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Biogeography and Species Density Distributions of Tasmanian Mammals

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AN ABSTRACT OF THE THESIS of Jerry E. Bevers for the Master of Science in Biology presented August 9, 1990.

Title: Biogeography and Species Density Distributions of Tasmanian Mammals.

APPROVED BY THE MEMBERS OF THE THESIS COMMITTEE:

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Separated from mainland Australia by the Bass Strait, Tasmania has acted as an island preserve maintaining large populations of many mammalian species presently uncommon, rare, or extinct on mainland Australia.

There are few studies of Tasmanian mammal distributions. Recent distributional maps, based on information from surveys and mammal specimens, allowed for an investigation of the species density distributions of the terrestrial mammals of Tasmania. Compilation of species' distributional information into species density distributions provides an overview as to which areas may provide the most significant habitat for the greatest number of species; what geographic variations may influence species distributions; and which regions remain least surveyed for mammalian species in Tasmania.

BIOGEOGRAPHY AND SPECIES DENSITY DISTRIBUTIONS
OF TASMANIAN MAMMALS

by

JERRY E. BEVERS

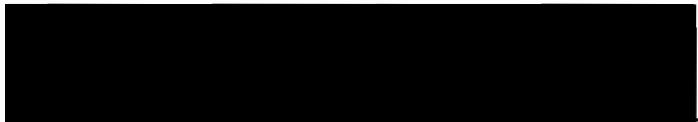
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in
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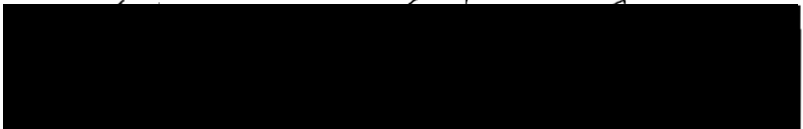
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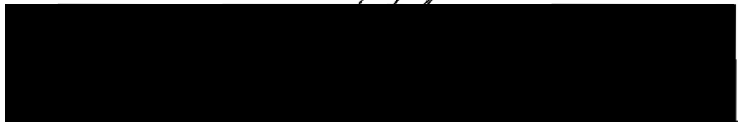
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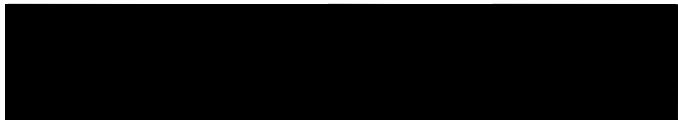
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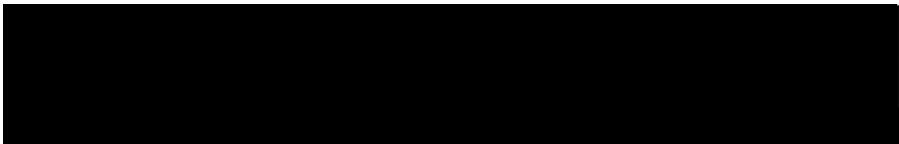


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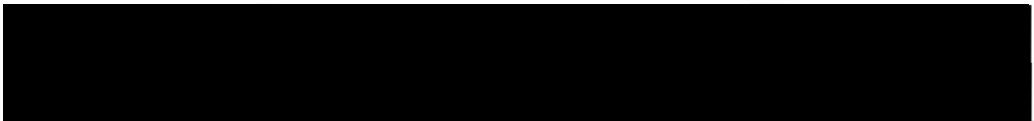


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CHAPTER I

INTRODUCTION

Tasmania, a continental island south of Australia, has acted as a natural reserve for numerous endemic Australian biota. The continued survival of many mainland Australian mammal species has become increasingly uncertain. Over the past two centuries several species of mammals indigenous to the Australian continent have become extinct. The causes behind these extinctions and declines in populations of other native species are varied. Destruction and disruption of suitable habitat, competition with introduced species, and hunting are some of the major causes. The present isolation of Tasmania from continental Australia by Bass Strait has allowed for the preservation of several species presently extinct or threatened with extinction on the mainland.

Excepting the thylacine (*Thylacinus cynocephalus*), no indigenous species of Tasmanian mammal is presently threatened with extinction. Though some Tasmanian species are uncommon or have restricted ranges, at the present time there are at least secure pockets of populations for each. The eastern quoll (*Dasyurus viverrinus*), the Tasmanian devil (*Sarcophilus harrisii*), the Tasmanian bettong

(*Bettongia gaimardi*), Tasmanian pademelon (*Thylogale billardierii*), and the long-tailed mouse (*Pseudomys higginsii*), are presently endemic to Tasmania. Several other indigenous Tasmanian species have become threatened or uncommon on the mainland. The uncertain future of many mainland populations makes Tasmania increasingly important as a reserve, possibly the last one for many species.

