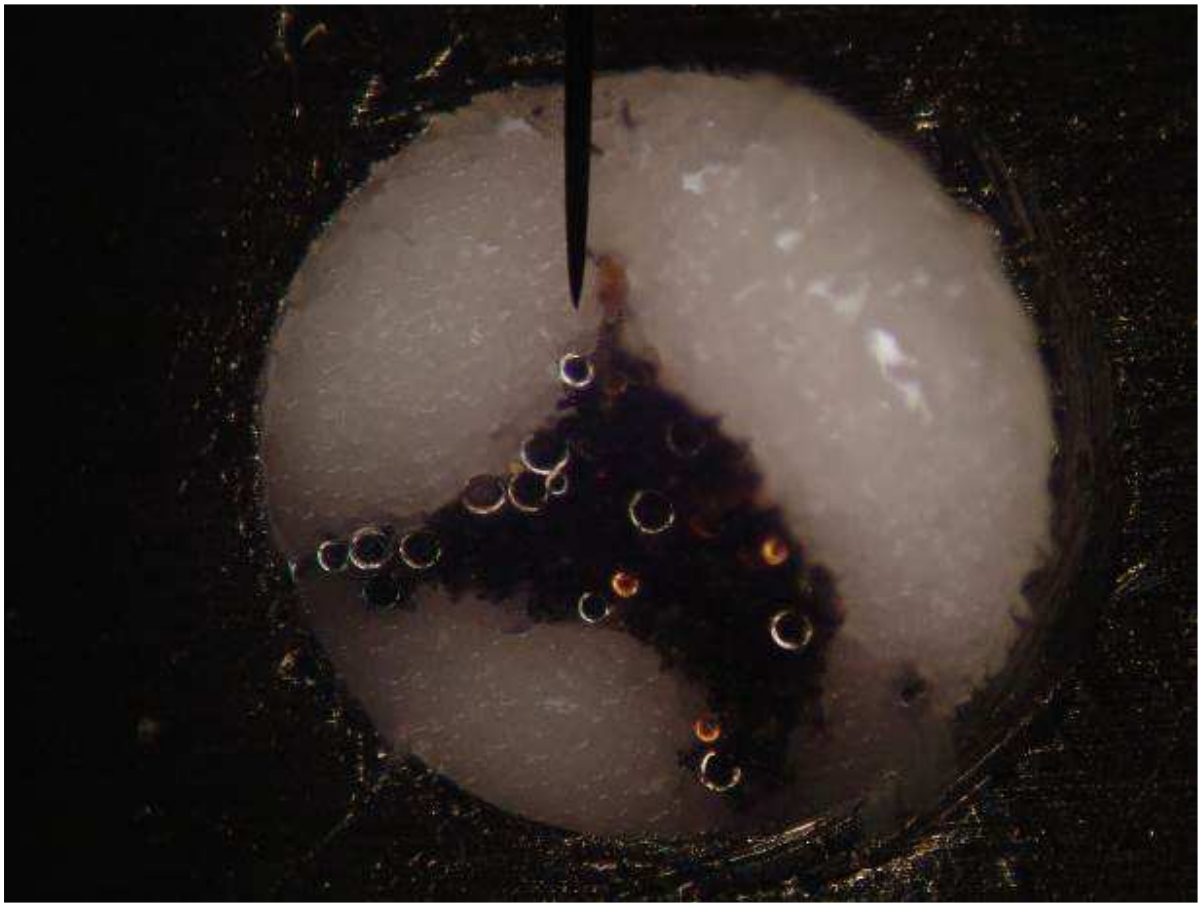


Figure 8: Example of the cross section through the light microscope

Diagnosis of cuticle scales

The size and shape of scales, and their pattern around the hair can also help with the hair ID. The scales vary considerably along the length of a single hair.
Scale margins may be defined as the free edge of all individual scales.
Scale separation is the distance between the free edge of one scale and that of adjacent scales above and below.
Scale patterns can be placed into four broad groups, Petal patterns, Mosaic patterns, Waved patterns and transitional patterns.
Each of these can be further subdivided into 11 distinct types.

Example of the scale pattern is illustrated in figure 9.

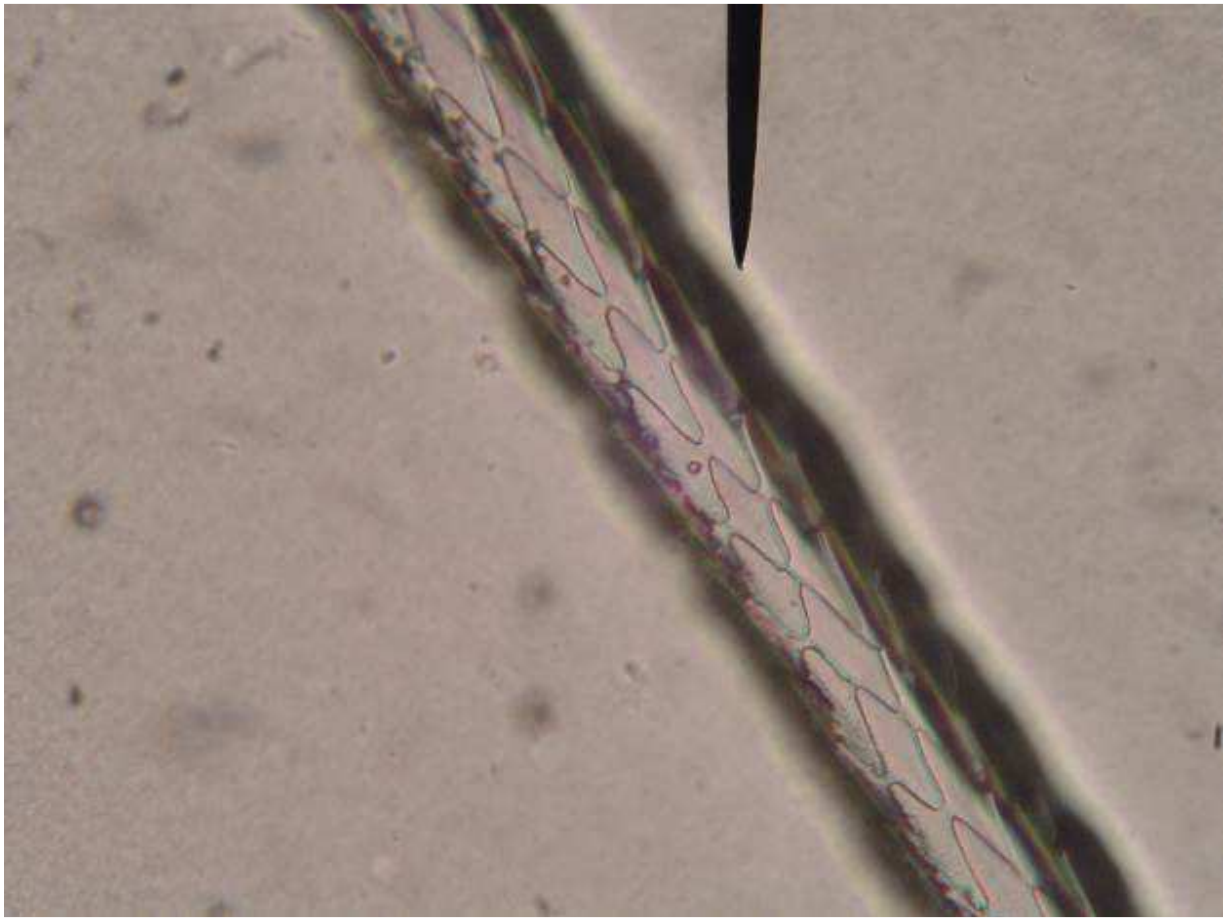


Figure 9: Example of the scales through the light microscope

RESULTS

Trapping success

Out of the 100 hair tubes placed along the five transect lines an average of 52% had hair samples.
Success rates along the different transect lines varied widely from 10% to 80% of hair tubes having hair samples. Refer to table 1.

Transect No.	Hair %	Hair yes	Hair no
TR1	70	14	6
TR2	80	16	4
TR3	30	6	14
TR4	10	2	18
TR5	70	14	6
Average	52		

Table 1: Percentage of hair in each transect line

Species identified

Readers should note that this project was my first attempt at identifying species using the hair analysis technique and some errors may have been made in identification.
To deal with this issue, a level of confidence has been applied to the hair identification results, the confidence levels used are as follow, moderately conclusive and inconclusive

It will take considerable practice to build up confidence and experience to consistently and correctly identify hair samples.

The identification of Antechinus to species level is particularly difficult due to similarities between species. The identification of *Pseudomys shortridgei* may also not be correct as it was based on only one hair strand.
For more details refer to Discussion section.

In the study, 12 different species were identified using the hair analysis technique, of these 8 species were regarded as moderately conclusive, 4 species were inconclusive and 2 species were contaminations such as human hair and sheep.
Unfortunately no hair sample collected revealed the presence of the Brush-tailed Phascogale.

Of the species identified, three species are listed as Near Threatened, one is listed as Vulnerable and one is listed as Endangered according to the Advisory list of threatened vertebrate fauna in Victoria 2003 prepared by the Department of Sustainability and Environment. Refer to table 2.

Species moderately conclusive identified

Scientific name	Common name	Conservation Status (Vic)
Antechinus minimus	Swamp Antechinus	Near threatened
Antechinus stuartii	Brown Antechinus	N/A
Antechinus swainsonii	Dusky Antechinus	N/A
Pseudomys shortridgei	Heath Mouse	Near threatened
Petaurus breviceps	Sugar Glider	N/A
Pseudocheirus peregrinus	Common Ringtail Possum	N/A
Sminthopsis crassicaudata	Fat-tailed Dunnart	Near threatened
Trichosurus vulpecula	Common Brushtail Possum	N/A

Species inconclusively identified

Scientific name	Common name	Conservation Status (Vic)
Cercartetus nanus	Eastern Pygmy-possum	N/A
Petaurus norfolcensis	Squirrel Glider	Endangered
Sminthopsis murina	Common Dunnart	Vulnerable
No clear identification	N/A	N/A

Table 2: Species identified in hair samples

Species most common

The species most commonly recorded were the Antechinus followed by the Common Brush-tailed Possum. Less commonly recorded were the Common Ring-tailed Possum and the Fat-tailed Dunnart. The Squirrel Glider and the Sugar Glider were least commonly recorded.
Refer to figure 10.

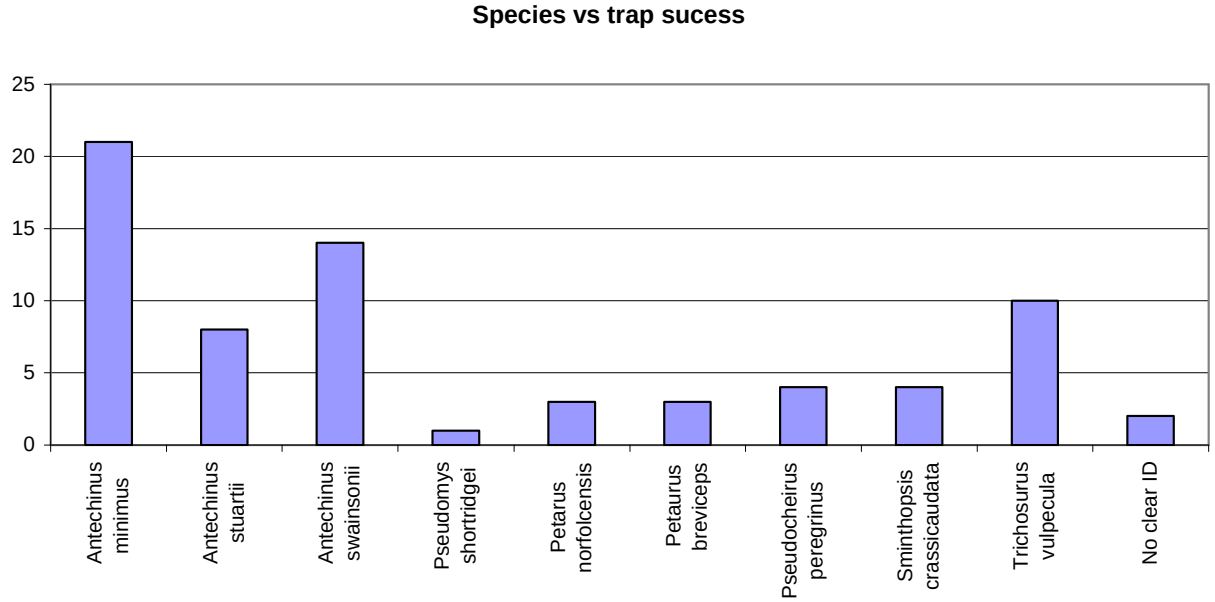


Figure 10: Species versus trap success

Species diversity

Species diversity between the different transect lines varied widely, possibly reflecting the vegetation type and habitat requirements of species. Data was based on the identification of the hair samples.
Refer to figure 11.

Interestingly, transect lines that existed of an open grassy under-story yielded the least hair samples, even thought there were plenty of hollow baring trees, fallen logs and rocky rises.

The most species diverse transect line was TR 5, which is the most southerly positioned of all transect lines. The vegetation was dominated by Manna Gum, scattered Blackwood and a dense Bracken fern under-story. There were many young Manna Gums, some large old trees, fallen logs, rocky rises, and ridges adjoined by a large open grassy clearing.

Transect number TR 2, positioned within the actual slopes of Mt. Napier, with many large old trees, rocky rises and a moderately dense, moist grassy and bracken fern under-story was also quite diverse.

