ABSTRACT

This study investigated the effects of hunting and rainfall on populations of Bennett's wallabies, *Macropus rufogriseus*, and Tasmanian pademelons, *Thylogale billardierii*, and represents the first major field based study on the biology of these species in their native environment. Three aspects of their biology were considered: body condition, breeding and population structure. Neither body condition nor population structure have been previously studied in either species.

This study was based on animals shot by commercial and non-commercial hunters. Study areas were located throughout Tasmania and represented a wide range of hunting and rainfall levels.

The start of the study coincided with the end of one of Tasmania's longest droughts. This drought provided an opportunity to investigate the effects of low rainfall on macropod populations in Tasmania.

Hunting had a direct effect on the age structure of the two wallaby species. High levels of hunting reduced the average age in populations of both wallaby species as a result of selective shooting of larger and, hence, older individuals. In Bennett's wallabies, the effect of selective shooting of large animals was greater on males than on females and this caused a reduction in the proportion of males in the population. By comparison, there was no evidence that hunting caused a difference in the sex ratios of Tasmanian pademelons. This suggests that discrimination between male and female pademelons by hunters was minimal. It may also reflect the fact that Tasmanian pademelons are hunted less intensively than Bennett's wallabies.

The loss of reproductively mature animals as a result of hunting was largely compensated for by increases in breeding performance. In areas subjected to high hunting pressure, wallabies of both species reproduced at a younger age than wallabies in areas subjected to low hunting pressure. Moreover, wallabies in areas subjected to high hunting pressure showed little decline

in breeding success during the drought. The higher breeding performance in areas subjected to high hunting pressure was attributed to a decrease in density and, subsequently, an increase in the quantity of resources available for the surviving individuals.

The results of this study indicate that hunting had a greater impact on Bennett's wallabies than on Tasmanian pademelons. At present, the two species of wallaby are managed by the Department of Parks, Wildlife and Heritage as one species in relation to hunting. This greater vulnerability of Bennett's wallabies to hunting should be taken into consideration in its management, especially given that the reproductive rate of Bennett's wallabies is lower than that of Tasmanian pademelons.

The 1987/88 drought was shown to reduce the body condition (as measured by kidney fat index) of both wallaby species which, in turn, reduced breeding performance. The drought had less effect on Tasmanian pademelons than on Bennett's wallabies and this was attributed to differences in diet and breeding patterns. Survival of dependent young was lower during the year of the drought than during the year of normal rainfall. Fewer male Bennett's wallaby pouch young survived than females during the year of the drought. The drought also delayed the onset of maturity with males being more affected than females. For Tasmanian pademelons, this resulted in first-time breeders giving birth late in the breeding season.

The effects of drought on the biology of the two wallaby species were, in general, similar to those reported for other macropods on mainland Australia. Although the 1987/88 drought was severe by Tasmania's standards, it did not produce the same level of response seen in macropods experiencing severe drought in arid and semi-arid areas of Australia. This reflects the fact that the rainfall of Tasmania is characterised by low variability. Nevertheless, the drought did significantly reduce the breeding performance of both species and this should be taken into account in their management.

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CONTENTS

CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Bennett's wallaby, *Macropus rufogriseus rufogriseus*, (Desmarest 1817) and the Tasmanian pademelon, *Thylogale billardierii*, (Desmarest 1822) are two species of macropod marsupial which are widespread and abundant in Tasmania and on many of its larger off-shore islands. Bennett's wallaby, together with the mainland subspecies, the red-necked wallaby, *Macropus rufogriseus banksianus*, ranges from central Queensland to south-eastern South Australia and into Tasmania. The Tasmanian subspecies differs from its mainland counterpart in that it is a seasonal breeder, whereas the mainland subspecies produces young in all months (Merchant and Calaby 1981). Bennett's wallaby has been introduced to the south island of New Zealand (Tyndale-Biscoe 1973, Gilmore 1977) and to some parts of Britain (Gilmore 1977). The Tasmanian pademelon once occurred in South Australia and Victoria (Wood Jones 1925) but is now restricted to Tasmania (Calaby 1971, Frith 1973).

Both Bennett's wallaby and the Tasmanian pademelon occur in a variety of habitats but show different preferences. Bennett's wallabies are most common in habitats with an open understorey whereas the Tasmanian pademelon is typically found in habitats with a dense understorey. Both species are particularly abundant where their natural habitat occurs adjacent to pasture. Although extensive land clearing for agriculture results in a reduction in numbers of both species through a loss of habitat, land clearance which produces a mosaic of cleared land and forest has lead to an increase in wallaby densities (Frith 1973, Johnson 1977a).

Both Bennett's wallaby and the Tasmanian pademelon have been hunted for skins, meat and sport since the earliest times of European settlement. Statistics on commercial hunting of wallabies have been collected by the Department of Parks, Wildlife and Heritage since the 1920s (Anon 1984). Prior to the 1950s a considerable trade in wallaby skins existed with an average of 150 000 skins traded each year. Approximately 66% of these skins were of Tasmanian pademelons. No figures are available for the sale of meat during this period, but according to Guiler (1957) it was "...a rather spasmodic and casual business".

