

# Spatial organisation & habitat selection patterns of three marsupial herbivores within a patchy forestry environment

by

Kirsten le Mar B.Sc. (Hons. I)

Submitted in fulfilment of the requirements for the Degree of  
**Doctor of Philosophy**

School of Zoology  
and  
Cooperative Research Centre for Sustainable Production Forestry

**University of Tasmania**

**July 2002**

Cent

Thesis

LE MAR

PH.D.

2002

THE  
UNIVERSITY  
OF TASMANIA  
LIBRARY

## Declaration

This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due acknowledgment is made in the text of the thesis.

Signed: Nydia G. M. A.

Date: 07/07/02

## Authority of Access

This thesis may be made available for loan and limited copying in accordance with the *Copyright Act, 1968*.

Signed: Nydia G. M. A.

Date: 07/07/02

## Abstract

In order to understand the ecology of a species, it is important to know how animals use their environment. This information can be determined at a range of spatial and temporal scales, and results may vary accordingly. The habitats that animals use determine resources available to them for different purposes (e.g. feeding and resting), and risks of predation to which they are exposed. Consequently, patterns of behaviour in relation to the environment are likely to influence survival and fitness. In Tasmania, Australia, three common and widely distributed native marsupial herbivores are the red-necked or Bennett's wallaby (*Macropus rufogriseus rufogriseus*), the red-bellied pademelon (*Thylogale billardierii*) and the common brushtail possum (*Trichosurus vulpecula*). Information on the behaviour of these species in relation to their environment is largely unavailable.

This thesis describes the abundance, spatial organisation and habitat selection patterns of these three species, within a patchy forestry landscape. The five major habitat types within this environment were: (1) a prepared site that was planted with commercial *Eucalyptus nitens* seedlings during the study (referred to as 'young plantation'); (2) 5-7 year old *E. nitens* plantation; (3) grassland; (4) native forest; and (5) harvested uncleared land.

Patterns of habitat use and selection were examined at three sequential spatio-temporal scales, within a hierarchy of decisions. These were: (1) location of home-range within the landscape, (2) feeding area within the home-range, and (3) vegetation consumed within one habitat, the young plantation. A radio-telemetry study of Bennett's wallabies, pademelons and possums was used to examine Scales 1 and 2 at the individual animal level. Animal surveys were carried out to examine Scale 2 for the entire herbivore community at the population level. These data were also used to estimate herbivore densities for the overall area and individual habitats. Fenced and unfenced vegetation plots, located within the young plantation, a highly used habitat, were monitored over time to examine Scale 3.

As part of this research, modifications to common line-transect sampling methods were made. These enabled methods that are usually applied to daytime surveys in open habitat, to be used in nocturnal surveys in densely vegetated habitats. Accuracy testing of the radio-telemetry system is also described, as the patchiness of the landscape required careful interpretation of results.

Results showed that, at night, wallabies and pademelons used all habitats, but consistently selected for open habitats (young plantation and grassland) across spatio-temporal scales. The use of these open habitats for feeding was confirmed by the large biomass of grass and forbs consumed by herbivores in a detailed study of vegetation on the young plantation. These patterns are consistent with their feeding strategies of grazer or mixed-feeder.

During the day, the two macropod species avoided open habitats and showed strong selection for closed habitats. Wallabies selected for older plantation, while pademelons selected for native forest. This difference reflects their respective predator avoidance strategy (crypsis for pademelons) or escape response (flight for wallabies). Although shelter habitat was important to the two macropod species, their lack of selection at the home-range scale was suggested to reflect the fact that resting animals require little space.

Patterns of habitat use and selection were difficult to interpret for possums, because results varied between the spatio-temporal scales. Spotlighting data showed that at night, possums selected for native forest, young plantation and particularly grassland at the population level. Radio-collared animals selected only for native forest. Older *E. nitens* plantations were avoided by possums at every level, and appeared to represent a biological desert to this species.

High overall densities of wallabies and pademelons (0.3 and 1.5 animals.ha<sup>-1</sup>, respectively), and small, round, home-ranges (61.6 ha and 22.3 ha, respectively) suggested that these

species benefited from the patchiness of this environment. This is attributed to the highly heterogeneous habitats, providing complimentary resources in the absence of ecotones or transitional flora zones, existing side by side, over a small spatial scale. In contrast, extremely low possum population density ( $0.04 \text{ animals.ha}^{-1}$ ) and very large home-ranges (39.1 ha) suggested that resources, presumably den sites and/or food, were limited within this forestry environment.