Transect number TR 3 had the next highest diversity ranking, positioned around a large spatter cone with a patchy under-story vegetation from grasses to dense bracken fern.

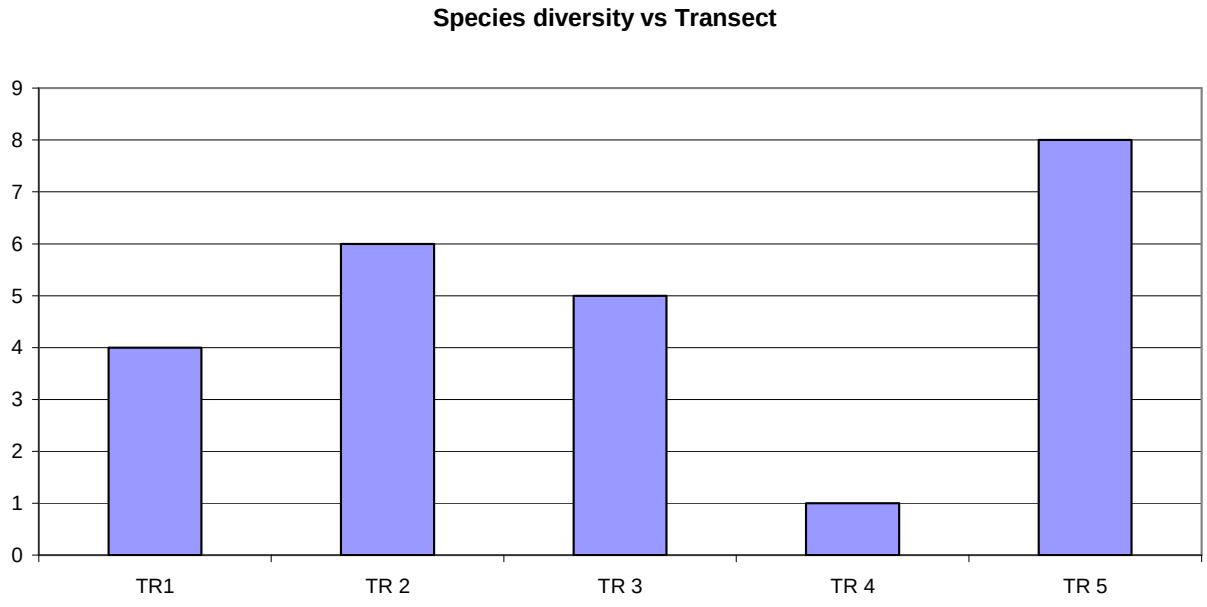


Figure 11: Species diversity versus transect line.

Transect description

Illustrated maps of the five transect line locations are shown in Figures 22, 23 and 24.

These maps were produced using GPS (Global Positioning System) way points and "Arc View" a system based on a GIS (Geographical Information System) database that is widely used in natural resource management.

Transect 1

The vegetation along TR 1, located in the northern section of the park, comprised of Manna Gum's of varied age, many had a diameter greater than 80cm as well as many large old dead and life trees. Randomly spread were pockets of Blackwood, Tree Everlasting, fallen logs and areas of dense Bracken fern as well as open grassy areas. The transect line traversed a rugged rocky rise with many depressions, canals and small rocky mounds.
Refer to figure 13.

Even thought hair-trapping success was reasonably high (70%), species diversity was restricted to four different species.
Refer to figure 12.

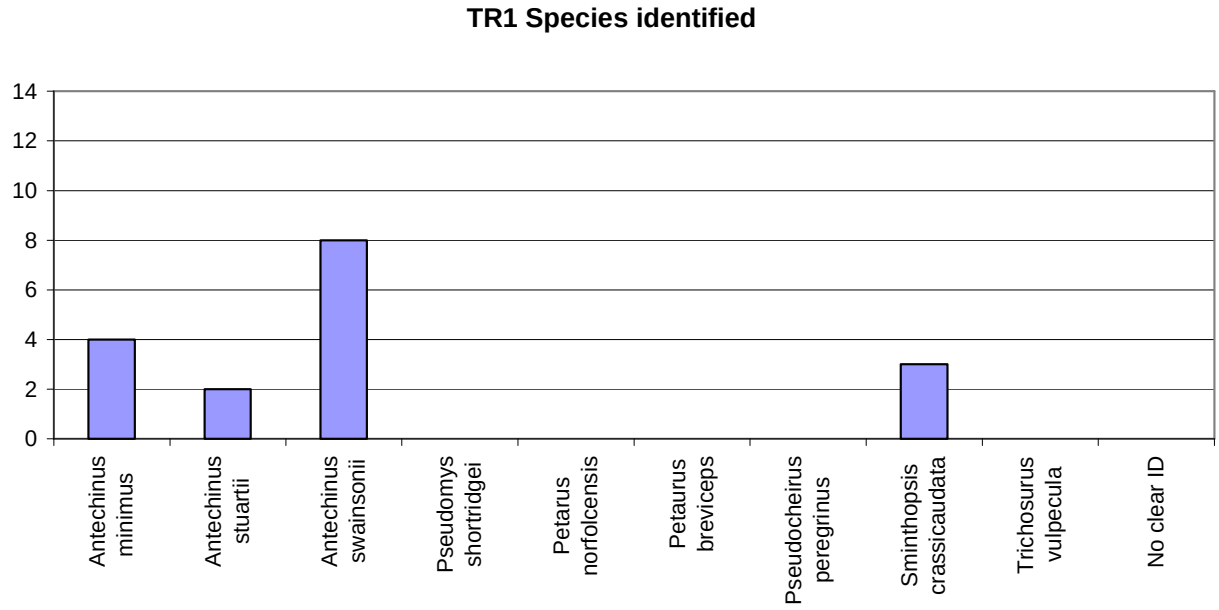


Figure 12: Species identified in TR1

Figure 13: Typical vegetation along TR1.

Figure 14: Typical vegetation along TR2.

Transect 2

The vegetation along TR 2, situated in the western slope of the actual mount, comprises of many large Manna Gum's and pockets of sizable old Blackwood's as well as some fallen trees and logs, surrounded by clusters of dense Bracken fern and open rocky rises dominated by Poa tussocks.
The transect line followed up the slope, parallel along an old man made stone wall, traversing some very rugged lava ridges and small blister caves. Many of the more shaded areas revealed a highly diverse moss and lichens community covering rocks and trunks of trees.
Refer to figure 14.

The more diverse vegetation and habitat structure is also reflected in the hair trapping success (80%) and species diversity, revealing six different species.
Refer to figure 15.

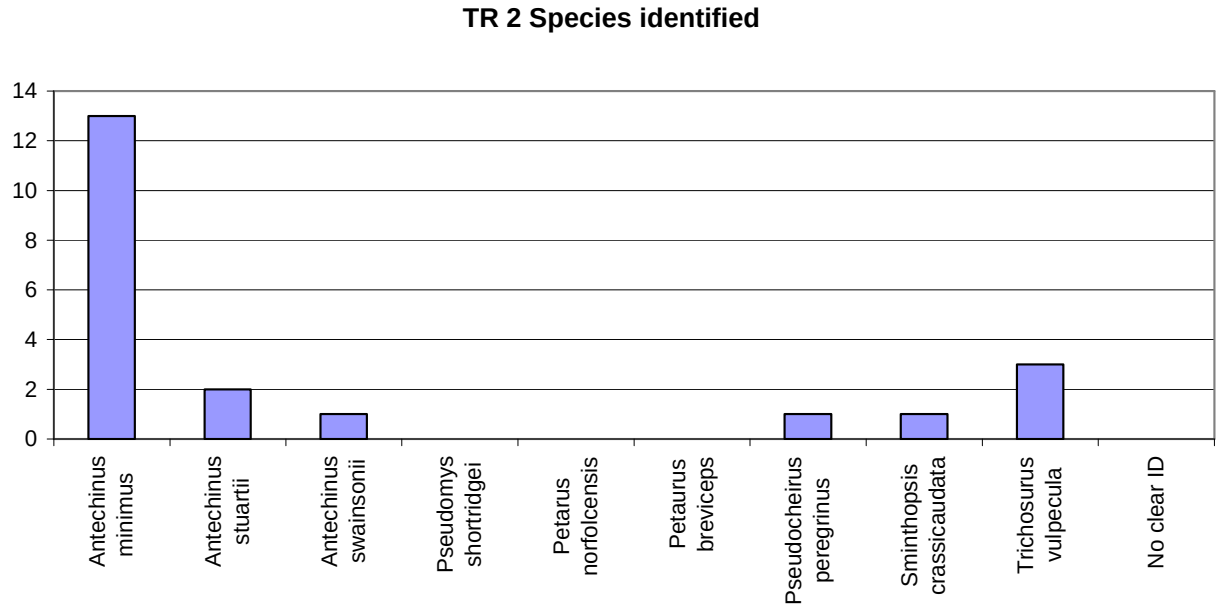


Figure 15: Species identified in TR2.

Transect 3

The vegetation along TR 3, situated in the center of the park, comprises of many young Manna Gum's, scattered trees with a diameter over 60cm and some large old live and dead hollow baring trees among which are pockets of Blackwood and some wooden debris.
There are sections of open, lightly wooded areas having many standing dead trees that are remnants of past fire events with a dense Bracken fern under story.
The transect line traverses the north-western slopes of a large spatter cone comprising of an open woodland with a lightly grassed under story.
The crater within the spatter cone reveals a well wooded vegetation with large Manna Gums and Blackwoods and increasingly dense Bracken fern toward the base of the crater.
Refer to figure 17.

Thought a geologically and vegetatively interesting transect line, hair trapping success was moderate (30%), species diversity in contrast was still high with five species including a hair sample for which no clear ID could be established.
Refer to figure 16.

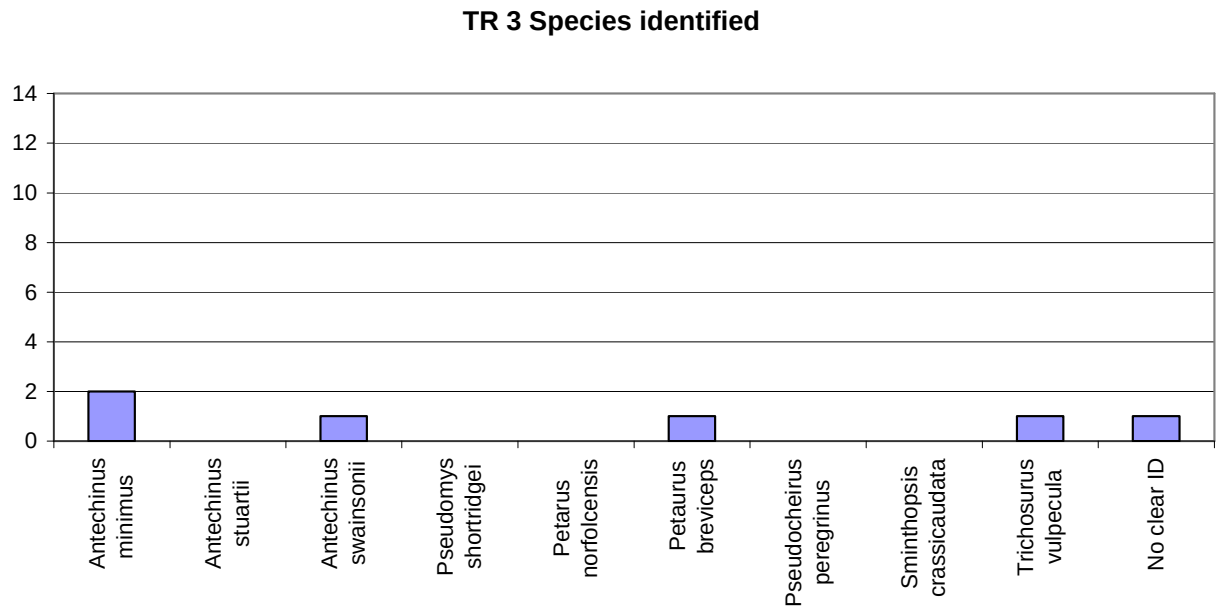


Figure 16: Species identified in TR3.

Figure 17: Typical vegetation along TR3.

Figure 18: Typical vegetation along TR4.

Transect 4

The vegetation along TR 4, the most westerly transect line, comprised of an open grassy Manna Gum woodland with pockets of Blackwood, Tree Everlasting, fallen logs and very spares Bracken fern.
The transect line traverses a very rugged stony landscape with many rocky blisters, depressions and low canals.
Refer to figure 18.

Even thought many hollow bearing trees and other shelters were present along the transect line, hair trapping success was surprisingly the lowest of all transect lines (10%), it also had the lowest species diversity, revealing only one species.
Refer to figure 19.