Since the 1950s the trade in wallaby skins has dropped considerably with an average of 50 000 skins traded every year between 1950 and 1988. This was despite an increase in the length of shooting season from 2-3 months prior to 1957 to 10-12 months since 1958. This decline in trade was associated with depressed skin prices (Anon 1984). An increase in skin prices in 1979/80 lead to 244 918 skins, worth over $780 000, being traded. However, the price of skins

soon fell and the number of skins traded in 1987/88 was 4574. The proportion of Tasmanian pademelons taken in relation to Bennett's wallabies dropped over this period to 50%. This may reflect a lesser demand for the use of fur in clothing for which the Tasmanian pademelon was sought. In recent years a reasonable trade in meat has been developed, with commercial operators selling both species to butchers for human and pet consumption (Anon 1984). In general, Bennett's wallaby is the preferred species for the meat trade due to its larger size.

Since the decline in skin prices most hunting of wallabies has been conducted by recreational shooters. However, even when skin prices were high, both species were extensively shot for sport (Guiler 1957) and wallaby hunting is considered to be a traditional past-time for many Tasmanians (Frith 1973). Estimates of the non-commercial harvest by postal questionnaire between 1979 and 1982 indicate that approximately 621 000 wallabies were taken every year (Anon 1984). On average 57% of this harvest comprised Bennett's wallabies.

Both species are regarded as significant pests in forestry and agricultural areas where their grazing and browsing activities cause extensive damage. As a consequence, both species have been subject to substantial control programs involving snaring (the use of snares is now outlawed), shooting and poisoning. In the past much of the control has been undertaken by commercial shooters, but with decreased skin prices culling is now mainly conducted by recreational shooters or by farmers using 1080 poison. In spite of the widespread use of these control methods over the last 50 years only short-term relief has been achieved and both species still represent an economic threat to forestry and agriculture.

Macropods have been hunted throughout Australia since the earliest times of European settlement. Historical evidence suggests that hunting in the last 200 years has had little effect on reducing numbers or distribution of macropods (Robertshaw and Harden 1989). The exceptions to this are the forester kangaroo, *Macropus giganteus tasmaniensis,* in Tasmania and the toolache wallaby, *Macropus greyi*, in South Australia (Robertshaw and Harden 1989).

Most studies have shown that current hunting levels have little effect in regulating macropod abundance. Studies by Bayliss (1985, 1987), Caughley *et al*. (1979) and J. Caughley *et al*. (1984) found that hunting pressure had little impact on red and grey kangaroos. In contrast, Driessen and Hocking (1992) found that very high levels of hunting during the late 1970s and early 1980s reduced the abundance of both the Tasmanian pademelon and Bennett's wallaby.

A few studies have demonstrated some effects of hunting on the population structure of macropods. Russell and Richardson (1971) found that hunting pressure led to a younger age structure in wallaroos, *M. robustus, M. antilopinus* and *M. bernardus,* as a result of selective shooting of older animals. Newsome (1977a) demonstrated that selective hunting for male red kangaroos, *M. rufa,* caused a sex ratio biased towards females. Wilson (1975) compared the

survival rates of grey kangaroos, *M. giganteus* and *M. fuliginosus*, red kangaroos and wallaroos, *M. robustus*, based on the age structures of skulls obtained by professional hunters. Survival rates were lowest for grey kangaroos and highest for red kangaroos, a difference that was attributed to greater tolerance by graziers for the latter.

The start of the present study coincided with the end of one of the longest droughts on record for Tasmania. This drought provided an opportunity to investigate the effects of low rainfall on the biology of macropod populations in Tasmania.

Several studies have shown that rainfall can regulate the abundance of various species of macropods (Newsome *et al*. 1967; J. Caughley *et al*. 1984; Caughley *et al.* 1985; Bayliss 1985; Robertson 1986; Driessen and Hocking 1992). The most common effect of rainfall on macropod populations is through its influence on plant growth and, hence, on food supply. This, in turn, will effect body condition, breeding and survival of a population. Shepherd (1987) was able to demonstrate a relationship between rainfall, pasture biomass, pasture quality and the condition of red and grey kangaroo populations. These rainfall induced changes in body condition were also linked to changes in fecundity and survival. Other studies have also demonstrated that rainfall influences the fecundity and survival of macropods (Newsome 1965, 1977b; Frith and Sharman 1964; Robertson 1986; Norbury *et al.* 1988).

1.2 AIMS OF STUDY

The aim of this study was to investigate differences in condition, breeding and age structure in Tasmanian pademelon and Bennett's wallaby populations in relation to hunting pressure and rainfall.

1.3 NOMENCLATURE

Bennett's wallaby is the common name used to distinguish the Tasmanian subspecies from its mainland counterpart, the red-necked wallaby. Bennett's wallaby is locally known as "kangaroo" or just "roo". The Tasmanian pademelon is also known in the literature as the red-bellied pademelon or rufous wallaby. I have chosen to use the former based on the terminology used in Strahan (1983). This species is locally referred to as "wallaby".

When referring collectively to Bennett's wallaby and the Tasmanian pademelon in this study, the term 'wallabies' will be used. The term, 'macropods' is used to refer to members of the superfamily Macropodoidea (Strahan 1983; Grigg *et al*. 1989).

1.4 PAST STUDIES ON BENNETT'S WALLABY AND THE TASMANIAN PADEMELON

Despite the abundance of wallabies in Tasmania and the large numbers shot every year, there have been very few field studies investigating the biology of either species. Most field studies on Bennett's wallabies and Tasmanian pademelons have been concerned with investigating their effect on regeneration forests (Cremer 1960, 1962, 1969; Gilbert 1959, 1961; Mollison 1960; Statham 1983) and pastures (Gregory 1988), and with developing a means for their control (Elgie 1961; Tustin 1971; Statham 1983; Gregory 1988; Warburton 1990).