This comes at a time when Tasmania is undergoing increasing loss or alteration of native vegetation through clear-cutting, conversion of forest to pasture land, and prescribed burnings. If the continued survival of indigenous Tasmanian species is to occur, more extensive studies of their distributions and habitats is needed.

Information on species distributions for native terrestrial mammals of Tasmania is being gathered by Rounsevell and Taylor (unpublished). I obtained a copy of their distributional data on Tasmanian indigenous mammals directly from them. Previous distributional studies in species density distributions (Kiestler, 1971; Rogers, 1976; Schall and Pianka, 1978; Simpson, 1964; Wilson, 1974) revealed broad trends correlated with geographic variations. Using Rounsevell's and Taylor's (unpublished) current distributional data, I have compiled a map of species densities over Tasmania and examined species density distributions for correlations with topographic relief. The purpose of this study was to see if any

patterns were apparent with the present distributional data for Tasmanian mammals. Such information may assist in efforts to preserve Tasmania's indigenous mammals.

CHAPTER II

REVIEW OF THE LITERATURE

DESCRIPTION OF THE STUDY AREA

The island of Tasmania, 67,900 square kilometers in area, lies south of the mainland of Australia separated over the Bass Strait by a distance of less than 200 kilometers. (Williams, 1974). The Tasmanian mainland is located between $40^{\circ}30'$ and $43^{\circ}30'$ south of the equator and between $144^{\circ}30'$ and $148^{\circ}30'$ east of Greenwich, (Hope, 1974) (see Figure 1). Between Tasmania and mainland Australia lie the Bass Strait Islands, totalling less than 4,000 square kilometers in area (Hope, 1974).

A marine climate, mountainous topography, and diverse vegetation typify Tasmania. Precipitation is generally higher in western Tasmania and lowest in the east-central Midlands region, with annual totals varying between 3560 mm and 760 mm (MacPhail, 1979). Though the overall climate is very mild, due to the influence of the surrounding oceans, extreme low temperatures of -15°C have been recorded, with the greatest snowfalls predominating in the central highlands in the winter months (MacPhail, 1979; Williams,