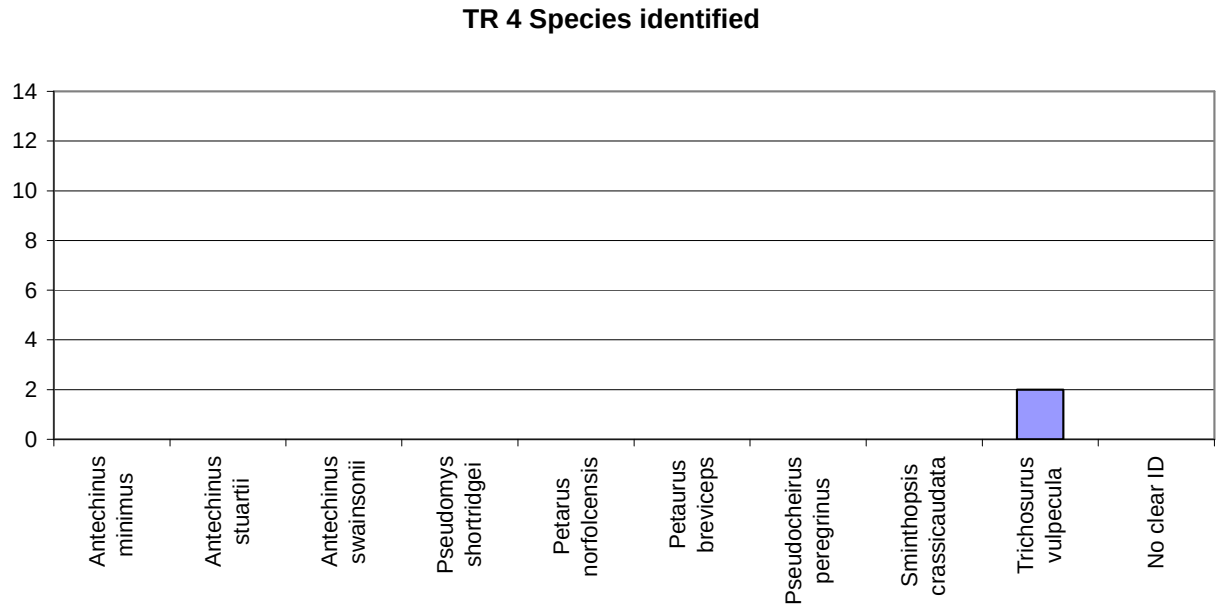


Figure 19: Species identified in TR4.

Transect 5

The vegetation along TR5, the most southerly transect line, comprised of many young Manna Gums with scattered large old trees bearing hollows, pockets of Blackwood and a dense Bracken fern understory.
The transect line followed along the edge of a rocky rise dipping to the south into a wide rocky flow with rugged rocky up dwellings and the occasional fallen tree and wooden debris. To the north the transect line was defined by a large clear area dominated by Poa tussock and scattered clumps of Tree Everlasting and Bracken fern.
Refer to figure 21.

Thought the trees and vegetation seemed rather young and appeared uniform the hair trapping success was reasonably high (70%) yielding surprisingly the highest species diversity of all transect lines with eight different species recorded.
Refer to figure 20.

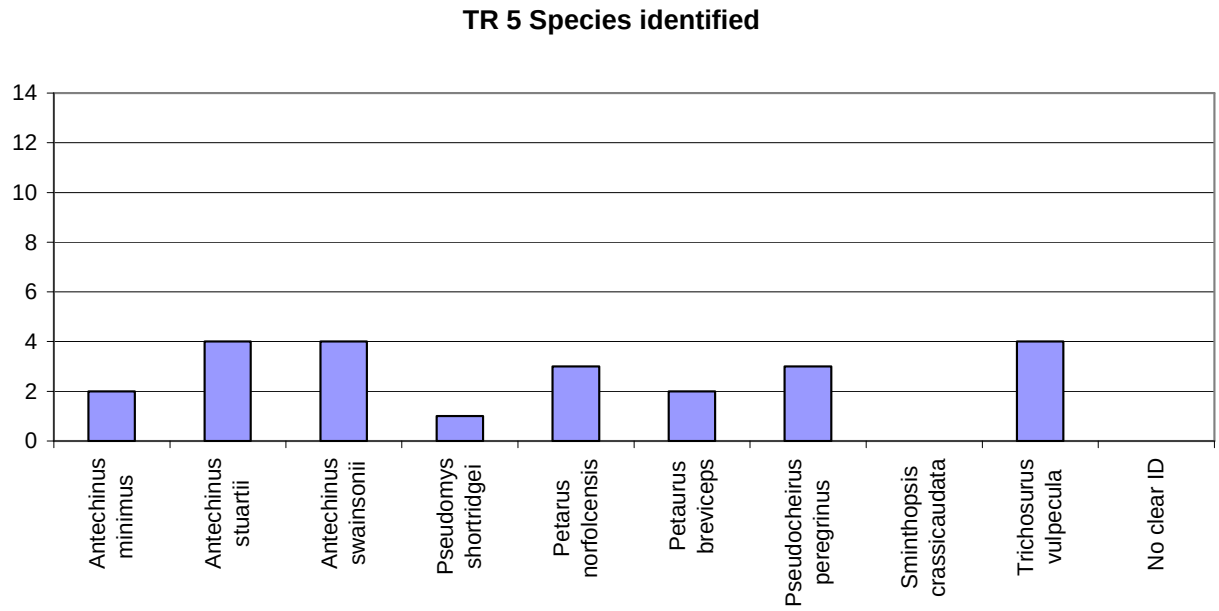


Figure 20: Species identified in TR5.

Figure 21: Typical vegetation along TR5.

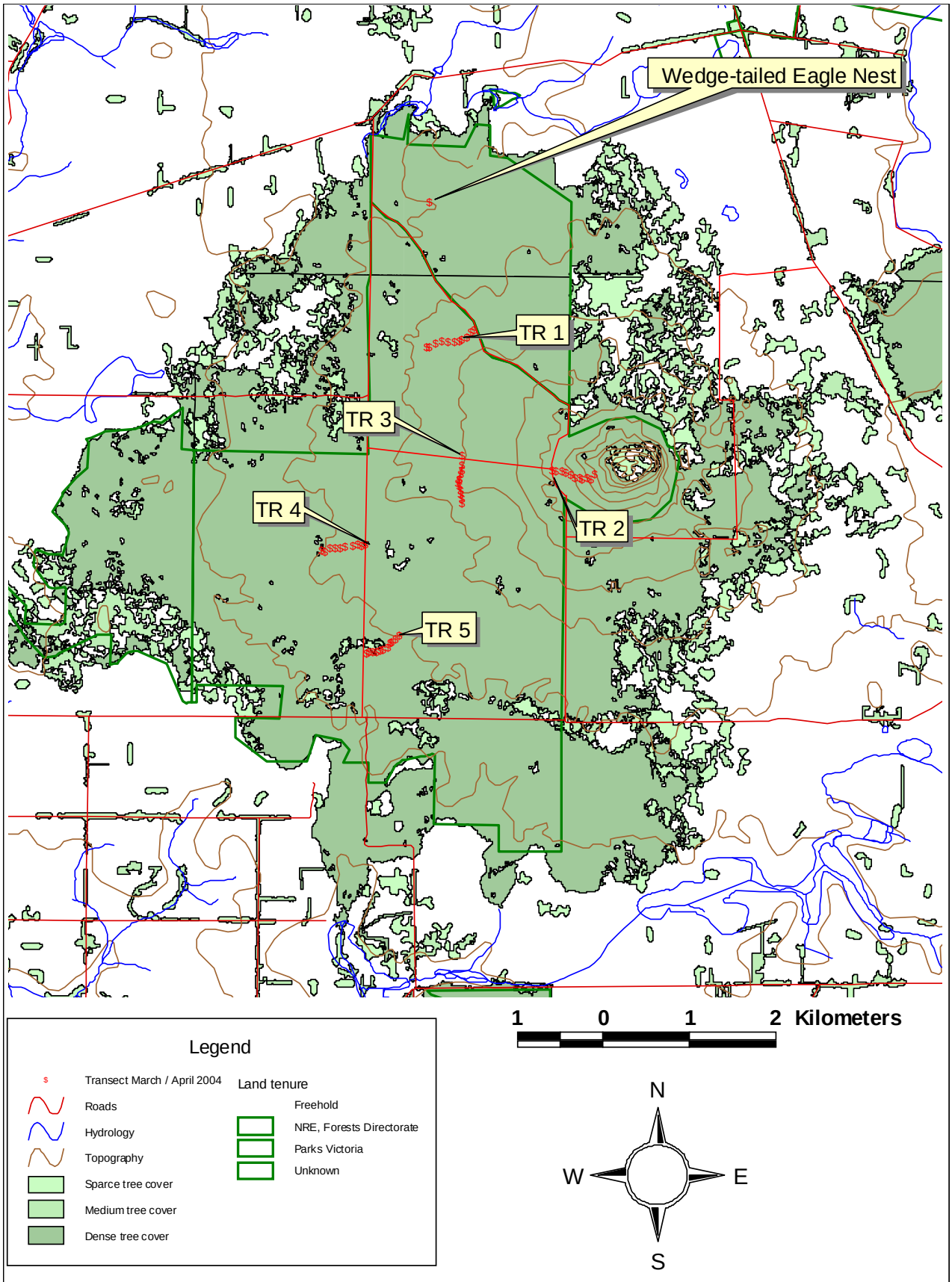


Figure 22: Topographic map showing location of survey transects.

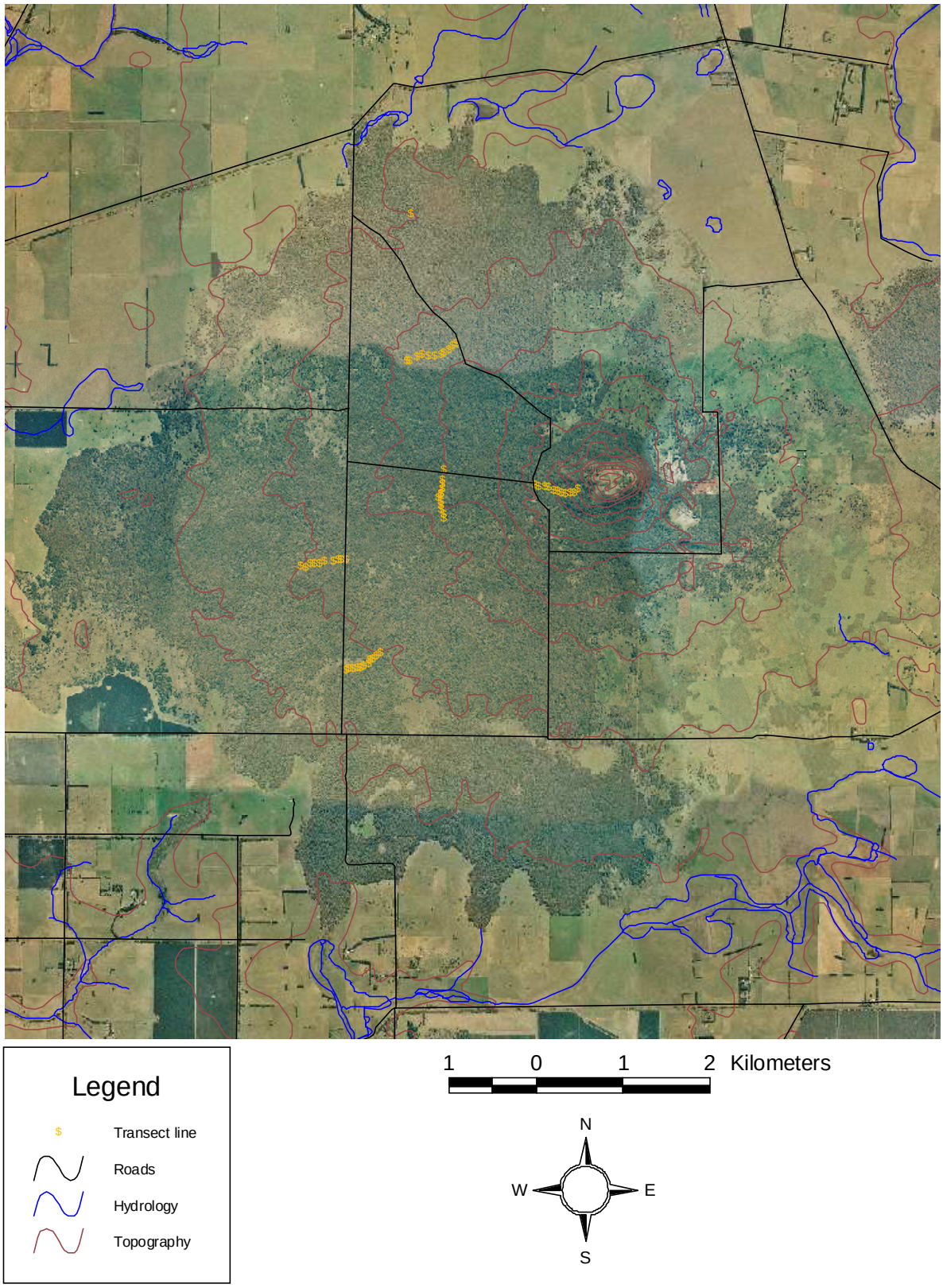


Figure 23: Aerial photo showing survey transects.