As a result of the concern expressed about the high level of culling of both species of wallaby, an investigation of census methods was undertaken by Johnson (1977a, 1978) and Mooney and Johnson (1979). Apart from reporting on methods of assessing abundance, they also examined their spatial and temporal use of habitat using radio tracking. Driessen and Hocking (1992) reviewed the method of census established by Johnson (1977a) and analysed the trends in abundance of both wallaby species from 1975 to 1990.

Aspects of Bennett's wallaby reproduction have been described from free-ranging populations in New Zealand (Catt 1977) and Britain (Fleming *et al.* 1983). Only one study has been conducted in Tasmania (Curlewis 1989) and this described the breeding season of Bennett's wallaby based on a small sample of young taken from three areas in Tasmania.

McCartney (1978) and Rose and McCartney (1982a) described the breeding season of the Tasmanian pademelon from samples taken from eastern and south-eastern Tasmania which included unpublished data collected by Bill Mollison in the late 1950s and early 1960s. Mollison collected data on the biology of both wallaby species whilst investigating the problem of wallaby and brushtail possum, *Trichosurus vulpecula*, damage to forest regeneration in the Florentine Valley (Mollison 1960). The data on the Tasmanian pademelon were later analysed by McCartney (1978). However, most of Mollison's data, including information on Bennett's wallaby, remain both unpublished and apparently unlocatable.

For both wallaby species, the majority of information on their biology has been based on captive populations with aspects of reproduction and development receiving most attention.

Most of the research on Bennett's wallaby reproduction has been conducted by Merchant and Calaby (1981) who compared the reproductive biology and development of Bennett's wallaby with the mainland subspecies, the red-necked wallaby, in captive colonies in Canberra. In Britain, Bennett's wallabies have been the subject of a number of studies investigating seasonal and lactational quiescence (Loudon *et al.* 1985; Curlewis *et al.* 1986; Curlewis *et al.* 1987;

Loudon and Curlewis 1987; Curlewis and Loudon 1988; Brinklow and Loudon 1989). In Tasmania, Walker (1977) and Walker and Rose (1981) described prenatal development in this species.

Walker (1977) made a preliminary investigation of delayed gestation length, oestrous cycle and pouch young growth following the birth of a diapausing blastocyst in the Tasmanian pademelon. This work was investigated further by McCartney (1978) and Rose and McCartney (1982a). Horak (1980) studied embryonic growth and development and aspects of delayed gestation with emphasis upon the analysis of ovarian and uterine interrelationships.

There have been a small number of behavioural studies conducted on captive populations of both species. Morton and Burton (1973) made observations on Tasmanian pademelons kept at the Melbourne Zoological Gardens and a similar study was conducted by Clancy (1982) at the University of Tasmania. Lafollette (1968, 1971) reported on agonistic behaviour and dominance in Bennett's wallaby in Ohio, U.S.A., and Merchant and Calaby (1981) noted the breeding behaviour of Bennett's wallaby held in captivity in Canberra.

Methods of aging Bennett's wallaby and Tasmanian pademelon pouch young have been developed by J. Merchant (unpublished data) and Rose and McCartney (1982b) respectively. Catt (1979) developed a means of aging Bennett's wallabies from counting annuli laid down in the periosteal zone of the mandible. J. Merchant (unpublished data) also established a relationship between age and molar eruption.

In contrast to Bennett's wallaby, a considerable amount of information has been published on the mainland subspecies, the red-necked wallaby. Most of this research was from studies conducted at Wallaby Creek in north-eastern New South Wales (Jarman *et al.* 1987). These studies have investigated; philopatry, reproductive success in females and maternal investment (Johnson 1986); the density and distribution of this species in relation to environmental variables (Southwell 1987); effect of fire on pasture utilisation (Southwell and Jarman 1987); home range and movements (Johnson 1987a); use of dung pellet counts for measuring absolute densities (Johnson and Jarman 1987, Johnson *et al.* 1987); relationships between mother and young (Johnson 1987b); social interactions and reproductive tactics (Johnson 1989a); grouping and the structure of association (Johnson 1989b) and mortality of immature red-necked wallabies (Johnson 1989c).

McEvoy (1970) described the subspecies as it occurs in Queensland, providing information on distribution, habitat types, breeding and conservation.

CHAPTER 2

DESCRIPTION OF STUDY AREAS

2.1 LOCATION OF STUDY AREAS

Wallabies were collected from a total of 12 areas distributed throughout Tasmania (Figure 2.1) representing different levels of hunting and rainfall. The selection of study areas was, in part, dependent upon the availability of hunters to regularly shoot wallabies. The Styx, Lemont, Maria Island and Nunamara study areas were not sampled regularly and the data collected from them were used only where relevant.

2.2 RAINFALL

Average annual rainfall data for all study areas are given in Table 2.1. The long-term average represents data gathered over at least the last 50 years. The average annual rainfall for the years 1977-1986 and the rainfall for 1987, 1988 and 1989 are given as an indication of more recent rainfall conditions. Total rainfall in 1987 was lower than the long term annual average at all study areas (Table 2.2). This lower rainfall in 1987 is associated with a drought which is described below.