Results on the ecological aspects of the three herbivore species, described above, are put in the context of the Tasmanian forestry industry, particularly in relation to management of herbivore browsing damage to planted seedlings. Based on this work, I suggest that future management strategies could involve: (1) reducing fragmentation of the natural environment, which supports small home-ranges and high macropod densities, by designing larger, rounder plantations; (2) considering the placement of plantations in relation to the proximity of open (feeding grounds) and closed (shelter) habitats; (3) reducing or removing windrows from newly established plantations to restrict pademelons to the plantation edge; (4) deliberately retaining groundcover or using cover crops to provision herbivores with an alternative food source, as grasses and herbaceous dicots are eaten in preference to *Eucalyptus nitens* seedlings; (5) recognising that wallabies and pademelons remove a large biomass of groundcover and therefore, could play a positive role in weed control, reducing the need to herbicide plantations; (6) monitoring newly planted plantations at short and regular time intervals so that damage caused by insects versus mammals can be differentiated; and (7) avoiding planting in winter when macropods may have little alternative food to eat on newly established plantations.

## Acknowledgments

I would like to thank my supervisor Dr Clare McArthur for her guidance, support and enthusiasm throughout this project. Dr Mick Statham is thanked for his assistance with trapping animals, the use of radio-tracking equipment, and valuable discussion of forestry issues. I am extremely grateful to Dr Colin Southwell for his advice on the design and analysis of the spotlighting data.

Thanks to many Gunns Ltd (formerly North Forest Products) staff who became involved with the study. This project owes much of its success to Ian Blanden, who is thanked for his support and flexibility with my often logistically difficult requests. Dr David de Little is thanked for his help with implementing this study. Various operations staff were extremely helpful in their assistance with numerous forestry operations, in particular Calton Frame, Trevor Docking and Alex Lindsay. Trevor Dick and Andrew Walker conducted the 1080 operation and are thanked for their time and patience with my endless questions about this lethal control method. I am incredibly grateful to Christine Mann for providing aerial photos of the site and the use of GPS units. James Dick and Jeremy Wilson are thanked for their generous time and assistance with digitising data into the GIS. Without these photos and maps, much of the habitat analysis work would not have been possible. I am also extremely grateful to Lawrence White for his help with all things mechanical (particularly the radio-tracking towers), his general carpentry and plumbing skills, and for generously allowing us to borrow his tools. Tony Rae and the guys at the workshop are also thanked for their help with maintaining field gear. Greg Holtz kindly provided climate data. I thank Gunns Ltd (formerly NFP Burnie) for the use of 'Hampshire Lodge' during the two years of fieldwork. Having accommodation so close to the field site made it possible to have such an intense fieldwork component to the study. The security guards at Hampshire Mill are thanked for their help with making the field site and house secure, and for making my time at Hampshire a pleasant one.

Thanks to those technical staff who assisted with the fieldwork. Miles Lawler and Stuart Millen are thanked for their great work, energy and humour during rather trying working conditions. I am particularly grateful to Miles for his assistance with setting up the field site (including the installation of 5000 garden stakes for the spotlighting transects), and the general smooth running of fieldtrips. I am also grateful to Julianne O'Reilly and Stephen Turner for their assistance with site preparation.

I would like to thank the numerous people that helped to collect the radio-tracking data. This component of the study required a team of highly skilled, hard-working, and extremely patient radio-trackers. Needless to say, sitting in a cold, dark hut for hours on end, listening to the dreaded 'beeps' is not glamorous science, and extremely tedious. Consequently, I am forever in the debt of Melissa Sharpe, Lisa Meyer and Helen Otley, who formed a core team of highly skilled trackers. Despite our confused body-clocks, and constant battle with sleep deprivation, there were lots of good times and laughter. I also thank Meika von Samorzewski, Janette Smithurst, Simon Whittock, James Bulinski, and David Taylor and for their help with collecting data.

Thanks to the Zoology staff. I am particularly grateful to Barry Rumbold for his assistance with shipping field gear between Hobart and Burnie. Di Moyle and Cindy Hull also provided radio-tracking equipment in emergency situations.

Dr Corey Bradshaw, Mark Morffew, Dr Eleanor Bruce and Robert Anders are thanked for their help with GIS.