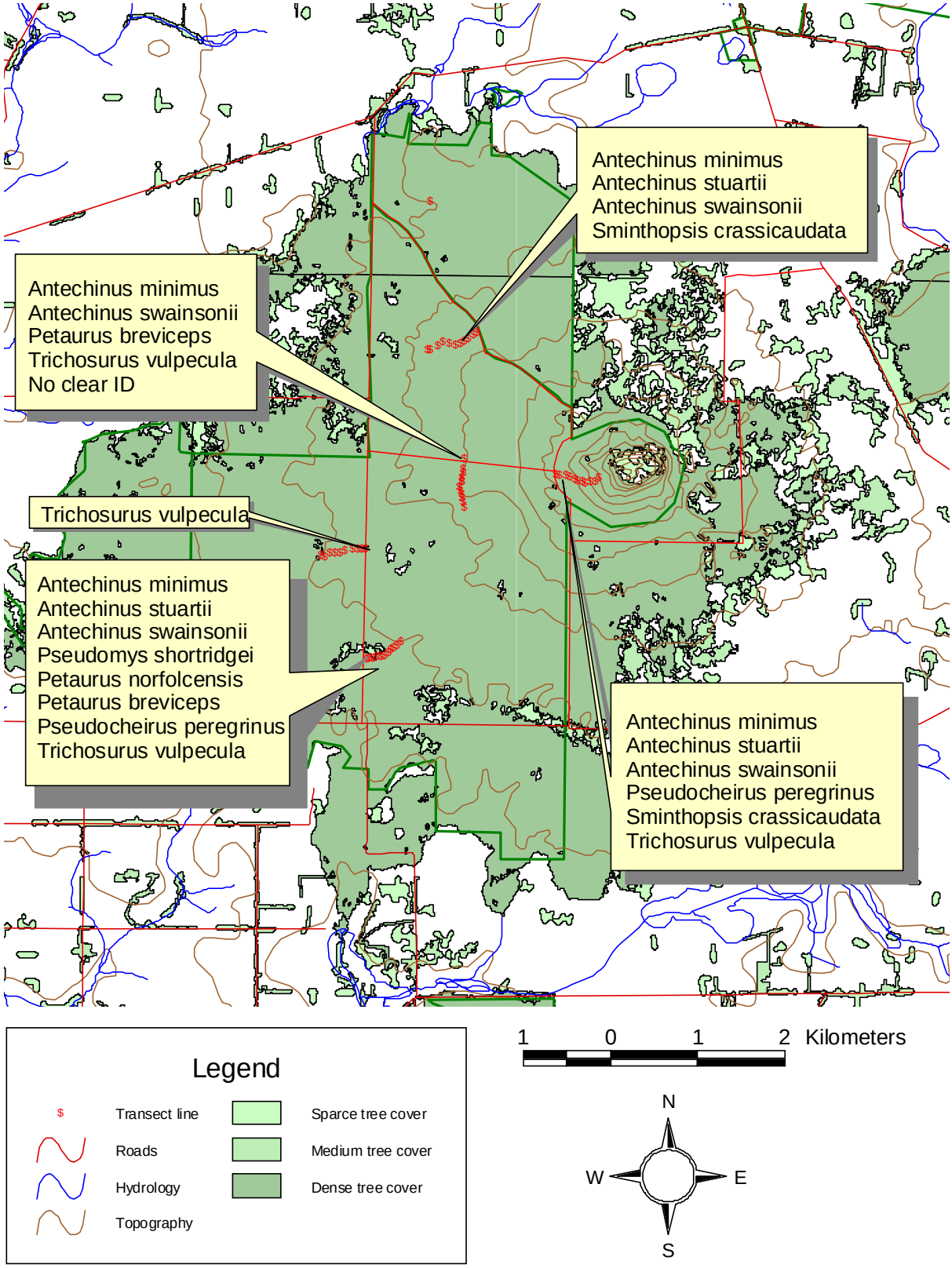


Figure 24: Topographic map showing transect lines and species identified.

Bait mix

To attract as many different species as possible, two different bait mixtures were used. Traps were ether placed on the ground or in the tree to sample different habitat types.

In 59 traps a mixture of Peanut Butter, Honey and Oats was used and in 41 traps a mixture of Sardine, Fish Oil, Oats and Flour was used.
Hair trapping success in relation to different bait mixtures revealed a 79.7% success rate in hair tubes using the Peanut Butter, Honey and Oat mix and a 56.1% success rate in hair tubes using the Sardine, Fish Oil, Oat and Flour mix. Refer to figure 25 and 26.

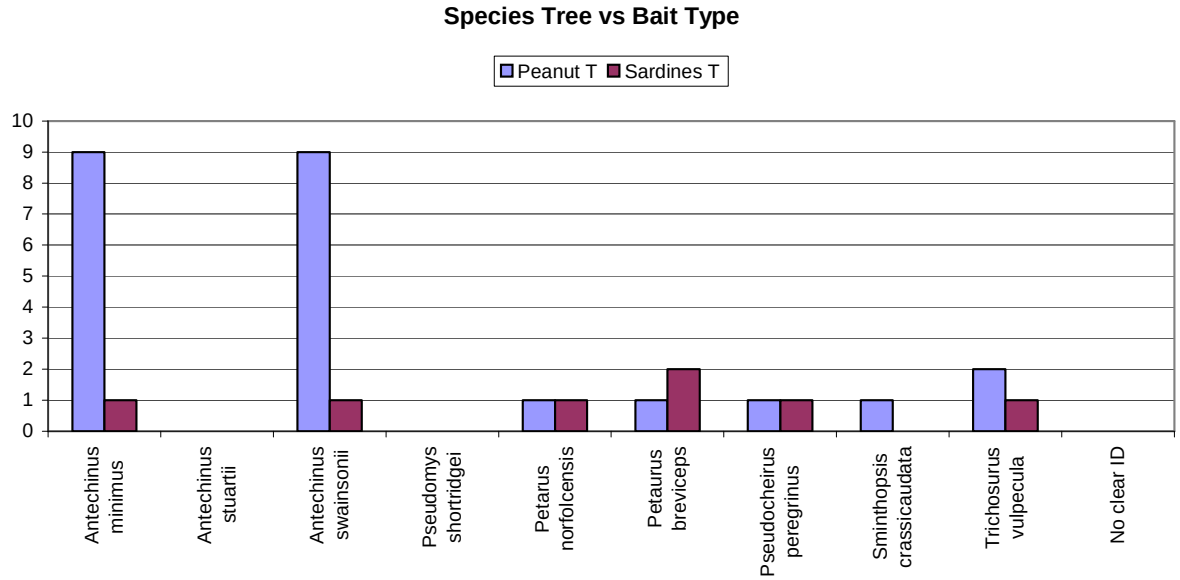


Figure 25: Species tree tubes versus bait type.

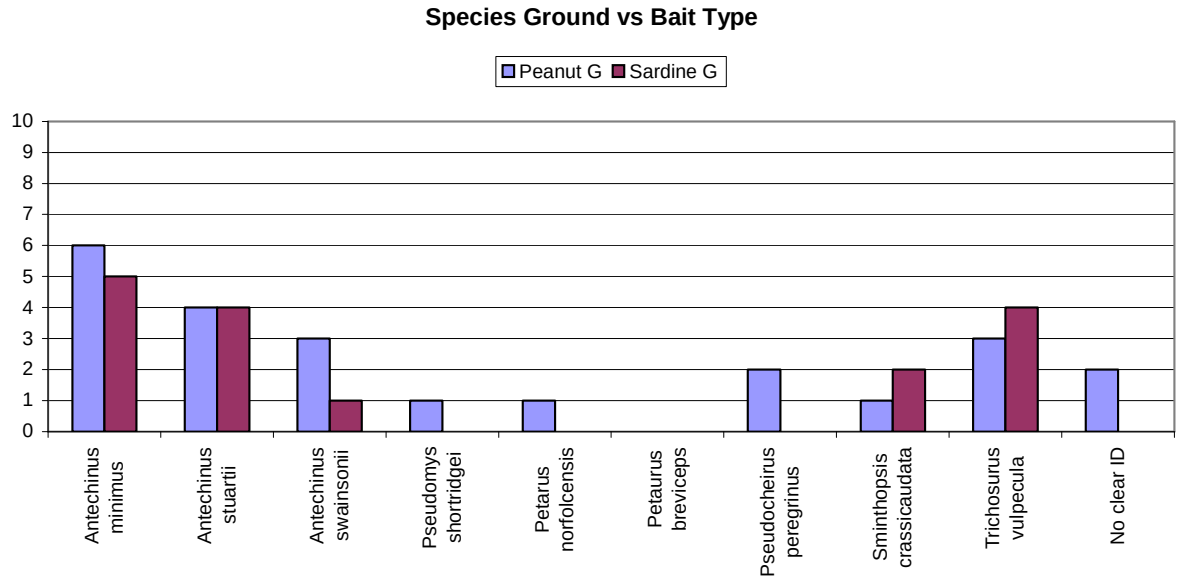


Figure 26: Species ground funnel versus bait type.

DISCUSSION

Accuracy of identification

The identification of Antechinus to species level using hair ID is difficult.
In some of the hair samples collected the Swamp Antechinus *Antechinus minimus* appeared to be the matching species. Swamp Antechinus usually occupy cool wet heathland and tussock grassland rather than dry sclerophyl woodlands such as occur at Mt Napier.
Transect number two had the greatest number of Swamp Antechinus recorded, coinsiding with vegetation of a more cool and moist plant community.
There may be a possibility of an isolated Swamp Antechinus colony persisting in that particular area but it may be a miss identification with one of the other Antechinus such as Dusky Antechinus or Agile Antechinus that are believed to occur at Mt. Napier.

The Brown Antechinus *Antechinus stuartii* may also be a miss matched species and is likely to be the Agile Antechinus *Antechinus agillis*, known to occur at Mt. Napier.
The Squirrel Glider *Petaurus norfolcensis* is another species that was possibly incorrectly identified and may be either a Sugar Glider *Petaurus breviceps* or Feather-tail Glider *Acrobates pygmaeus*.

Shortfalls experienced using the Hair ID Database were the limited number of visual examples of the medulla, scales and cross section views for some species, making it difficult to distinguish between similar species.

Hair ID depends strongly on the capture of Guard Hairs for clear identification but hair samples often contained only a few hair samples and did not necessarily include guard hairs.

To further improve accuracy of identification in the steps toward learning Hair ID it is helpful to establish a reference hair sample collection and compare own identification with that of a professional identification.

Are there Brush-tailed Phascogales ?

Unfortunately no Brush-tailed Phascogale *Phascogale tapoatafa* was identified in the initial survey between April and May 2004. Never the less hair identification alone can not rule out the presence, absence of the species.
The absence of the target species Brush-tail Phascogales may not be surprising due to their scarce distribution.

For example, quite large areas of suitable habitat such as Chiltern Box-Ironbark National Park with about 4200ha, only supports 35-50 breeding females, a density equivalent to about one female per square kilometre (Action Statement No 79, 1995).

The Brush-tailed phascogale are monoestrous meaning all male die-off at the end of the breeding season (age 11-12 month). Females generally die after weaning their young and few survive to breed in a second season (Action Statement No 79, 1997).

This breeding strategy guarantees, in an intact ecosystem, a secure supply of food for their young, but at the same time make the species prone to local and possibly regional extinction caused by loss of suitable habitat.

The frequent fire history up until about 1980 as well as past grazing management of Mt Napier would have had an impact on species such as the Brush-tailed Phascogale *Phascogale tapoatafa* or the Spotted-tailed Quoll *Dasyurus maculatus*.
The extensive clearing and modification of the remnant vegetation for agricultural purposes left Mt Napier as a fragmented island with only a view disjointed wildlife corridors to allow species migration from other remnant areas.
These and other factors could also explain the absence of species that require large areas to forage or are subject to predation and changed in habitat quality.

The result of the survey were still significant considering that the hair samples revealed the presence of several other listed species such as the Fat-tailed Dunnart *Sminthopsis crassicaudata*.
The fact that there were no introduced species found such as House Mouse indicates a more or less functional habitat.

Foxes and feral cats are thought to be present and a sighting of a feral cat during field work confirms their presence, but non of those species were found in the hair samples. Consulting with DSE staff, having many years of experience in mammal survey, revealed that Foxes are very trap shy and seldom found in hair samples.

Further investigation

In the initial planning of the project two hair trapping sessions were planned.
The second trapping session, based on findings during the first trapping, was conducted between September and October 2004 using 60 Hair traps along three transect lines.
One transect line (TR 6) existing of 20 funnel and tube traps was placed about one kilometer to the north of the initial TR1 transect in a section previously not covered.
Two transect line (TR 7 & TR 8) consisting of 40 funnel and tube traps was placed within TR5 transect which had yielded the most diverse species range. The traps were laid out as a cross heading north–south and east–west basing TR5.8 in the center of it.
Refer to Appendix XIV
The trapping success evaluation of the second trapping exercise revealed that out of 60 hair tubes an average of 75% had hair samples. The success rate varied from 60% to 85% of hair tubes having samples, considerably higher compared with the first trapping exercise. Refer to table 3.

Transect No.	**Hair %**	**Hair yes**	**Hair no**
TR 6	60	12	8
TR 7	80	16	4
TR 8	85	17	3
Average	75		

Table 3: Percentage of hair in each transect line

Due to time constraints the results of the second hair trapping attempt could not be included in these paper.

An alternative low intrusive fauna survey technique.

Of the several survey methods used for fauna surveys, the use of artificial nest boxes is the most efficient for locating Brush-tailed Phascogals and is most useful for long-term monitoring of the species.
This method has successfully been used by the FSG (Fauna Survey Group) of the FNCV (Field Naturalists Club of Victoria).
The FSG conducted regular surveys of the Rushworth Forest from June 1994 to March 2001 on a four to six monthly basis using a combination of trapping, spotlighting and nestbox inspections. The six year study showed that Phascogales were mainly found using nestboxes in the absence of suitable natural hollows (S. Dashper & S. Myers 2003).

An alternative techniques for Hair analysis.