A drought or rainfall deficiency is defined by the Australian Bureau of Meteorology as a period of at least three months when the level of rainfall fell below the 10th percentile. Using the results of Shepherd (1991) it is possible to put the drought which occurred prior to the start of the present study into historical perspective. Shepherd determined the number of droughts which occurred between 1910 and 1991 for three regions of Tasmania and ranked them in terms of length and in terms of the magnitude of the departure of rainfall from the median (severity). Only information from northern and eastern Tasmania will be discussed here as there were no study areas in southeastern Tasmania (as defined by Shepherd (1991)). In northern Tasmania, the drought occurred from March 1986 to June 1988. For this region, the drought was the longest on record and the 7th most severe. In eastern Tasmania, the drought occurred from April 1987 until July 1988. For this region, it was the 2nd longest on record and the 11th most severe. No information is available for western Tasmanian where three study areas, Florentine Valley, Styx and Granville Harbour, were located. However, the results in Table 2.2 suggest that the effect of the drought was less severe.

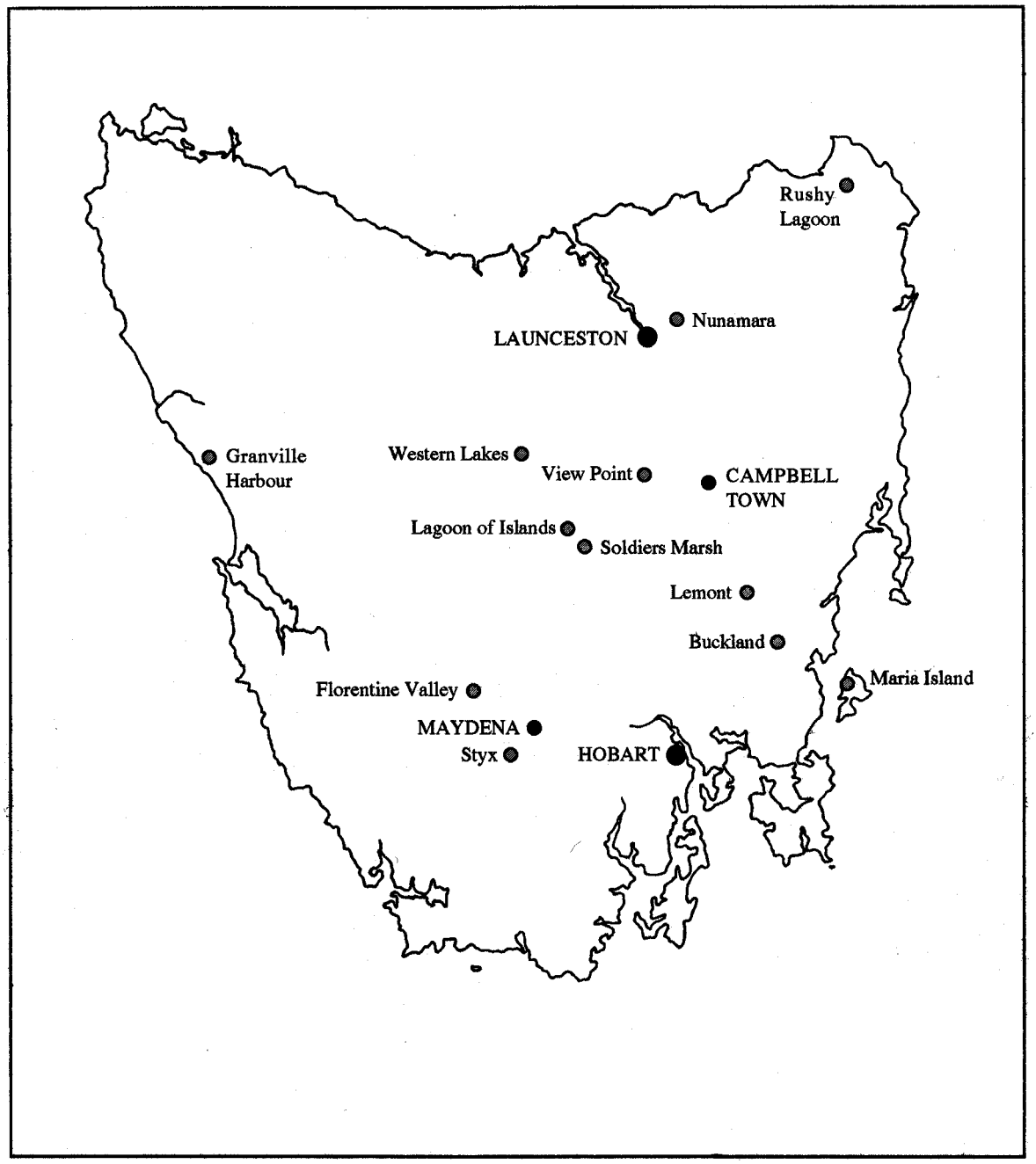

Figure 2.1 Location of study areas (●)

Table 2.1 Annual rainfall (mm) data for each study area.

Study Area	Long-Term Average	Average for 1977-1986	1987	1988	1989
Lemont	561	503	403	492	-
View Point	630	633	505	643	739
Buckland	657	635	477	596	574
Maria Island	663	623	443	614	594
Rushy Lagoon	745	703	-	732	802
Soldiers Marsh	840	793	691	857	800
Lagoon of Islands	840	793	691	857	800
Western Lakes	1291	1259	1051	1372	1290
Styx	1208	1157	1112	1192	-
Florentine Valley	1208	1157	1112	1192	-
Nunamara	1352	1084	1216	1112	1268
Granville Harbour	1515	1426	1348	1417	1294

Table 2.2 Rainfall in 1987 as a percentage deficit of the long-term average annual rainfall.