Thanks to the CRC for Sustainable Production Forestry staff. I am extremely grateful to the CRC for allowing me to use a vehicle for the length of the fieldwork. Shelley Caswell is thanked for administrative help, Vin Patel and Stephen Paterson assisted with occasional fieldwork.

Dr's David Ratkowski, Leon Burmuta and Glenn McPherson are thanked for assistance with statistical issues. Dr Roger Martin (Monash University) is thanked for dart-gunning the animals. The Astronomical Society of Tasmania kindly provided lunar and solar timetables.

I would like to thank my colleagues for their friendship and support over the years: Kerrie Swadling, Lynda Bellchambers, Naomi Parker, Martina Doblin, Louise Wynn, James Bulinski, Julianne O'Reilly, Jenny Skerrat, Phillip Tracey, Hugh Fitzgerald, Fiona Hume, Mary-Anne Lea, Cindy Hull, Karin Beaumont and Karen Evans. I am also eternally grateful to Lynda and Mart for giving me somewhere to live between all the fieldwork.

Finally, I thank my parents for their never ending encouragement, love and support over the years.

This project was funded by the Co-operative Research Centre for Sustainable Production Forestry, North Forest Products (Burnie), the Browsing Animal Research Council and the School of Zoology of the University of Tasmania. Animals were caught and radio-collared under Parks and Wildlife Permit # FA96071 and FA97006, and the University of Tasmania Animal Ethics Permit # 95052.

## Table of Contents

<b>Chapter 1. General Introduction</b>	<b>1</b>
1.1 Landscapes and Habitat Quality	1
1.2 Habitat Use and Selection by Herbivores	2
1.3 The Tasmanian Forestry Landscape and its Herbivores	2
1.4 Impact of Herbivores on Forestry	3
1.5 Project Design	4
1.6 Thesis Aims	5
1.7 Thesis Structure	6
<b>Chapter 2. Study Site &amp; Animals</b>	<b>7</b>
2.1 Study Site	7
2.1.1 Geographic Information System	7
2.1.2 Forestry operations on the young plantation	15
2.2 Study Animals	16
2.2.1 Bennett's wallaby	16
2.2.2 Red-bellied pademelon	19
2.2.3 Common brushtail possum	19
<b>Chapter 3. Population Surveys: Spotlighting Methods</b>	<b>21</b>
3.1 Introduction	21
3.2 Materials and Methods	22
3.2.1 Study site	22
3.2.2 Transect lines	24
3.2.3 Survey	25
3.2.4 Data analysis	26
3.3 Results	27
3.4 Discussion	29
3.4.1 Assumption 1: Objects on the line are detected with a probability close to 1	29
3.4.2 Assumption 2: Objects are detected at their initial location before any movement in response to the observer	30
3.4.3 Assumption 3: Perpendicular distances are measured accurately	30
3.4.4 Differences in sightability within species and between habitats	31
3.4.5 Sample size	32
3.4.6 Logistics	32
3.4.7 Management implications	32
<b>Chapter 4. Population Surveys: Density &amp; Habitat Selection</b>	<b>35</b>
4.1 Introduction	35
4.2 Materials and Methods	35
4.2.1 Data collection	35
4.2.2 Line-transect analysis	36
4.2.3 Overall density	36
4.2.4 Biomass density	36
4.2.5 Habitat selection	36
4.2.6 Temporal change	37
4.2.7 Macropod distribution on the young plantation	37
4.2.8 Herbivore densities before and after planting	38

4.3 Results	38
4.3.1 Overall density	38
4.3.2 Habitat selection	38
4.3.3 Distribution of macropods on the young plantation	40
4.3.4 Densities of animals before and after planting	40
4.4 Discussion	41
4.4.1 Overall density	41
4.4.2 Habitat selection	42
4.4.3 Distribution of macropods on the young plantation	43
4.4.4 Herbivore densities before and after planting	45
<b>Chapter 5. Population Surveys: 1080-Poisoning Operation</b>	<b>47</b>
5.1 Introduction	47
5.2 Materials and Methods	48
5.2.1 Study site	48
5.2.2 1080 poisoning operation	48
5.2.3 Density estimates	48
5.2.4 Data analysis	48
5.2.5 Overall density	50
5.2.6 Habitat use	50
5.3 Results	50
5.4 Discussion	51
5.4.1 Pademelons	54
5.4.2 Wallabies	54
5.4.3 Possums and rabbits	55
5.4.4 Wombats	55
5.5 Conclusion	55
<b>Chapter 6. Radio-Telemetry: Accuracy of the System</b>	<b>57</b>
6.1 Introduction	57
6.2 Materials and Methods	57
6.2.1 Test points	57
6.2.2 Radio-tracking system	58
6.2.3 Calculating error	60
6.3 Results	60
6.4 Discussion	62
<b>Chapter 7. Radio-Telemetry: Home-Range</b>	<b>65</b>
7.1 Introduction	65
7.2 Materials and Methods	65
7.2.1 Capture of animals	65
7.2.2 Radio-telemetry	67
7.2.3 Data collection	67
7.2.4 GIS	68
7.2.5 Data analysis	68
7.3 Results	70
7.3.1 Data set	70
7.3.2 Home-range	70
7.4 Discussion	82
7.4.1 Macropods	82
7.4.2 Possums	83
7.4.3 Intersexual differences in home-range	84