Traditional methods of identifying hairs use light microscopy to determine morphological characters typical of the species (Brunner and Coman 1974). However, very few people within Australia have the expertise to identify hairs consistently and correctly from marsupials (e.g. Barbara Triggs, Genoa, Victoria).
Dasyurids are known to be difficult to identify by microscopic hair analysis due to either morphological similarity of hairs from different species or due to the varieties of the types of hairs collected (guard hairs v. undercoat hairs v. vibrissae, etc.). Similarly, the presence of scats, or faecal material, at field sites may indicate the presence of rare species. However, it is often difficult to identify scats to the species level based upon their morphological characteristics alone.
Genetic identification of hairs or faecal samples using molecular forensic techniques and mtDNA loci, which show fixed differences between species (Firestone 2000), could provide a cost-effective, accurate and definitive means of overcoming problems using traditional identification methods.
These emerging techniques could not only be used to accurately determine presence / absence of species but also potentially identify sex and genotype individuals for conservation management (Firestone 2003).

These could be a possible future direction in hair analysis that delivers much more accurate results using modern mtDNA loci techniques. Thougt this still requires expensive laboratory equipment which is most likely out of reach for many volunteer groups attempting their own Hair analysis.

Costs and time

Costs

Purchase of Hair ID CD ROM by TAFE	$195	one off purchase
Purchase of Hair funnels by HFNC, 50 x $10.83	$ 541.50	one off purchase
Wafers (sticky stuff for funnels) 90 x $1.72	$ 154.80	
Special equipment (Metal slides, rayon)	$47.00	
Travel (six return trips to Mt Napier) 180km x $ 0,50	$ 90.00	
Miscellaneous (bait mix scissors tweezer)	$ 59.70	
TOTAL Cost (approximately)	$ 1088.00 +	

Time

Preliminary field trip	6 hours
Preparation and organisation	8 hours
Setting and collecting of hair funnels	32 hours
Hair analyses (considering learning of technique)	64 hours
Preparing report	90 hours +
Learning Arc View system	12 hours
TOTAL Time (approximately)	212 hours +

ACKNOWLEDGEMENTS

Thanks to everyone involved assisting in the project, especially:

My wife Yvonne Ingeme for her support and helping with preparation, field work, review of the paper, teaching Arc View and professional advice in her capacity as a Flora and Fauna officer with DSE Hamilton. Ken Grimes for helping in field getting leached. Hamilton Field Naturalists Club for generously supporting the purchase of 50 Hair Funnels. TAFE South West for lending of equipment necessary for Hair ID.
Geoff Sharrok senior Ranger at Mt.Eccles for support, Andrew Arnold Flora and Fauna with DSE Balarat for hints and tips in trapping Phascogales and providing a photo of the animal, DPI & DSE Hamilton for allowing me to use various equipment as well as the use of a color printer.

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APPENDIXES

Appendix I

History of hair analysis
Description taken from Triggs, Brunner, Ecobyte Pty Ltd and CSIRO (2002)

Originally, the main purpose for hair identification in Australia was to study the diet of predators such as foxes, wild dogs, feral cats and raptor birds, This was done by examining hairs found in stomachs, scats and pellets.
Hair identification has also played some part in the field of forensic science and the policing of wildlife laws.

One of the earliest Australian references that attempts to use hair analysis as a diagnostic tool to identify mammal species is a study by Lynne and McMahon (1951). Prior to this, research of hair structure focused on the monotremes e.g. Hausman 1920, Wildman and Mangy 1938.
Seebeck (1964) developed a key for the Victorian muridae based on the characters of the guard hairs.

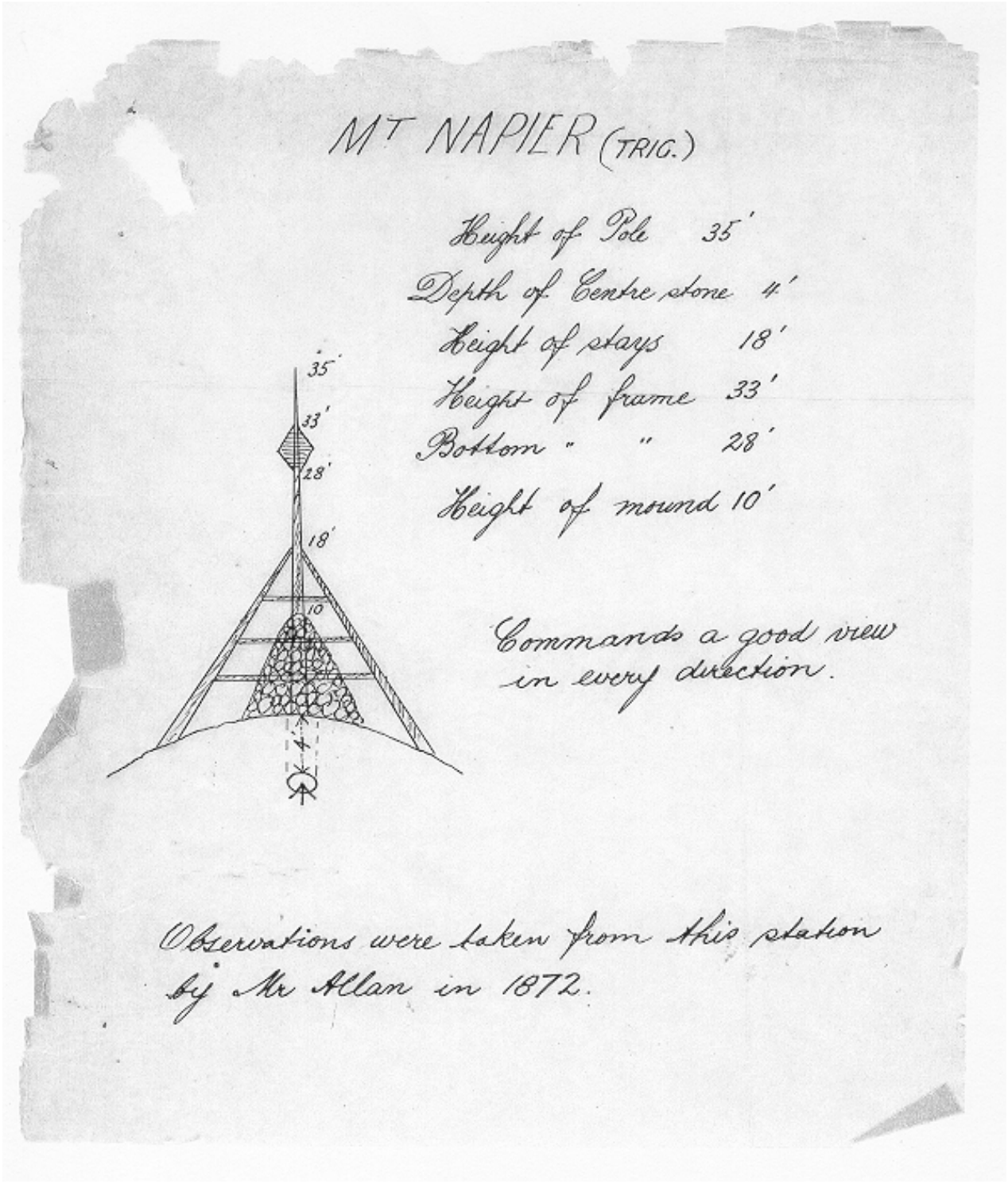
But it was not until the publication of “The Identification of Mammalian Hair” (Brunner and Coman 1974) introducing a sophisticated technique for the identification of species hair. This book provided the first photographic reference of indigenous and introduced mammals occurring in south-eastern Australia.

Subsequent hair identification papers of mammals of southern Western Australia by Valente and Woolley in 1982 and Tasmania by Taylor in 1985 followed the methods described by Brunner and Coman (1974)

The Hair ID database has been designed around identification keys adapted from those developed by Brunner and Coman (1974). Species have been keyed into the database based on their known hair characteristics and distribution ranges.

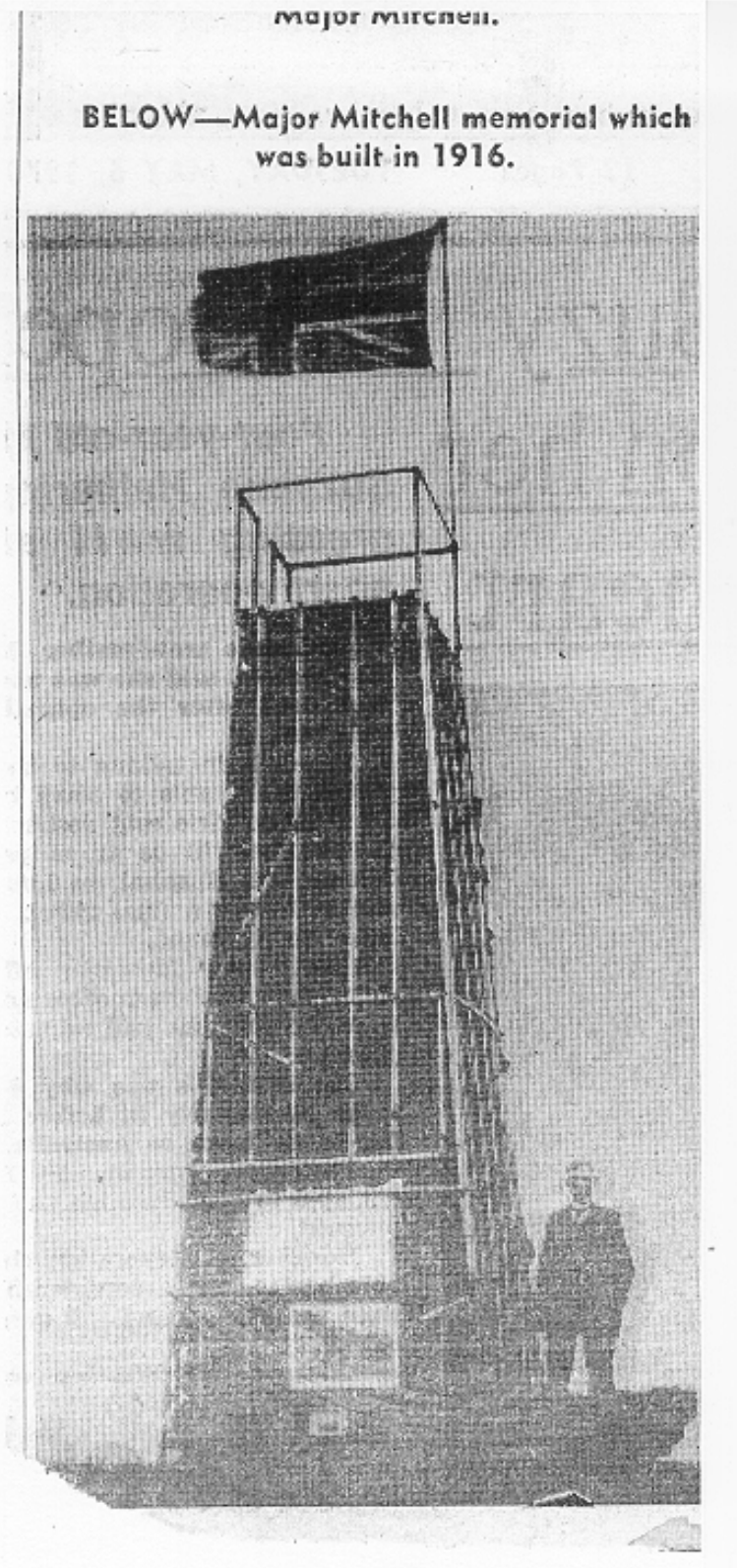
Appendix II

A copy, showing original sketch of the Mt. Napier Trigonometrical station.
(Mt Napier Departmental File)



Appendix III

Old photograph of Major Mitchell memorial built on top of Mt. Napier in 1916. (Mt Napier Departmental File)



Appendix IV

News paper article printed in the Hamilton Spectator in November 1965. (Mt Napier Departmental File)

The Hamilton Spectator
EST. 1859

16 Pages TUESDAY, NOVEMBER 23, 1965 Price 6d

FIRE DESTROYS 1,000 ACRES OF SCRUB COUNTRY

Fire has burnt about 1,000 acres of scrub and waste land at Mt. Napier and is still burning.

Reports late last night said the fire had not caused damage to any private property and fire brigades expected to have it under control this morning.

Almost the whole of the south-eastern side of Mt. Napier has been burnt and the fire has gone around to the northern side.

It is burning in an inaccessible area. Fire brigade members have tried to make sure that outbreaks do not spread to grazing land rather than go into the mountain to fight the fire.

The fire started on Sunday afternoon.

Country Fire Authority officer at Hamilton Mr. J. Morris said last night he strongly suspected the fire started from burning off which got out of control.

But there is a possibility that the fire was caused by a match thrown carelessly into some bracken.

Mr. Morris said the nearest grazing properties were a considerable distance from the fire.

Although brigade members expected to have it out today a strong north wind and hot weather could greatly increase the danger of it spreading.

Until the fire spreads away from the mountain there is little chance of fire brigades putting it out.

The Forests Commission has been experimenting with aircraft which would "bomb" fires with chemicals and water but none of their aircraft are stationed in this district.

Gazette and Buckley Swamp Rural Fire Brigades have been keeping an eye on the fire's progress.

Mr. Morris has warned of the danger of fires in the summer season which is approaching.

He said: "People must be careful and realise that the summer fire season is not far off."

RJ1706

Reserves Branch

Appendix V

News paper article featuring the proposal for a public reserve at Mt. Napier. (Mt Napier Departmental File)

• *Field naturalists are concerned that little of the Western plains have been reserved as parkland. Here reporter James Mulcahy looks at plans for a public reserve at Mt. Napier.*

Don't mow trees down—go around them

Field naturalist, Mr. Lionel Elmore, has proposed a 4000-acre public reserve at Mt. Napier.

Mr. Elmore envisages a natural museum, camping facilities, roads, flora and fauna sanctuary and a staff consisting of a ranger, biologists, geologists, anthropologists and technicians.