Study Area	Rainfall Deficit in 1987 (%)
Lemont	28
View Point	20
Buckland	27
Maria Island	33
Rushy Lagoon	-
Soldiers Marsh	18
Lagoon of Islands	18
Western Lakes	19
Styx	8
Florentine Valley	8
Nunamara	10
Granville Harbour	11

Long-term, mean monthly rainfall distributions for each study area are given in Figure 2.2. In low rainfall areas, rainfall is evenly distributed throughout the year, whereas in high rainfall areas rainfall peaked in winter. Plant growth in Tasmania is restricted by low temperatures in winter and low effective rainfall, due to high evapotranspiration in summer and early autumn (Scott 1965; Kirkpatrick *et al*. 1988). Hence, growth mainly occurs in spring and late autumn. In high rainfall areas the growing season is extended into summer, whilst in inland areas and areas of high elevation the growing season is shortened by lower temperatures.

The study areas covered much of the range of rainfall that occurs in Tasmania. For the purposes of the present study, the study areas were divided into the three groups shown below.

Low Rainfall	< 700 mm a year	Lemont, View Point, Buckland, Maria Island
Medium Rainfall	700-1000 mm a year	Rushy Lagoon, Soldiers Marsh, Lagoon of Islands
High Rainfall	> 1000 mm a year	Western Lakes, Styx, Nunamara, Florentine Valley, Granville Harbour

2.3 TEMPERATURE AND ALTITUDE

Temperature and altitude statistics for each study area are given in Table 2.3. The minimum and maximum temperatures at each study area were a function of altitude. Thus, as altitude increased, the temperature decreased.

2.4 VEGETATION, LAND USE AND HUNTING OF WALLABIES

(a) Lagoon of Islands

Lagoon of Islands is located on the lower slopes of the Central Plateau. It consists of a mosaic of pasture, subalpine woodlands and forests and marshes.

The canopy of the forests and woodlands is open and common *Eucalyptus* spp. present include *E. dalrympleana* (mountain white gum), *E. pauciflora* (weeping gum) and *E. rodwayi* (swamp peppermint). The tall shrub layer is usually sparse containing regenerating eucalypts and *Acacia dealbata* (silver wattle). The low shrub and ground layer varies from open areas dominated by native grasses to dense sedgey and heathy areas. Species include *Cyathodes juniperina* (pink berry), *Leucopogon hookeri*, *Hakea microcarpa*, *Lomatia tinctoria* (guitar plant) and various sedges in the poorly drained areas. Large areas of habitat suitable for both species of wallaby occur beyond the study area.