<b>Chapter 8. Radio-Telemetry: Habitat Use &amp; Selection</b>	<b>85</b>
8.1 Introduction	85
8.2 Materials and Methods	85
8.2.1 Habitat Use	85
8.2.2 Habitat selection	86
8.2.3 Before and after planting	87
8.3 Results	87
8.3.1 Habitat use	87
8.3.2 Habitat selection	87
8.4 Discussion	96
8.4.1 Habitat use	96
8.4.2 Habitat selection	100
8.4.3 Response to planting	101
<b>Chapter 9. Radio-Telemetry: 1080-Poisoning Operation</b>	<b>103</b>
9.1 Introduction	103
9.2 Materials and Methods	103
9.2.1 Study site	103
9.2.2 Poisoning operation	105
9.2.3 Radio-collared animals	105
9.2.4 Uncollared animals	105
9.3 Results	106
9.3.1 Radio-collared animals	106
9.3.2 Uncollared animals	107
9.4 Discussion	108
9.4.1 Distance from the bait-line	108
9.4.2 Carcass location	108
9.4.3 Sex ratio of killed animals	108
9.4.4 Non-target species	109
9.4.5 Management implications	109
<b>Chapter 10. Vegetation Surveys: Impacts of Foraging Herbivores</b>	<b>111</b>
10.1 Introduction	111
10.2 Materials and Methods	111
10.2.1 Data collection	112
10.2.2 Data analysis	113
10.3 Results	113
10.3.1 Percentage cover of vegetation	113
10.3.2 Vegetation height	115
10.3.3 Percent cover vs. biomass indices	115
10.3.4 Biomass indices for all vegetation	118
10.3.5 Biomass indices within plant categories	118
10.4 Discussion	124
10.4.1 Effects of herbivores on ground vegetation	124
10.4.2 Ground vegetation before and after planting	124
10.4.3 Management implications	124
<b>Chapter 11. Commercial Seedlings: Impacts of Browsing Herbivores &amp; Other Factors</b>	<b>127</b>
11.1 Introduction	127
11.2 Materials and Methods	127
11.2.1 Monitoring of seedlings	127
11.2.2 Forestry operations	128
11.2.3 Data collection	129
11.2.4 Data analysis	130

11.3 Results	131
11.3.1 Seedlings within plots	131
11.3.2 Seedlings within transects	135
11.4 Discussion	141
11.4.1 Mortality	141
11.4.2 Mammal browsing	141
11.4.3 Insect damage	145
11.4.4 Management implications	145
<b>Chapter 12. General Discussion</b>	<b>147</b>
12.1 Use of the forestry environment	147
12.1.1 Macropods	147
12.1.2 Possums	148
12.2 Were Herbivores Enhanced or Hindered by Patchiness?	149
12.2.1 Macropods	149
12.2.2 Possums	150
12.3 Conclusions in Relation to Herbivore Ecology	150
12.4 Impact of Herbivores on Forestry	151
12.4.1 Role of landscape design	151
12.4.2 Role of plantation vegetation	151
12.5 Conclusions in Relation to Forestry	152
<b>References</b>	<b>153</b>
<b>Appendix A. Radio-Telemetry: Data Set Resolution</b>	<b>163</b>
A.1 Introduction	163
A.2 Methods	163
A.2.1 Data collection	163
A.2.2 Data analysis	163
A.3 Results	163
A.4 Discussion	164
<b>Appendix B. Flora on the Young Plantation</b>	<b>169</b>