"Great care would have to be taken when establishing the reserve," he said.

"The roads would have to be carefully designed to fit in with the natural landscape.

"This would mean instead of mowing down a tree you go around it!" he added.

A mixture

Mr. Elmore said any buildings erected would be made out of local material and placed in such a position that they would blend in with the surroundings.

"What better place for a natural museum than in a bush setting" he said.

"To be viable it would have to have a mixture of items that could serve the whole of the region.

"The museum would also be of great educational value to school children," he added.

Wealth of interest

Mr. Elmore said children travel hundreds of miles to see the Melbourne museum and more than 100 daily pass through its doors.

"Already there has been a wealth of interest in the basalt and fossil beds at Yulecart," he said.

"About a year ago 50 scientists from all over the world visited the Mt. Napier area to study the soils and their formation.

"Soil is becoming increasingly important in agriculture and so displays on soil types would be of great benefit to farmers and students," he added.

Mr. Elmore said there were aboriginal camps on the proposed reserve and these were more than 1000 years old. He has had them marked out.

He would like to see animals like kangaroos and koalas brought into the reserve.

Tiger cats?

"There have been many reports of tiger cats in the area so if they can live in this terrain it would be suitable for other animals," he said.

The main area of the proposed reserve is Crown land and forest reserve so negotiations would mainly concern these two.

"Very little of the Western plains has been reserved so it is about time we started," he said.

Appendix VI

Subset flora species list

	Family	Scientivic name	Common name
Mosses	Bartramiaceae	Breutelia affinis Philonotis tenuis	Common Breutelia Apple Moss
	Brachytheciaceae	Rhynchostegiella muriculata	Feather Moss
	Fabroniaceae	Fabronia australis	Fringe Moss
	Fissidentaceae	Fissidens curvatus Fissidens leptocladus Fissidens megalotis Fissidens taylorii	Portuguese Pocket-moss Limestone Pocket-moss Curly Pocket-moss Pygmy Pocket-moss
	Hedwigiaceae	Hedwigia ciliata	Grey Hoar-moss
	Hypopterygiaceae	Hypopterygium muelleri Lopidium concinnum	Umbrella Moss Fern Moss
	Meesiaceae	Leptobryum pyriforme	Golden Thread-moss
	Mniaceae	Pohlia nutans	Nodding Thread-moss
	Pottiaceae	Triquetrella papillata	Common Twine-moss
Ferns and Fern-like Plants	Adiantaceae	Adiantum aethiopicum	Common Maidenhair
	Aspleniaceae	Asplenium flabellifolium	Necklace Fern
	Dennstaedtiaceae	Pteridium esculentum	Austral Bracken
Monocotyledons	Cyperaceae	Carex breviculmis Isolepis platycarpa	Common Grass-sedge Broad-fruit Club-sedge
	Orchidaceae	Dipodium campanulatum Dipodium punctatum s.l.	Bell-flower Hyacinth-orchid Hyacinth Orchid
	Poaceae	Austrodanthonia duttoniana Austrodanthonia laevis Austrodanthonia racemosa var. racemosa Dichelachne crinita Dichelachne rara Echinopogon ovatus Eragrostis brownii Hemarthria uncinata var. uncinata Lachnagrostis filiformis Microlaena stipoides var. stipoides Pentapogon quadrifidus Poa ensiformis Poa labillardierei var. labillardierei	Brown-back Wallaby-grass Smooth Wallaby-grass Stiped Wallaby-grass Long-hair Plume-grass Common Plume-grass Common Hedgehog-grass Common Love-grass Mat Grass Common Blown-grass Weeping Grass Five-awned Spear-grass Sword Tussock-grass Common Tussock-grass
Dicotyledons	Asteraceae	Cassinia longifolia Cymbonotus preissianus Euchiton collinus s.l. Euchiton collinus s.s. Euchiton involucratus s.l. Ozothamnus ferrugineus Picris spp. Senecio glomeratus Senecio pinnatifolius Senecio quadridentatus Taraxacum spp.	Shiny Cassinia Austral Bear's-ear Clustered/Creeping Cudweed Creeping Cudweed Common Cudweed Tree Everlasting Picris Annual Fireweed Variable Groundsel Cotton Fireweed Dandelion
	Boraginaceae	Cynoglossum suaveolens	Sweet Hound's-tongue
	Campanulaceae	Wahlenbergia communis s.s.	Tufted Bluebell
	Chenopodiaceae	Einadia nutans ssp. nutans	Nodding Saltbush
	Clusiaceae	Hypericum japonicum	Matted St John's Wort
	Crassulaceae	Crassula sieberiana	Sieber Crassula
	Euphorbiaceae	Poranthera microphylla	Small Poranthera
	Fabaceae	Cullen microcephalum	Dusky Scurf-pea
	Geraniaceae	Geranium potentilloides Geranium sp. 4	Cinquefoil Cranesbill Rough Cranesbill
	Lamiaceae	Ajuga australis	Austral Bugle
	Mimosaceae	Acacia melanoxylon	Blackwood
	Myrtaceae	Eucalyptus viminalis Eucalyptus viminalis ssp. cygnetensis Eucalyptus viminalis ssp. viminalis	Manna Gum Rough-barked Manna-gum Manna Gum
	Onagraceae	Epilobium hirtigerum	Hairy Willow-herb
	Oxalidaceae	Oxalis exilis	Shady Wood-sorrel
	Polygonaceae	Rumex brownii	Slender Dock
	Ranunculaceae	Clematis microphylla Ranunculus pumilio	Small-leaved Clematis Ferny Small-flower Buttercup
	Rosaceae	Acaena echinata Acaena novae-zelandiae	Sheep's Burr Bidgee-widgee
	Rubiaceae	Galium migrans	Wandering Bedstraw
	Scrophulariaceae	Derwentia derwentiana ssp. derwentiana	Derwent Speedwell
	Violaceae	Viola hederacea sensu Entwisle (1996)	Ivy-leaf Violet

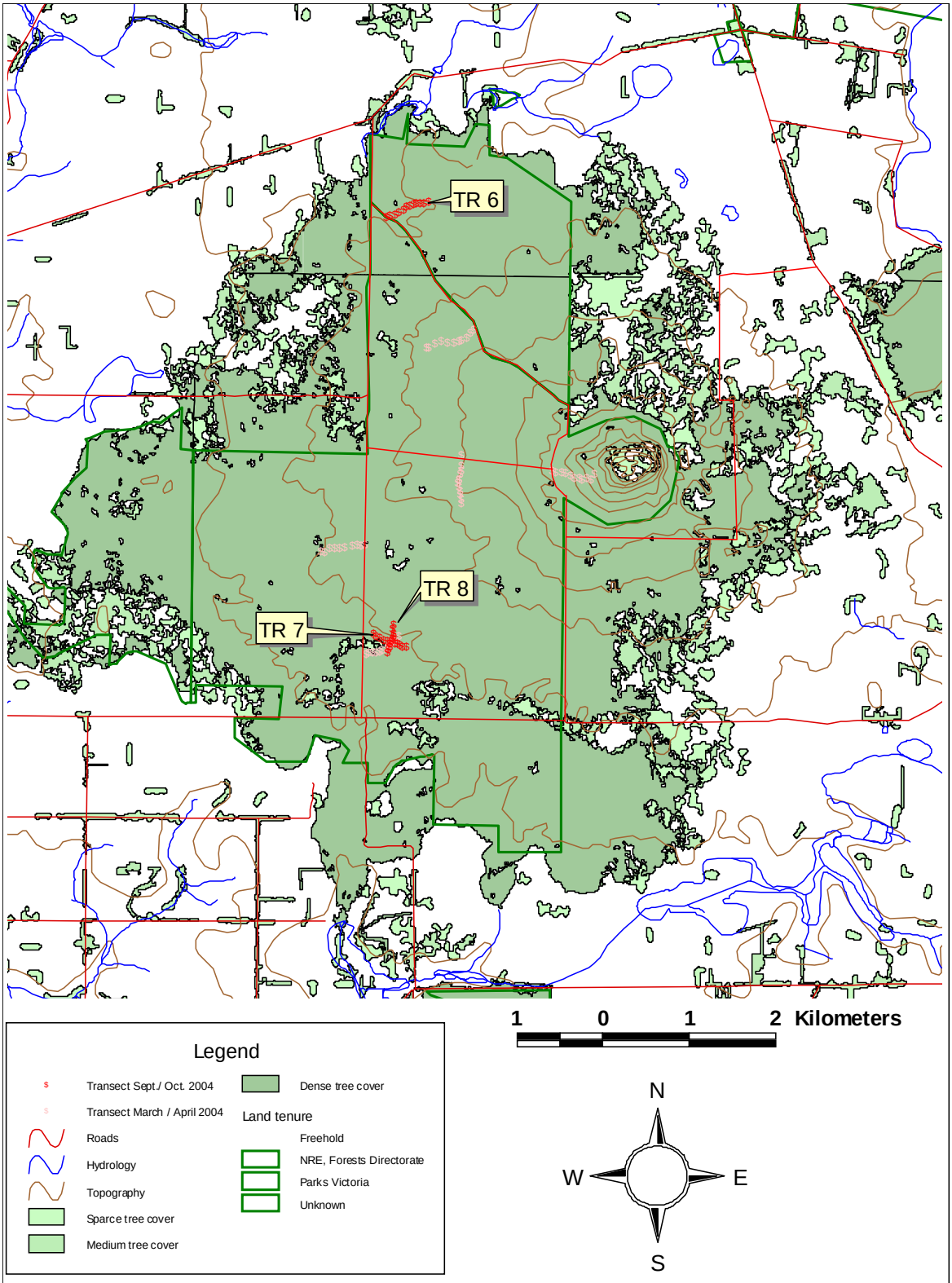
Appendix VII

Subset fauna species list

	Family	Scientivic name	Common name
Mammals	Dasyuridae - Dasyurids	Agile Antechinus Dusky Antechinus	Antechinus agilis Antechinus swainsonii
	Muridae - Rats/Mice	Bush Rat Swamp Rat Water Rat	Rattus fuscipes Rattus lutreolus Hydromys chrysogaster
	Phalangeridae - Brushtail Poss	Common Brushtail Possum	Trichosurus vulpecula
	Phascolarctidae - Koala	Koala	Phascolarctos cinereus
	Vespertilionidae - Small Bats	Chocolate Wattled Bat Common Bent-wing Bat Gould's Long-eared Bat Gould's Wattled Bat Large Forest Bat Lesser Long-eared Bat Little Forest Bat Southern Forest Bat unidentified Eptesicus	Chalinolobus morio Miniopterus schreibersii Nyctophilus gouldi Chalinolobus gouldii Vespadelus darlingtoni Nyctophilus geoffroyi Vespadelus vulturnus Vespadelus regulus Eptesicus sp.
Birds	Accipitridae - Eagles/Hawks/Ki	Grey Goshawk Wedge-tailed Eagle	Accipiter novaehollandiae Aquila audax
	Anatidae - Ducks/Swans	Australian Shelduck Black Swan Pacific Black Duck	Tadorna tadornoides Cygnus atratus Anas superciliosa
	Ardeidae - Herons/Egrets/Bitte	White-faced Heron	Egretta novaehollandiae
	Artamidae - Woodswallows/Magpi	Australian Magpie Grey Currawong	Gymnorhina tibicen Strepera versicolor
	Cacatuidae - Cockatoos	Long-billed Corella Sulphur-crested Cockatoo	Cacatua tenuirostris Cacatua galerita
	Charadriidae - Plovers/Dottere	Masked Lapwing	Vanellus miles
	Climacteridae - Tree-creepers	White-throated Treecreeper	Cormobates leucophaeus
	Corvidae - Ravens/Crows	Australian Raven Corvid Little Raven	Corvus coronoides Corvus sp. Corvus mellori
	Cuculidae - Cuckoos	Fan-tailed Cuckoo	Cacomantis flabelliformis
	Dicruridae - Flycatchers/Fanta	Grey Fantail Willie Wagtail	Rhipidura fuliginosa Rhipidura leucophrys
	Falconidae - Falcons	Brown Falcon	Falco berigora
	Halcyonidae - Inland Kingfishe	Sacred Kingfisher	Todiramphus sanctus
	Hirundinidae - Swallows/Martin	Welcome Swallow	Hirundo neoxena
	Maluridae - Fairy-wrens	Superb Fairy-wren	Malurus cyaneus
	Meliphagidae - Honeyeaters/Cha	New Holland Honeyeater Red Wattlebird White-eared Honeyeater White-naped Honeyeater Yellow-faced Honeyeater	Phylidonyris novaehollandiae Anthochaera carunculata Lichenostomus leucotis Melithreptus lunatus Lichenostomus chrysops
	Motacillidae - Wagtails/Pipits	Richard's Pipit	Anthus novaeseelandiae
	Neosittidae - Sittellas	Varied Sittella	Daphoenositta chrysoptera
	Pachycephalidae - Whistlers	Golden Whistler Grey Shrike-thrush	Pachycephala pectoralis Colluricincla harmonica
	Pardalotidae - Pardalotes/Thor	Brown Thornbill Spotted Pardalote Striated Pardalote Striated Thornbill White-browed Scrubwren	Acanthiza pusilla Pardalotus punctatus Pardalotus striatus Acanthiza lineata Sericornis frontalis
	Passeridae - Sparrows/Grass-fi	Red-browed Finch	Neochmia temporalis
	Petroicidae - Robins	Eastern Yellow Robin Pink Robin Scarlet Robin	Eopsaltria australis Petroica rodinogaster Petroica multicolor
	Phasianidae - Pheasants/Quails	Stubble Quail	Coturnix pectoralis
	Podicipedidae - Grebes	Hoary-headed Grebe	Poliocephalus poliocephalus
	Psittacidae - Parrots/Lorikeet	Crimson Rosella Purple-crowned Lorikeet	Platycercus elegans Glossopsitta porphyrocephala
	Rallidae - Rails/Crakes/Swamph	Eurasian Coot Purple Swamphen	Fulica atra Porphyrio porphyrio
	Threskiornithidae - Ibis/Spoon	Yellow-billed Spoonbill	Platalea flavipes
	Zosteropidae - Silvereyes	Silvereye	Zosterops lateralis

Appendix VIII

Topographical map showing transects location during second hair trapping exercise between September and October 2004.