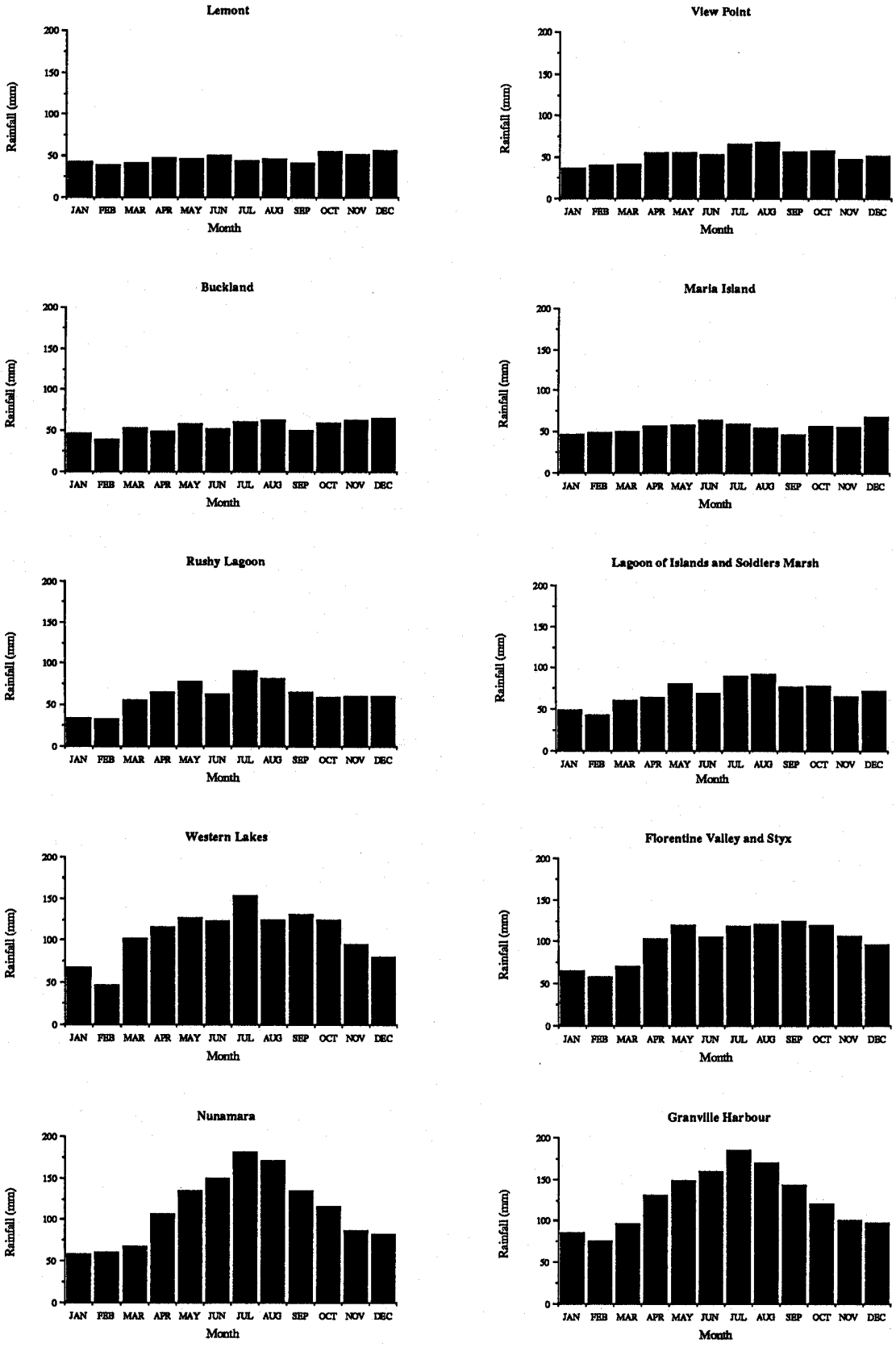

Figure 2.2 Long-term mean monthly rainfall distribution for all study areas.

Table 2.3 Altitude and temperature data for each study area.

Study Area	Altitude (m)	Temperature (°C)			
		mean minimum	mean maximum	extreme minimum	extreme maximum
Maria Island	10	-	-	-	-
Granville Harbour	20	7.8	16.4	-3.0	37.2
Rushy Lagoon	60	10.3	16.7	-1.1	36.1
Buckland	200	7.3	17.8	-5.3	39.4
Nunamara	200	6.2	16.8	-7.1	37.3
Lemont	300	5.0	15.5	-12.8	40.0
View Point	200	5.2	17.2	-9.4	37.8
Florentine Valley	300	4.8	15.6	-6.7	39.4
Styx	300	4.8	15.6	-6.7	39.4
Soldiers Marsh	700	3.9	16.6	-12.5	37.5
Lagoon of Islands	800	3.9	16.6	-12.5	37.5
Western Lakes	1150	2.3	11.4	-13.0	33.4

Sampling took place on part of an 11 000 ha property. The property included 1500 ha of pasture which had been fertilised with super phosphate every year for at least the past 15 years. The main pasture species were rye grass and clover. During the last 5-6 years sheep have grazed on the property and cattle have been present during the summer months. Large areas have been selectively logged during the past 4 years with 20 ha clearfelled in the last 15 years. In 1985, 1080 poison was laid to control wallabies in one of the paddocks. This was the only use of this poison in the last 20 years.

Over the last 15 years, intensive wallaby shooting has been conducted by a local hunting club, the Steppes Wildlife Trust, on a weekly basis. Club records indicate that an average of nearly 3000 wallabies have been shot every year and that hunters prefer to shoot Bennett's wallabies despite Tasmanian pademelons being more abundant.

(b) Soldiers Marsh

Soldiers Marsh is also located on the lower slopes of the Central Plateau. The habitat is similar to that of the Lagoon of Islands except that there is no improved pasture and there are larger areas of marshes.

The structure and floristics of the native vegetation of this study area are similar to that described for Lagoon of Islands. However, there are noticeably more *E. delegatensis* (gum-topped stringybark) and *E. gunnii* (cider gum). Large areas of suitable habitat for both species of wallaby, particularly Bennett's wallaby, extend beyond the study area.

The area where sampling occurred is owned by a logging company but little logging has occurred. Sheep graze on the study area all year round. In at least the last 10 years no 1080 poison has been laid and no super phosphate has been applied.

The Bagdad Field and Game Club has been shooting in the area for the last 15 years. Members estimate that around 500-800 wallabies are shot each year and that 75-90% are Bennett's wallabies. Tasmanian pademelons, although present in the area, have never been common.

(c) Western Lakes

Western Lakes is a high altitude study area in the Central Plateau Protected Area. Samples were taken from the stretch of land adjacent to the 16 km road between the settlement of Liaweenee and Double Bay Lagoon.

The vegetation includes woodland dominated by *E. coccifera* (snow gum) but alpine heath is the most extensive plant community comprising xeromorphic species such as *Orites revoluta, O. acicularis, Epacris serpyllifolia, Olearia ledifolia* and *Helichrysum hookeri*. These woody shrubs form rounded bushes which are usually less than a metre high but in places reach 2 m high. Other common species are *Richea sprengelioides, Diselma archeri, Microcachrys tetragona* (Strawberry pine) and the cushion plants *Abrotanella forsteroides* and *Donatia novae-zelandiae.*

No poisoning, logging or grazing occurs within the study area. Bennett's wallabies were common and Tasmanian pademelons were uncommon. However, according to the local ranger the number of Tasmanian pademelons has been slowly increasing in recent years.

It was difficult to assess the hunting pressure in this extensive area. The local ranger, from the Department of Parks, Wildlife and Heritage, estimated that a couple of hunting parties would arrive every weekend over winter but their success rate was not high, rarely taking more than a half dozen Bennett's wallaby. Thus it is likely that less than 500 wallaby are taken in a year.

(d) Granville Harbour

Granville Harbour is located on the west coast of Tasmania. It comprises 80 ha of pasture bounded on one side by the sea and on the remaining sides by extensive tracts of forest.