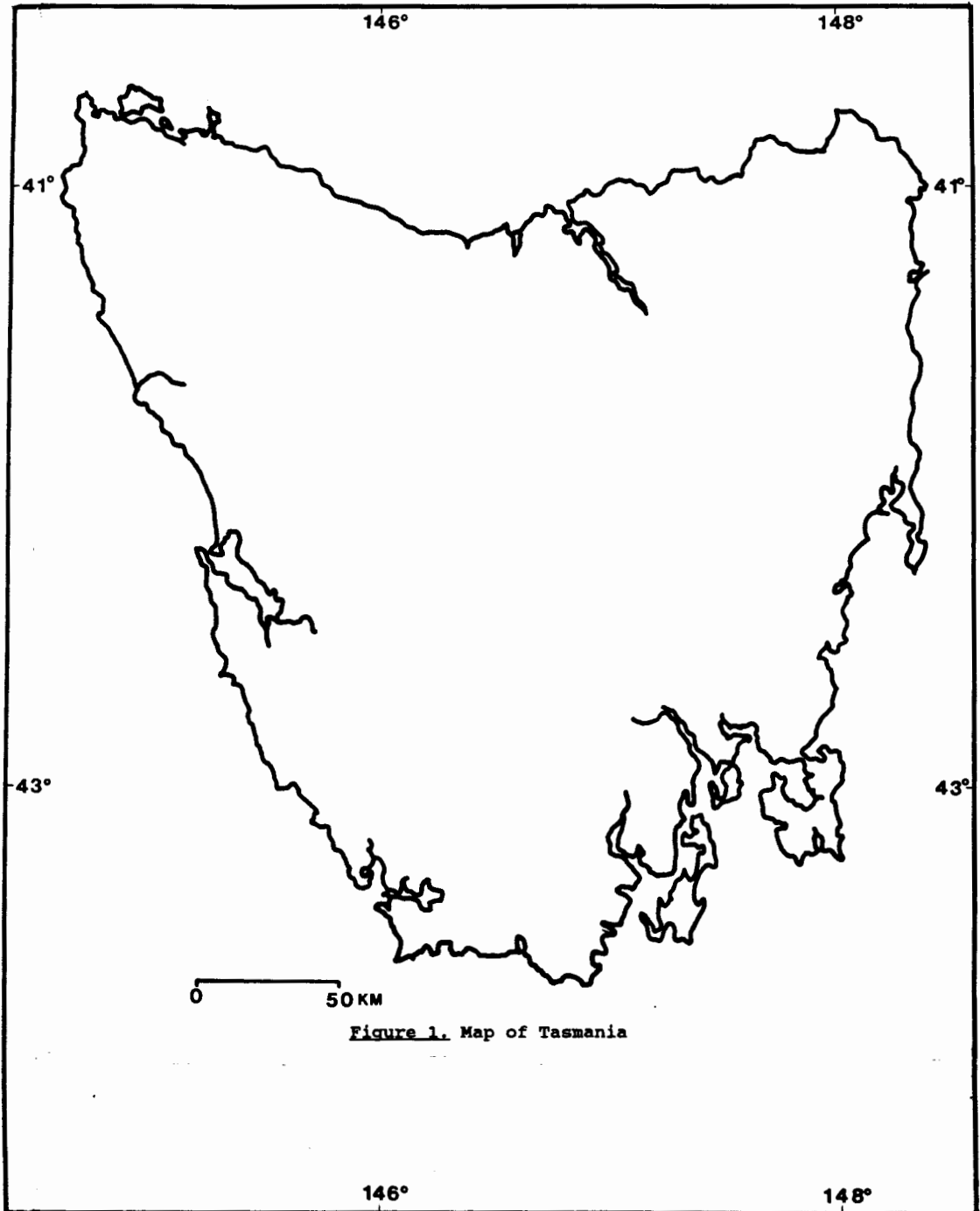


Figure 1. Map of Tasmania

1974). Summer frosts may occur at the higher altitudes, controlling the distribution of trees and shrubs in those areas.

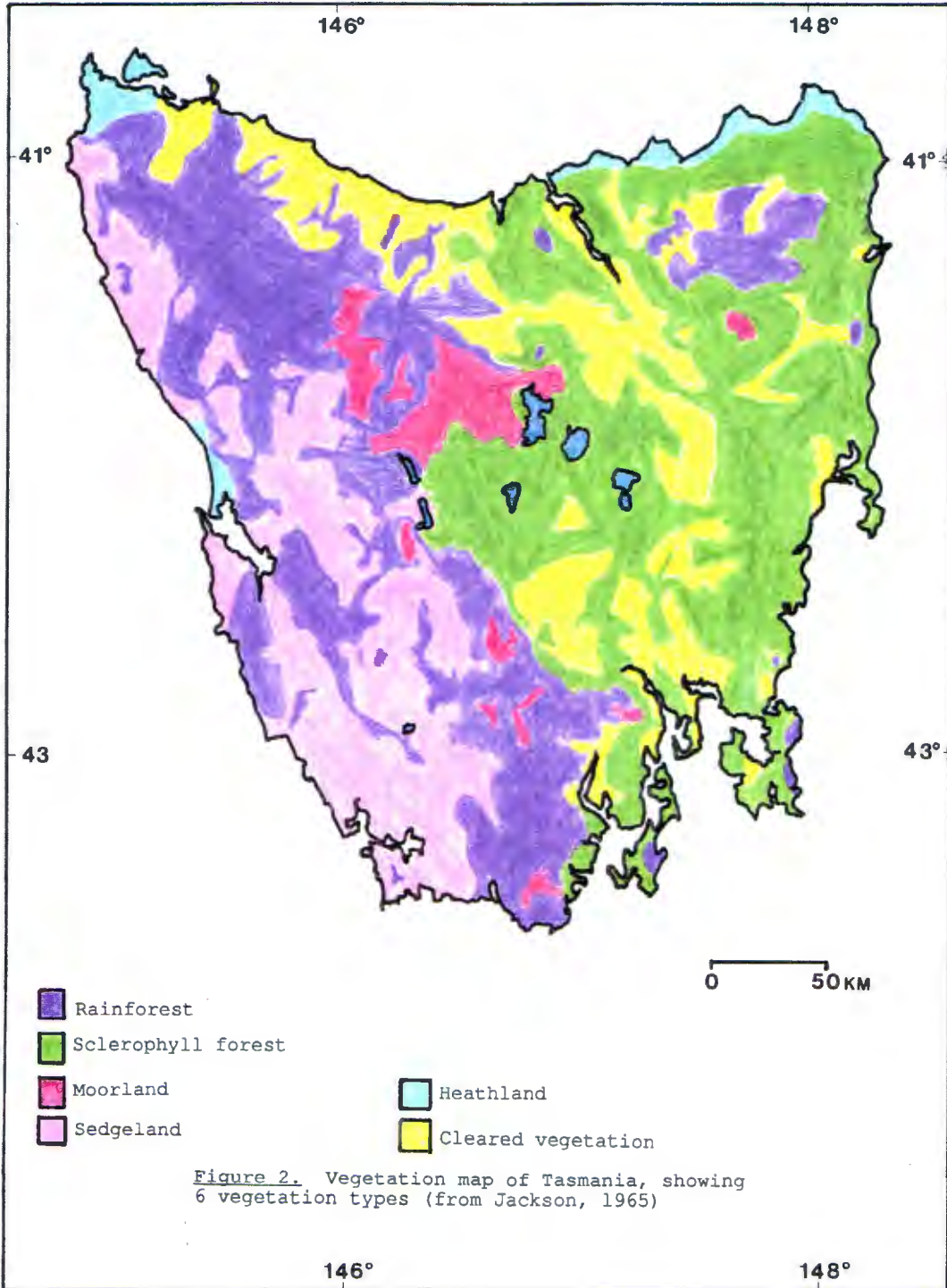
Topographic relief is extreme over much of Tasmania, a circumstance which has allowed significant areas of native vegetation to remain free from pastoral clearance (Green, personal communication). Elevations in excess of 1500 meters can be found and large areas above 300 meters are present (Williams, 1974). The northern Midlands, a region covering 2,744 square kilometers, is the only extensive inland plain. Except for the far northeast and northwest, hills and mountainous regions arise close to the coastline (Davies, 1965; Williams, 1974).