EXTENDED APPENDIX

Results of Second Trapping Session

September – October 2004

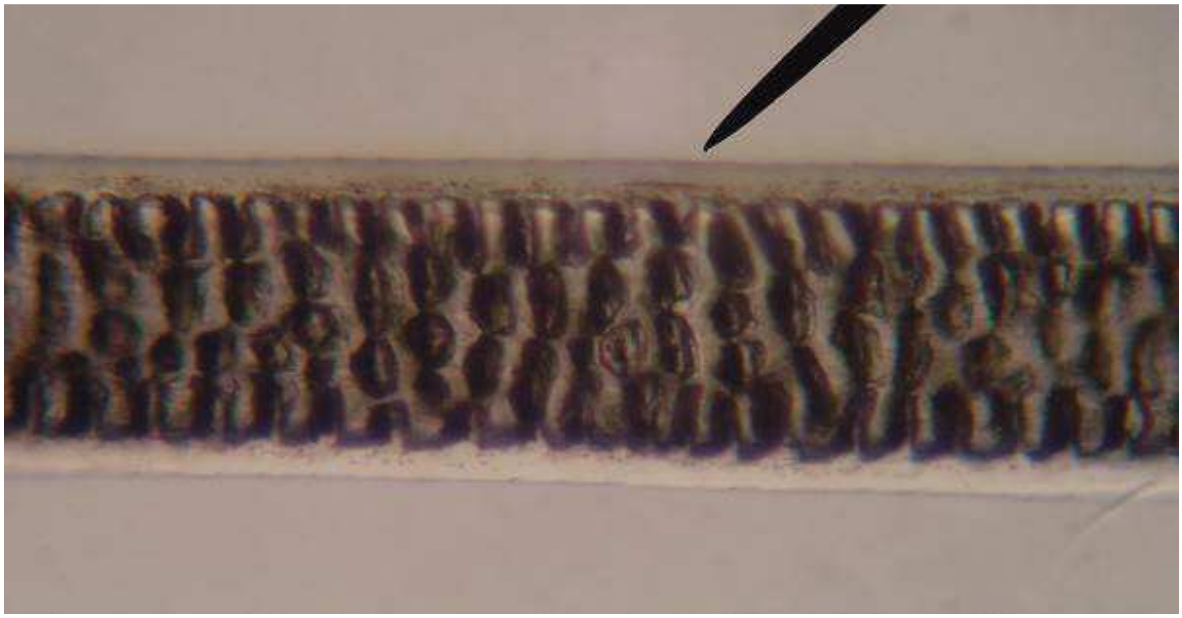


Photo: Medulla of Swamp Rat guard hair as seen through the light microscope.

A practical study, learning to apply the Hair Trapping and Identification Technique, to help determine presence, absence of Brush-tailed Phascogales *Phascogale tapoatafa* in Mt. Napier State Park, Victoria

R.P. Zollinger

March 2005

RESULTS OF SECOND TRAPPING SESSION

The second trapping session, based on findings during the first trapping, was conducted between September and October 2004 using 60 Hair traps along three transect lines.
Refer to Appendix XIV.

Trapping success

The trapping success evaluation of the second trapping exercise revealed that out of 60 hair tubes an average of 75% had hair samples. The success rate varied from 60% to 90% of hair tubes having samples, considerably higher compared with the first trapping exercise.
Refer to table I.

Transect No.	Hair %	Hair yes	Hair no
TR6	60	12	8
TR7	75	15	5
TR8	90	18	2
Average	75		

Table I: Percentage of hair in each transect line

Species identified

Species identified using the light microscopy method in conjunction with the Hair ID data base revealed 7 different species of which 3 have not been recorded in the previous data. Thought the Agile Antechinus could have been mistaken with one of the other antechinus species and one could be confirmed as being Swamp Rat rather than Heath Mouse.
No species identified is listed in the Advisory list of threatened vertebrate fauna in Victoria 2003.
Unfortunately, still no hair sample collected revealed the presence of the Brush-tailed Phascogale.
Refer to table II.

Species moderately conclusive identified

Scientific name	Common name	Conservation Status (Vic)
Antechinus agilis	Agile Antechinus	N/A
Antechinus swainsonii	Dusky Antechinus	N/A
Petaurus breviceps	Sugar Glider	N/A
Pseudocheirus peregrinus	Common Ringtail Possum	N/A
Trichosurus vulpecula	Common Brushtail Possum	N/A
Wallabia bicolor	Swamp Wallaby	N/A
Rattus lutreolus	Swamp rat	N/A

Table II: Species identified in hair samples

Species most common

The species most commonly identified was the Common Brush-tailed Possum followed by the Antechinus. Less common were the Common Ring-tailed Possum and Sugar Glider. The Swamp Rat was least common.
Refer to figure A.

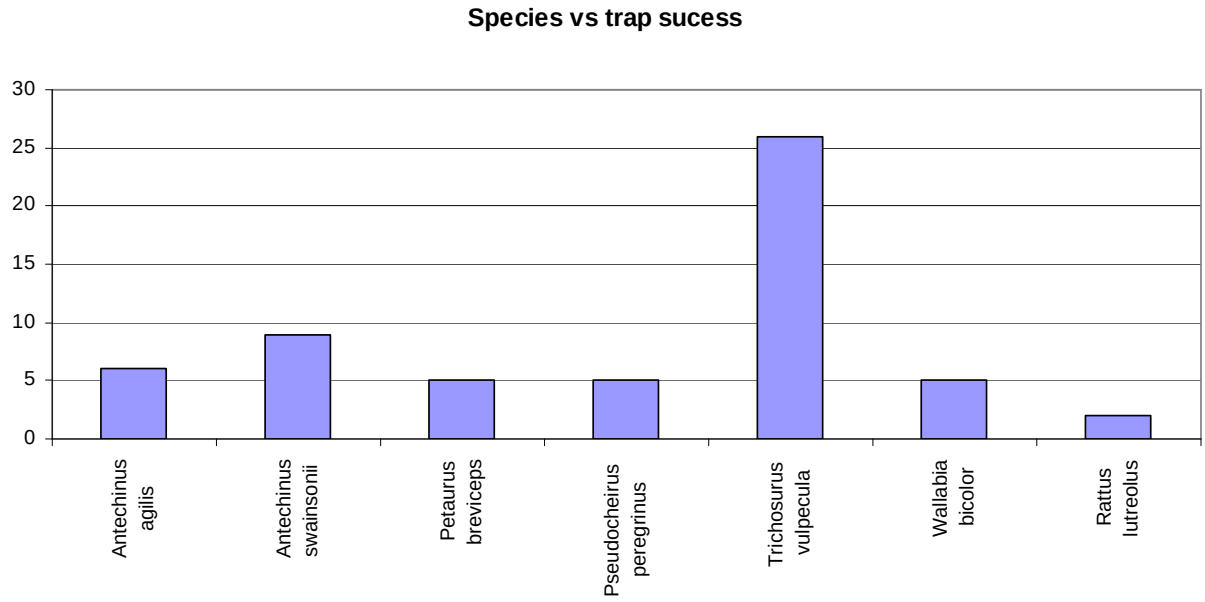


Figure A: Species versus trap success

Species diversity

Species diversity along transects TR 7 and TR 8, placed in the area previously yielding the highest range which was transect TR 5, ones again showed a higher species number compared with the other transect lines.
Refer to figure B and C.

It is to assume that the vegetation around TR 5, TR 7 and TR 8 comprising of a continuous dense bracken fern under-story and scattered large hollow baring trees provides a more secure habitat from predation for species such as Antechinus, Swamp Rat and Possum.

Thought the vegetation around transect TR 6 comprising of a similar vegetation combination but more patchy with open grassy areas in between dense Bracken fern understory may just be enough to increase the chance of predation reducing species numbers.

This observations seam to show a lack of suitable habitat greatly due to past fire frequencies and management practices, triggering a reduction in plant species, wooden debris, fallen logs and hollow baring trees that used to provide diverse shelter for a wide

array of species. Those frequent fires and poor management practices created a fragile environment where Bracken fern and widely scattered hollow-baring trees are now providing for lost shelter and habitat but only for some more common and hardy species.

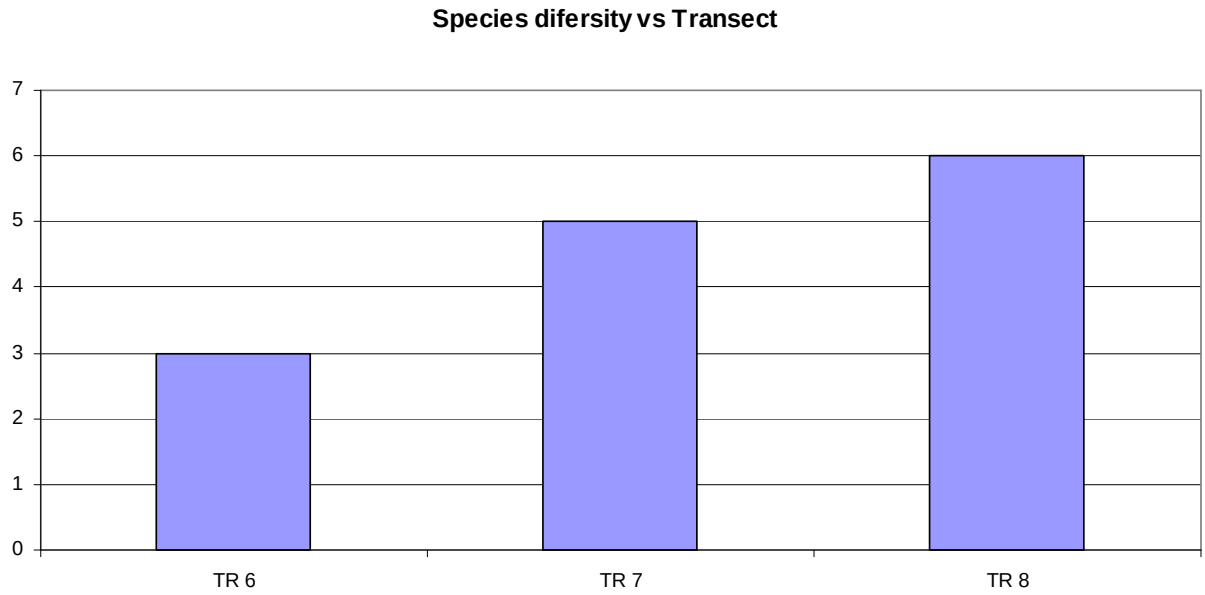


Figure B: Species diversity versus transect lines second trapping session.

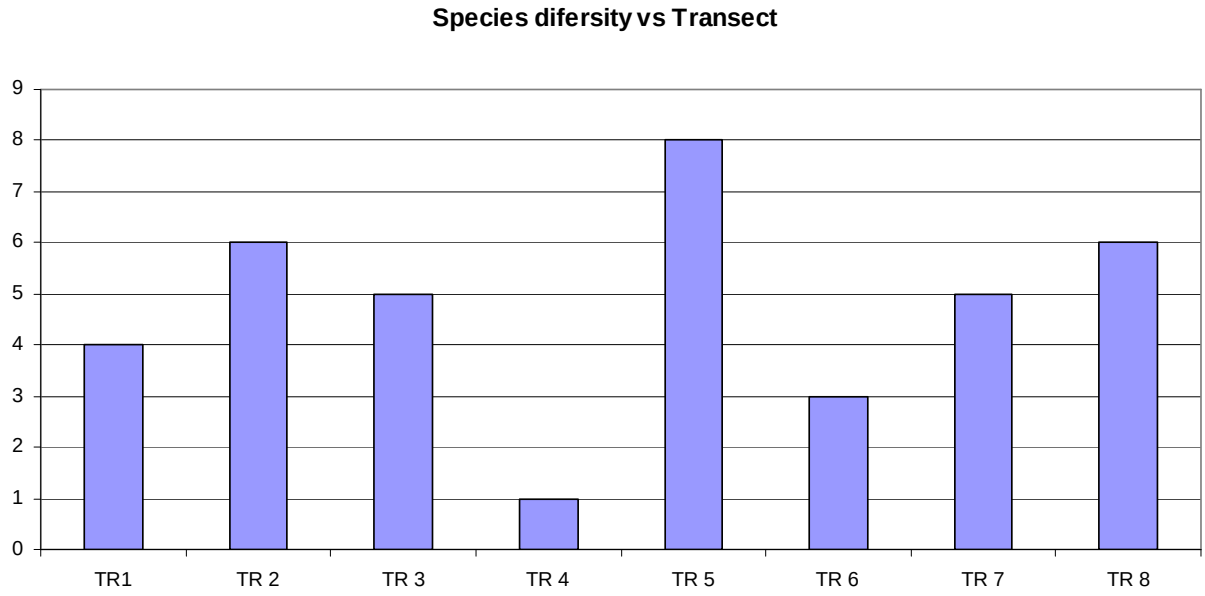


Figure C: Species diversity across all transect lines.