The forest consists of an emergent stratum of *E. obliqua* (stringybark) over a tall rainforest understorey which includes tree species such as *Nothofagus cunninghamii* (myrtle), *Atherosperma moschatum* (sassafrass), *Phyllocladus aspleniifolius* (celery-top pine), *Pomaderris apetala* (dogwood), *Olearia argophylla* (musk), *Phebalium squameum* (lancewood) and *Pittosporum bicolor* (cheesewood). Ferns such as *Blechnum wattsii, Polystichum proliferum*

and *Dicksonia antarctica* (manfern) are common in the understorey as is the cutting grass, *Gahnia grandis*.

Cattle were run on the pasture for ten years up until 1987. Since then it has not been grazed by stock, and bracken, *Pteridium esculentum*, has begun to take over. In at least the last ten years no fertiliser has been applied and no 1080 poison has been laid.

Tasmanian pademelons are far more common in the area than Bennett's wallabies. The number of wallabies shot in the area was difficult to assess due to unauthorised shooters hunting on this remote property. The owner and one regular shooter estimates that about 500 are known to be shot each year.

(e) Buckland

The Buckland study area is located in the Buckland Military Training Reserve on the east coast of Tasmania. It comprises extensive areas of mature heathy and sedgey dry sclerophyll forest and approximately 20 ha of pasture.

The open eucalypt canopy includes *E. obliqua* (stringy bark), *E. amygdalina* (black peppermint), *E. ovata* (swamp gum) and *E. globulus* (blue gum). The tall shrub layer is sparse and includes *Acacia dealbata* (silver wattle) and *Exocarpos cupressiformis* (native cherry). The low shrub and ground layer is dominated by the bracken, *Pteridium esculentum*, the sagg, *Lomandra longifolia* and the sedges *Lepidosperma* spp., *Juncus* spp. and *Restio* spp. Shrub species include *Pultenaea juniperina* (prickly beauty) and *Cyathodes glauca* (cheeseberry).

Sheep grazed on the small area of pasture all year round and super phosphate was added every year for at least the last 10 years. No logging has occurred and no 1080 poison has been laid in the last decade.

Approximately 500 wallabies, of which approximately 75% are Tasmanian pademelons, are shot annually by the caretaker of the reserve. Tasmanian pademelons are more common adjacent to the pasture areas, whereas, Bennett's wallabies are more common in the native forest.

(f) Rushy Lagoon

Rushy Lagoon is located in northeastern Tasmania. The area consists of large areas of pasture interspersed with native vegetation.

The native forest on the property is mostly heathy dry sclerophyll forest dominated by *E. amygdalina* (black peppermint). The tall shrub layer is usually open and is dominated by *Casuarina littoralis* (bull-oak) but also includes *Banksia marginata* and *Exocarpos cupressiformis* (native cherry). The low shrub and ground layer are dominated by *Pteridium*

esculentum (bracken), *Lomandra longifolia* (sagg) and *Lepidosperma concavum* (sedges). Shrubs present include *Epacris impressa* (common heath), *Leptospermum scoparium* (tea tree) and *Aotus ericoides* (golden pea).

Sampling occurred on part of a property which covers 28 000 ha including 16 000 ha of pasture. The property is grazed by sheep and to a lesser extent cattle. Lime and super phosphate are applied annually. Crops grown include species of rye grass, cocksfoot, turnips, wild white clover, sub-clover and strawberry clover.

Wallabies at this study area are subjected to a high harvesting pressure. A commercial shooter has taken approximately 5000 wallaby annually since 1985. Of these less than 200 Tasmanian pademelons were shot a year. Additionally, the local shooting club accounts for approximately 3000 wallabies shot every year since 1974. Club shooters generally shot equal numbers of both species. Other shooters account for another 500-1000 wallabies. In all, approximately 9000 wallabies are shot each year. Prior to 1985, 1080 poison was laid regularly. The neighbouring property shoots and lays poison each year.

(g) View Point

View Point is located in the northern Midlands and comprises large areas of pasture interspersed with native woodlands.

Both grassy and shrubby open dry sclerophyll forest occur on the study area as well as small areas of wetter forests on southern slopes. *E. amygdalina* (black peppermint) and *E. viminalis* (white gum) are the most common eucalypts present, although *E. obliqua* (stringybark) dominates on wetter areas. The tall shrub layer is generally sparse and is dominated by *Acacia dealbata* (silver wattle) and also includes *Banksia marginata*, and *Bursaria spinosa* (prickly box). The low shrub and ground layer is dominated by native and introduced grasses as well as the sagg, *Lomandra longifolia*.

Sampling took place on part of a 2500 ha property which includes 1000 ha of pasture. The main stock on the property are sheep (90%) but cattle are also present. Fertiliser has been added to the pasture nearly every year over the last ten. Main pasture species are rye grass and clover. In recent years no 1080 poison has been laid in the area due to the presence of deer farming. Some logging has occurred.

The Bagdad Field and Game Club has conducted shooting on the property since 1988. Up to 2000 wallabies have been shot annually over the last 10 years with neighbours culling at a similar level. In 1988 and 1989 hunting was restricted to less than 1000 due to deer trapping operations.

(h) Florentine Valley

This study area is located in southwest Tasmania. It contains a mosaic of pine plantations and *Eucalyptus* spp. regrowth forest at various stages of development and is surrounded by mature mixed forest.