A cooler climate and abundant precipitation produced many glacial areas in the Tasmanian highlands during the Pleistocene (Davies, 1974; MacPhail, 1979). More importantly for faunal exchange, a land bridge existed intermittently during the Pleistocene between Tasmania, the Bass Strait Islands, and the mainland of Australia. The most recent connection to the mainland of Australia is estimated to have been inundated by rising sea levels between 10,000 and 15,000 years ago. (Hope, 1974). Until the time when the Bass Strait became flooded again, Tasmania existed as a peninsula of Australia, with few barriers to the terrestrial mammalian fauna (Green, 1974).

VEGETATION

Vegetational distribution in Tasmania may be more complex than anywhere in mainland Australia (Williams, 1974; Orchard, 1988) and is influenced by climatic, topographic, edaphic, and pyric factors (Jackson, 1965; MacPhail, 1979). Most fires since the late Pleistocene have been the result of human activities; more recently land has been cleared for agricultural and grazing use (Fensham, 1989; Hiatt, 1967; MacPhail, 1979). As many as forty-nine floral communities have been recognized by Kirkpatrick and Dickinson (1984). Six major plant communities (see Figure 2), including cleared land, have been recognized as important and distinctive faunal habitats (Green, 1974; Orchard, 1988; Williams, 1974; Jackson, 1965). These broad vegetational categories, which often have poorly defined boundaries due to geographic complexities (Jackson, 1965; MacPhail, 1979), include temperate rain forest, sclerophyll forest, moorland, sedgeland, coastal heath, and cleared land (Jackson, 1965; Williams, 1974).

The temperate rainforests of Tasmania contain climax species of *Nothofagus*, *Athrotaxis*, *Atherosperma*, *Lagarostrobos* (*Dacrydium*), *Phyllocladus*, *Eucryphia* and *Anodopetalum*. These grow from sea level to 1200 meters elevation, in areas with at least 2700 mm annual rainfall



(MacPhail, 1979), with soil fertility determining the dominant species (Jackson, 1965; Kirkpatrick and Dickinson, 1984). The floral mix of the rainforests contains numerous genera with closer evolutionary ties to the Gondwanan representatives presently found in New Zealand and southern South America than to mainland Australian species (Jackson, 1965; Williams, 1974). Increased fire frequencies create a wet sclerophyll forest, wet scrub, sedgeland, or grassland in what would otherwise be suitable for development of rainforest (Jackson, 1965; Williams, 1974).