Accuracy of Hair identification

To further improve the accuracy of hair identification while learning Hair ID, a reference hair sample collection was started, using clearly identifiable off chance specimens found as road kill or simply by taking hair samples of pet animals and other legit sources. Those samples, prepared in slides are then used to cross-reference some of the species known to occur in the area.

Further more, an accuracy test was conducted by sending 15 hair samples identified by the author to an experienced Hair identifier such as Hans Brunner.
The result from that identification test revealed a correct identification of 7 in 15 samples, a correct identification to family level in 2 samples (Antechinus) and an incorrect identification in 6 samples.
Considering the complexity of hair identification where often only fine differences within the guard hair separate species as well as being a novice in hair identification, the result was encouraging.
Refer to table III.

Serial ID.	Reto Zollinger's ID	Hans Brunner's ID	Comments
1A	Trichosurus vulpecula	Correct	
1B	Trichosurus vulpecula	Correct	
1C	Trichosurus vulpecula	Correct	
2	Pseudocheirus peregrinus	T.vulpecula & F. catus	x-section
3	Antechinus agilis	Correct	
4	Potorous tridactylus	W.bicolor	Medula in colour band
6.10t	Phascogal tapoatafa	T. vulpecula	x-section
7.2t	Antechinus swainsonii	Correct	
8.3t	Trichosurus vulpecula	Correct	
TR 8t	Petaurus breviceps	Antechinus agilis	
8.10t	Phascolarctos cinereus	Most likely macropod	Fine hair, diffuse simple medula, scales not distant enough
8.6g	Antechinus swainsonii	A. flavipes ?	
8.7g	Rattus lutreolus	Correct	120 microns
8.7g1	Antechinus swainsonii	Antechinus agilis?	
8.8g	Sminthopsis crassicaudata	Antechinus agilis	

Table III: Comparison list species identified R.Z. vs. H.B.

Transect description

Transect 6

The vegetation along TR 6, located in the North eastern section of the Park within the Education sub area, comprises of a Manna Gum, Blackwood and Bracken Fern woodland with many young trees, clusters of aged trees some of which were dead and pockets of open clearings with a grassy understory.
Many old hollow baring trees and fallen logs appear to follow along the edges of a rocky ridge. Refer to figure G.
Near the end of the transect line an area with some large hollow baring trees and Bracken Fern understory is the location of a Wedge-Tailed Eagle nest positioned 12 meter high in a Manna Gum. (see photo p. 14)

Transect 6 had the lowest % hair-trapping success in the second trapping exercise and also revealed the lowest species diversity. Interestingly TR 6 had the only evidence of larger marsupials such as Swamp Wallaby (Wallabia bicolor).
The closeness to cleared farmland may have an edge effect on species diversity.
Refer to figure D.

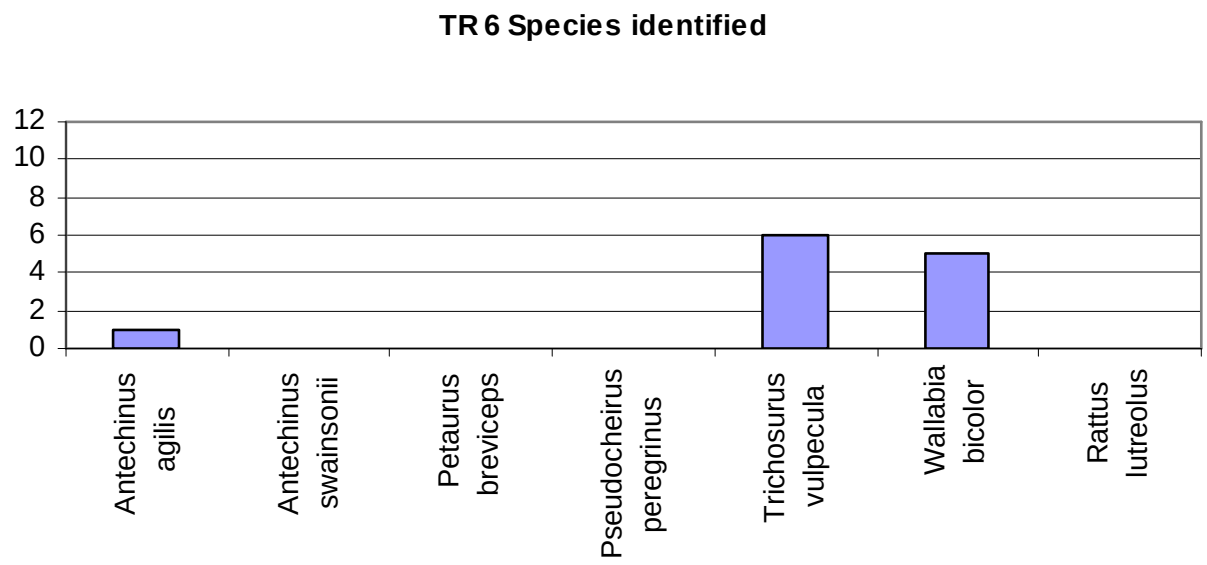


Figure D: Species identified in TR 6

Figure G: Typical vegetation along TR 6.

Figure H: Typical vegetation along TR 7.

Transect 7

TR 7 was placed near TR5 transect which yielded the most diverse species range in the previous trapping session. The traps were laid out crossing over TR 5.8 heading northwest to southeast.

The vegetation along TR7, was the same as described in TR 5 comprising of many young Manna Gums with scattered large old trees baring hollows, pockets of Blackwood and a dense Bracken fern understory.
The transect line started near a large clear area, dominated by Poa tussock, scattered clumps of Tree Everlasting and Bracken fern, heading in a south easterly direction. The other end was located on the downslope of a rocky ridge leading into a wide rocky flow with a dense Bracken fern understory and the occasional large tree.
Refer to figure H.

Again, trapping success and species diversity was high.
Refer to figure E.

Of greatest concern was the occurrence of Feral Cat (Felis catus) especially when considering the location of the transect lines, well away from any cleared land or dwellings. The hair sample was identified by Hans Brunner in the hair samples sent for the accuracy test.

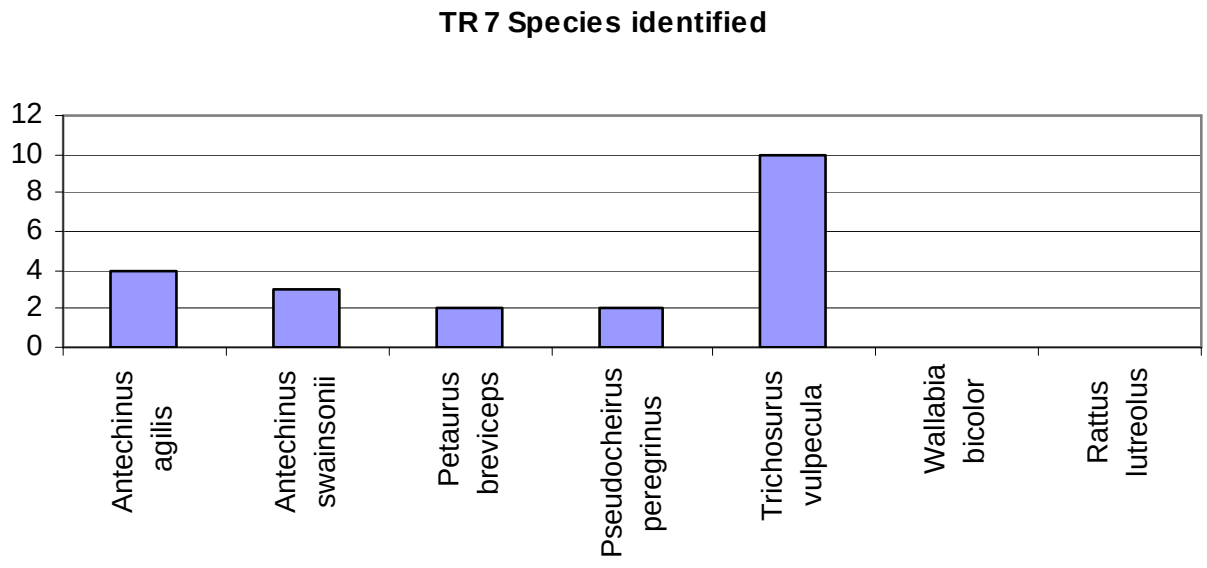


Figure E: Species identified in TR 7

Transect 8

TR 8 was also placed near TR5 transect which yielded the most diverse species range in the previous trapping session. The traps were laid out crossing over TR 5.8 heading north to south.
The transect line started near a large Manna Gum still showing blackened bark from a past fire many years ago. The other end was located in a wide stony flow with rugged rocky up dwellings multi aged Manna Gums, Blackwood clusters and the occasional fallen tree and wooden derby with a dense Bracken fern understory.
Refer to figure J.

Transect 8 yielded the highest trapping success wit a 90% success rate as well as the highest species diversity.
Refer to figure F.

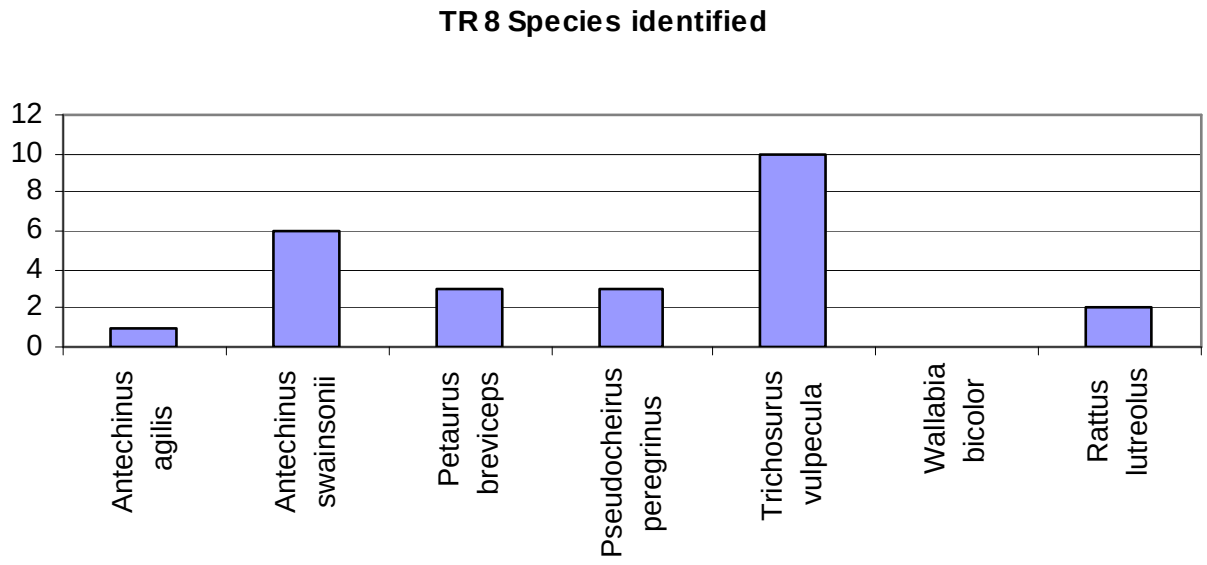


Figure F: Species identified in TR 8

Figure J: Typical vegetation along TR 8

CONCLUSION

The second trapping session revealed a hot spot for species diversity around TR 5, TR 7 and TR 8. The vegetation around those transect lines consisted of many young trees scattered large old hollow baring trees, clusters of Blackwood some fallen logs and a dense Bracken fern understoty over a rugged rocky rise. To our eyes the vegetation may appear young and uniform but in fact provides sufficient habitat for many more common species such as Antechinus and Swamp Rat. These observations raise questions about management of such areas and highlight the complexity of our environment particularly for Natural Resource Management decision making.
The second trapping session also cleared some uncertainties in regards to species identified during the first trapping session. The possible Heath Mouse hair sample turned out to be a Swamp Rat, the Fat-tailed Dunnart is more likely one of the Antechinus species and the Swamp Antechinus may be one of the other Antechinus more commonly found. Unfortunately still no evidence of the Brush-tailed Phascogale. Never the less, the success rate of hair samples captured using hair tubes placed alternatively on the ground and in a tree along transect lines leading away from access tracks proved to be a useful low impact method for initial fauna surveys.

The Hair identification test conducted together with Hans Brunner was very useful. Refer to table IV.
It provided me with the confidence to be on the right track using the Hair Identification tools and also helped me to improve on the technique. Although hair identification is a skill that builds on experience and practice it can be learned relatively quickly.
The test also confirmed the presence of pest animals such as the Feral Cat causing great concern over the long term survival of any possible Brush-tailed Phascogals that may sill persist in Mt. Napier and highlighted to me that there is still a lot to learn.

Final fauna list

Scientific name	Common name	Conservation Status (Vic)
Antechinus agilis	Agile Antechinus	N/A
Antechinus swainsonii	Dusky Antechinus	N/A
Trichosurus vulpecula	Common Brushtail Possum	N/A
Wallabia bicolor	Swamp Wallaby	N/A
Rattus lutreolus	Swamp Rat	N/A
Felis catus	Feral Cat	Pest animal

Table IV: Species clearly confirmed using Hair identification test data.

ACKNOWLEDGEMENTS

Thanks to everyone involved assisting in the second trapping session, especially:
Hans Brunner for his professional support and comments on hair identification.