The mixed forest consists of emergent eucalypts such as *E. dalrympleana*, and *E. obliqua* (stringy bark) over a tall dense shrub layer which includes *Phebalium squameum* (lancewood), *Pittosporum bicolor* (cheesewood), *Pomaderris apetala* (dogwood), *Zieria arborescens* (stinkwood), *Nothofagus cunninghamii* (myrtle), *Phyllocladus aspleniifolius* (celery-top pine) and *Olearia argophylla* (musk). Ferns such as *Dicksonia antarctica* (manfern), *Pteridium esculentum* (bracken), *Polystichum proliferum* and *Blechnum wattsii* are common. *Gahnia grandis* (cutting grass) is also common.

The study area is controlled by Australian Newsprint Mills (ANM). Most of the pines in the study area were planted in 1982 and 1987. The eucalypt regrowth was cleared in 1989 just before sampling finished. The pine plantation was fertilised once after planting. 1080 poison was laid twice in the year after planting and once every year thereafter. The study area also included a site which has been cleared and replanted 4 times in the last 10 years.

Shooting pressure has varied over the last ten years. Just before and after planting, in 1982, the hunting pressure was particularly high with 1000-2000 being shot annually. Between 1983 and 1986 approximately 6-700 were shot and since then less than 500 a year were shot.

(i) The Styx

This study area is also located in the southwest of Tasmania. Samples were taken from a stretch of road about 17 km long through mostly mixed forest similar to that described for the Florentine Valley. This study area is also controlled by ANM.

Hunting pressure is very low with less than 50 wallabies shot a year. No 1080 poisoning has occurred in the area of sampling. This study area was sampled only in the winter of 1988. It was not sampled again due to the difficulty in obtaining adequate samples of wallaby in the dense vegetation which occurred adjacent to the road. Tasmanian pademelons were the most common of the two species in this area with only one Bennett's wallaby being seen during seven nights of sampling.

(j) Maria Island National Park

This study area is located on Maria Island off the east coast of Tasmania. The island includes large areas of dry sclerophyll forest and pasture.

The main eucalypts which dominate the native vegetation where sampling took place include *E. pulchella* (white peppermint), *E. globulus* (blue gum) and *E. obliqua* (stringybark). The open tall shrub layer is dominated by *Acacia dealbata* (silver wattle) *Casuarina littoralis* (she-oak) and *Bursaria spinosa* (prickly box). Grasses dominate the ground layer along with *Lomandra longifolia* (sagg) and *Lepidosperma* spp. (sedges).

A small number of Tasmanian pademelons and Bennett's wallabies were shot in this National Park as part of a monitoring program involving these species. The island suffers from chronic over-population and in times of drought abnormally high juvenile mortality has occurred due to starvation (G. Hocking, unpublished data). Highest densities of wallabies occur around the settlement at Darlington where there are large areas of pasture. Samples of Bennett's wallabies were taken from this area as well as from native forest south of Darlington. Tasmanian pademelons were only taken from around Darlington.

Small numbers of Bennett's wallabies have been shot in the past to control numbers and to remove sick animals. No 1080 poison has been laid on the island and fertiliser has not been used in the past decade.

(k) Lemont

This study area is located in the southern Midlands near the town of Lemont. Only a small sample of Bennett's wallabies was taken from this study area. The area consists of a mosaic of large open pastures and small patches of native dry sclerophyll forest. The area is heavily hunted by commercial shooters and local residents.

(l) Nunamara

This study area is located in northern Tasmania. A small number of wallabies (skulls, testes and pouch young and skins) were collected from a number of properties in this area by Mr L. Smith. The area includes a mosaic of pasture and dry and wet sclerophyll forest. The area is regularly hunted.

2.5 SUMMARY

A summary of rainfall, altitude, vegetation, land use and hunting pressure is given in Table 2.4. Hunting pressure was estimated based on the following:

(i) The number of wallabies shot per year within and around the immediate study area.
(ii) The number of years wallabies were subjected to hunting.
(iii) The distribution and abundance of wallabies within and around the study area.

Table 2.4 Summary of study area descriptions

Study Area	Rainfall	Altitude (m)	Vegetation	Stock	Poison	Shooting
Lemont	low	<500	Dry Sclerophyll / Improved Pasture	sheep	?	high
View Point	low	<500	Dry (& Wet) Sclerophyll / Improved Pasture	sheep	no	medium
Buckland	low	<500	Dry Sclerophyll (some Improved Pasture)	(sheep)	no	low
Maria Island	low	<500	Dry Sclerophyll / Unimproved Pasture	no	no	very low
Rushy Lagoon	medium	<500	Dry Sclerophyll / Improved Pasture	sheep/cattle	no[a]	very high
Soldiers Marsh	medium	500-1000	Subalpine Dry Sclerophyll	sheep	no	low
Lagoon of Islands	medium	500-1000	Subalpine Dry Sclerophyll / Improved Pasture	sheep/cattle	no[b]	high
Western Lakes	high	>1000	Alpine Heath (and Woodland)	no	no	low
Styx	high	<500	Mixed Forest	no	no	very low
Florentine Valley	high	<500	Mixed Forest / Pine Plant./ Regenerating Eucalypts	no	yes	low
Nunamara	high	<500	Dry and Wet Sclerophyll Forest	sheep/cattle	yes	medium
Granville Harbour	high	<500	Mixed Forest / Unimproved Pasture	no	no	low

a poisoned once in recent years, regular poisoning occurs on neighbouring properties.

b poisoned once in last 15 years.