Species of the genus *Eucalyptus* form the sclerophyll forests and are dominant in areas receiving less than 2700 mm annual rainfall or having a high frequency of fire. Though forming a mosaic with other vegetation types the sclerophyll forests are most extensive in the central and eastern portions of Tasmania (Jackson, 1965). Related eucalypt forests are found in eastern and southwestern mainland Australia. The eucalypt forests of mainland Australia and Tasmania, considered to be the habitat of greatest importance to the largest number of species of indigenous mammals, have been and continue to be threatened by logging practices (Braithwaite, 1984; Lunney and Barker, 1986; Lunney and Leary, 1988; Norton, 1983). This logging rate presently exceeds the regeneration rate for sclerophyll forests in Tasmania by two and a half times (McConnell, personal communication).

The alpine or moorland vegetation complex exists above timberline and is dominated by bolster shrubs, coniferous shrubs, deciduous shrubs, scleromorphic shrubs, graminoids, tussock grass, wetland sedge, moss, and fern (Jackson, 1965; Kirkpatrick and Dickinson, 1984). Species compositions are influenced by wind, duration of snow cover and soil drainage (MacPhail, 1979). Vegetational cover is generally complete unless subjected to fires.

Poor soil fertility or frequent fires support a sedgeland vegetation in what would otherwise be climatically favorable for rainforest (Jackson, 1965). Sedgeland is dominated by *Gymnoschaenus sphaerocephalus* (buttongrass), *Leptospermum* sp., *Melaleuca*, *Banksia marginata*, and *Poa labillardieri* (grassland) (Kirkpatrick and Dickinson, 1984).

Vegetation limited by wind, salt and infertile soils is found in areas about the coast, the larger regions being in the northeast and northwest (Jackson, 1965). However a thick ground cover of several species, including heaths are present, while a mixture of several larger genera of *Acacia*, *Dianella*, *Lepidosperma*, *Eucalyptus*, *Leptospermum*, *Banksia*, *Xanthorrhoea*, *Melaleuca* and *Causuarina* may be found often in a stunted form (Green, 1974; Kirkpatrick and Dickinson, 1984).

Land cleared of native vegetation for pastoral use has been and continues to be a major force for change in the

Tasmanian environment. Since colonial exploitation, over 83% of the native vegetation in the Midlands of Tasmania and half of Tasmania's entire forest cover has been removed (Fensham, 1989, Norton, 1983). Since 1960, large areas of sclerophyll and heathland have also been cleared in northeastern Tasmania (Kirkpatrick and Dickinson, 1984). According to Green (1974):

In the central, eastern and northern regions regions, pastoral development has replaced extensive areas of the natural vegetation, but the indigenous mammals invade these areas only for feeding, usually under cover of darkness.

THE MAMMALS OF TASMANIA

Mammalian Origins

As a continental island of Australia (Darlington, 1957), the origin of Tasmania's vertebrate fauna is closely linked with the origin of Australia's vertebrate fauna. The indigenous species of terrestrial mammals in Tasmania, and of the Australian mainland, belong to four orders. Reflecting the known sequence of arrival in Australia, and Tasmania, they are Monotremata, Marsupialia, Chiroptera, and Rodentia.

The oldest known mammalian fossil in Australia is the early Cretaceous monotreme, *Steropodon galmani*, discovered on the eastern mainland of Australia (Archer, et al, 1985). This 110 million year old representative indicates that at

least some mammals were well established on the Australian side of Gondwanaland before separation from Antarctica in the early Tertiary. Scant fossil records provide few clues about monotreme radiations though the highly specialized living forms of three surviving species, belonging to two families, implies a long evolutionary history (Murray, 1984).

Precisely when and where the marsupials of Australia arose is debatable, but evidence strongly suggests a Gondwanan connection between the continents of South America, Antarctica, and Australia (Archer, 1984; Woodburne and Zinsmeister, 1984). Present distributions of marsupials in South America and Australia, along with fossil evidence in South America, Antarctica, and Australia, supports a "marsupial trail" between these former Gondwanan continents (Cox, 1974; Kirsh, 1984; Woodburne and Zinsmeister, 1984). At least by the time Australia became separated from Antarctica, between 45 to 55 million years ago, the ancestors of the present day marsupial fauna were established on Australian soil (Archer, 1984). The oldest known fossil marsupial from Australia is the Oligocene (40 million year) *Wynyardia*, discovered in Tasmania. With the possible exception of the Thylacinidae, fourteen families of marsupials survive in Australia today, and nine of them are represented in Tasmania (Strahan, 1983).

After its land connections to Antarctica were severed, Australia became the island continent it is today. Monotremes and marsupials developed in isolation as the only terrestrial mammals in Australia until the arrival of bats some 15 million years ago in the Miocene (Hall, 1984; Hand, 1984). Six families of Chiroptera are indigenous to Australia, though only the Vespertilionidae is represented in Tasmania (Hall, 1981; Hall, 1984; Green; 1974). *Pteropus poliocephalus*, the grey headed flying fox (Pteropidae), has been collected on Babel Island and King Island in the Bass Strait, but not the mainland of Tasmania (Green 1974; Hall 1986).

Rodents arrived, apparently in successive waves of colonization into Australia, from either the Indonesian Archipelago or New Guinea (Baverstock, 1984; Hand, 1984). All Australian rodents belong to the family Muridae. The oldest fossil representatives are from the Pliocene, some 4.3 million years in age. Of the thirteen Australian rodent genera representing over fifty species, four genera representing five indigenous species are present in Tasmania (Baverstock, 1984; Grainger, M., et al, 1987).

Human Origins and Influences

Humans have existed in Australia since the late Pleistocene, 40,000 years or more (Strahan, 1983). Dingos, arriving in Australia only 4,000 years ago, and never

became established on Tasmania, since the Bass Strait land bridge became submerged about 12,000 years ago (Archer, 1984; Hiatt, 1967). Aborigines colonized Australia, coming from New Guinea via the Torres Straits. Though no direct evidence is linked to Pleistocene faunal extinctions by the Aborigines in Australia, hunting and alteration of the vegetation through firing suggests stresses which, when linked with climatic changes, may have been the downfall of several megafauna species (Archer, 1984), including the largest diprotodont and macropod marsupials.

Tasmanian Aborigines, derived from mainland Australian groups, are believed to have been in Tasmania for at least 23,000 years. The Bass Strait land bridge was submerged some 12,000 years ago, physically and culturally isolating the Tasmanian Aborigines from the mainland groups (Bowdler, 1982). The human population may have been as few as 3,000 to 4,000 individuals. Outside of rainforest vegetation, Tasmanian Aborigines inhabited all of the island (Hiatt, 1967). The firing of vegetation by the Tasmanian Aborigines altered the landscape, increasing hunting areas and decreasing rainforest cover (Hiatt, 1967; Jackson, 1965). Although information is scanty, Hiatt (1967) has compiled evidence to indicate that *Macropus giganteus*, *Macropus rufogriseus* (and/or *Thylogale billardieri*), *Potorous tridactyla*, *Trichosurus vulpecula*, *Pseudocheirus convolutor*, *Antechinus* sp., *Vombatus ursinus*, *Dasyurus* sp.,

peramelid sp., and *Tachyglossus aculeatus* were among the mammals eaten by the Tasmanian Aborigines. *Thylacinus cynocephalus* was also hunted, though it is not known if it represented a food source. Not one of the mammals known to have been hunted in Tasmania became extinct as a result of actions of the Tasmanian Aborigines. Conflict between the British settlers and the Tasmanian Aborigines mounted from 1803 on, into what became the worst case of genocide in Australia. In 1876, Truganini, the last person of full Tasmanian Aboriginal descent died, and the Pleistocene culture of Tasmania was lost (Bowdler, 1982).

Contemporary Mammalian Compositions of Tasmania

With the possible extinction of *Thylacinus cynocephalus* and a question over the introduction of *Petaurus breviceps*, there are 35 extant species (Appendix) of indigenous terrestrial mammals in Tasmania (Green, 1974; Grainger, et al, 1987) Eight additional species of large marsupials, belonging to the families Vombatidae, Thylacoleonidae, Diprotodontidae, and Macropodidae, became extinct in Tasmania during the late Quaternary (Hope, 1974). Since the arrival of Europeans, seven species of introduced mammals, representing four orders and families, have become established feral populations on the mainland of Tasmania (Green, 1974; Strahan, 1983). These are *Rattus rattus*, *R. norvegicus*, and *Mus musculus* (Rodentia:

Muridae), *Lepus capensis* and *Oryctolagis cuniculus* (Lagomorpha: Leporidae), *Felis catus* (Carnivora: Felidae), and *Dama dama* (Artiodactyla: Cervidae).

SPECIES ACCOUNTS

Order Monotremata. Family Ornithorhynchidae.
Ornithorhynchus anatinus (Platypus)

O. anatinus is an aquatic, oviparous, mammal which forages along stream beds and lake bottoms for crustacea, molluscs, insects, annelids and small vertebrates (Green, 1974; Grainger, M. et al, 1987). A common resident of riparian habitats which have remained free from dams, irrigation, and other waterway alterations that would adversely affect local populations, the platypus inhabits suitable areas between mountainous and coastal regions (Green, 1974; Strahan, 1983). This small mammal may be found close to human residence if habitats remain suitable (Bever, pers. obs.). *O. anatinus* nests and resides in a burrow which may be over 10 meters in length, and has one or more openings one to two meters above the normal water level (Ride, 1970). *O. anatinus* is readily distinguished from other Tasmanian mammals by its a duck-like leathery bill, webbed front and hind feet, a broad tail, lack of external pinnae, and a dense grey to brown fur dorsally, and a creamy color ventrally (Ride, 1970; Grainger, M. et al, 1987).

Family Tachyglossidae. *Tachyglossus aculeatus*
(Echidna)

The echidna is one of the few mammals which may be active at any time of the day. (The majority of Tasmanian species being nocturnal and do not emerge to forage before dusk [Green, 1974].) *T. aculeatus* uses its strong foreclaws, long snout and slender vermiform tongue to excavate and forage almost exclusively on ants and termites (Green, 1974; Strahan, 1983). This highly specialized, oviparous, toothless mammal is found throughout Australia. Its pelage includes many stiff spines except on the venter. The snout is tubular (Grainger, M. et al, 1987, Strahan, 1983). The Tasmanian echidna has longer, denser fur than has the mainland form. Echidnas may be found throughout Tasmania but are most abundant in the sclerophyll forests and heathlands (Green, 1974). When threatened, the echidna rapidly buries itself, using its powerful front and hind claws, and leaving only its dorsal spines exposed; or it may curl into a spiny ball covered in spines if disturbed on hard ground (Grainger, M. et al, 1987, Strahan, 1983).

Order Marsupialia. Family Dasyuridae.
Dasyurus maculatus (Spotted-tailed Quoll)

The largest of the Australian quolls, females up to 4 kilograms and males up to 7 kilograms have been recorded. A predator, *D. maculatus* is capable of capturing vertebrate

and invetebrate animals on the ground and in the trees. It is also known to scavage carrion (Strahan, 1983). The distribution of *D. maculatus* shows a preference for the wet sclerophyll forests and rainforests in the west, northwest and northeast of Tasmania (Green, 1974; Grainger, M. et al, 1987). Though common in suitable habitat, local populations may be threatened from competition by feral cats and forest clearing (Green, 1974; Grainger, M., et al, 1987; Strahan, 1983).

Dasyurus viverrinus (Eastern Quoll)

Now only common in Tasmania, *D. viverrinus* may be extinct in its former range over the southeastern mainland of Australia (Grainger, M., et al, 1987; Strahan, 1983). Though found in a variety of habitats the eastern quoll seems to prefer dry sclerophyll forests and heathland (Green (1974). Twenty-five individuals of *D. viverrinus* were observed one night in northeast Tasmania, near Gould's Country (Bever, Robertson and Robertson, pers. obs., 1990). Individuals may have a dimorphic pelage color, with fur either appearing black or fawn brown, and a pale or cream color ventrally. They may be distinguished from *D. maculatus* by the absence of variously sized white spots on their tails, though they do have spots dorsally and laterally along their body (Grainger, M., et al, 1987; Strahan, 1983). Proportionally larger eyes and ears also

help to distinguish them from *D. maculatus* (Grainger, M., et al, 1987). Green (1966) found *D. viverrinus* to be an opportunistic feeder, existing upon vertebrates, invertebrates and a small amount of vegetable matter. They may also scavenge carcasses, possibly competing with *Sarcophilus harrisii*.

Sarcophilus harrisii (Tasmanian Devil)

Excepting the possible continued existence of *Thylacinus cynocephalus*, *S. harrisii* is the largest extant marsupial carnivore. Large males may weigh 8 kilograms and females up to 6 kilograms. Highly opportunistic in its feeding habits, the Tasmanian devil is largely a scavenger but is known to prey upon small vertebrates and invertebrates (Strahan, 1983). Often more than one individual has been observed to feed on carcasses, which may be of other devils, sheep, macropods, birds, crustaceans, or marine fish (Green, 1966; Strahan, 1983). The relatively large head and powerful jaws are capable of devouring a carcass in its entirety, including the skull, leaving behind only a few remnants of bone or hair (Green, 1974).

Once widespread on the mainland of Australia, *S. harrisii* became extinct there as recently as 600 years ago, perhaps due to competition with the dingo. The Tasmanian devil is now endemic only to Tasmania. Though populations

have become very low in the past, perhaps due to an epidemic around 1909 (which may also have affected *Thylacinus cynocephalus* and *Dasyurus viverrinus*), present Tasmanian devil populations are considered to be high. Devil's are found wherever food is available. Green (1974) notes that they prefer sclerophyll forests and heathlands.

Antechinus minimus (Swamp Antechinus)

This small carnivorous marsupial, weighing an average of 55 grams, is known to prey upon insects, annelids, arachnids, and lizards (Grainger, M., et al, 1987). Its Tasmanian distribution tends to follow buttongrass sedgeland, coastal heathlands, and a few wet forested areas (Green, 1972; Grainger, M., et al, 1987; Taylor and Rounsevell, unpublished). Their distribution follows the wetter areas of the southwest, northwest and northeast of Tasmania, from sea level to 1000 meters of elevation (Green, 1972). *A. minimus* is threatened by destruction of its preferred habitat through grazing, mining, industrial development and frequent fire burning (Green, 1972; Grainger, M., et al, 1987; Strahan, 1983).

Antechinus swainsonii (Dusky Antechinus)

Males average 65 grams, exceeding the females average of 41 grams by more than fifty percent (Strahan, 1983). This active, vocal, marsupial forages equally by day and night amidst the dense litter floor of rainforests and wet

sclerophyll forests for soil invertebrates, fruit, and carrion (Green, 1972; Grainger, M., et al, 1987; Strahan, 1983). *A. swainsonii* Found in western Tasmania and isolated pockets in the northeast. It is common in its preferred habitats, which it inhabits from the coast to the subalpine zone, and shuns treeless areas of buttongrass sedgelands where *A. minimus* is found (Green, 1972) Though not threatened as a species, land clearing and burning of its preferred habitats have reduced local populations of *A. swainsonii* (Strahan, 1983).

Smithnopsis leucopus (White-footed Dunnart)

This small, nocturnal marsupial, averaging 20 grams for females and 28 grams for males, has an uncertain status, due to the difficulty in obtaining specimens (Green, 1972; Grainger, M., et al, 1987; Strahan, 1983). Green (1972) states that the lack of specimens may reflect an overall rarity in the population of the species, though Grainger, et al (1987) believes it to be more common than the lack of specimens suggests. Green (1972, 1974), Grainger, et al (1987), and Strahan (1983) all make it clear that the distribution of this mammal is not known with any certainty. In Tasmania *S. leucopus* has been captured in a variety of habitats, including rainforests, sclerophyll forests, and wet and dry coastal heathlands, and at altitudes ranging from sea level to 600 meters

(Green, 1972; Strahan, 1983). It feeds on a variety of invertebrates and small vertebrates (Grainger, et al, 1987).

Family Thylacinidae. *Thylacinus cynocephalus*
(Thylacine)

"The *Thylacinus* is far more common in some parts of the Colony than in others, and commits occasionally great havoc among the lambs"
(Breton, 1846).

The thylacine, or Tasmanian tiger, was the largest extant marsupial carnivore in the world when first described in 1805. It became well known for its apparent evolutionary convergences with the canids (Archer, 1984; Guiler, 1985; Strahan, 1983). These superficial similarities were simply the end result of convergence between two carnivorous groups of mammals reflecting selection pressures favoring a cursorial predator (Green, 1974; Strahan, 1983). The thylacinids appear to have arisen from the Dasyuridae, and fossil evidence of *Thylacinus potens* indicates they were in Australia for at least 13 to 15 million years (Archer, 1984). Their former distribution included much of Australia and New Guinea, but thylacines had become extinct virtually everywhere except Tasmania by the time Europeans arrived in Australia. Competition from the dingo (*Canis familiaris*) may have led to their demise on the mainland around 2,000 years ago, though one questionable date of 0 to 80 years was given to

a 1950 record from Western Australia (Archer, 1984; Strahan, 1983).

Unfortunately for the thylacine, a bounty system was placed upon them in 1930 by the Van Dieman's Land Company and later increased by the Tasmanian government (Guiler, 1985). The bounty was enacted in response to concern about the thylacine's sheep-killing. Thylacines are reported to have preyed upon sheep, though the numbers of sheep killed by thylacines appears to be greatly exaggerated (Guiler, 1985). The persecution of the species took its toll, and 2,184 individuals between 1888 and 1909 were presented for bounty (Green, 1974; Guiler, 1985). The hunting, compounded by a probable epidemic after the turn of the century, brought the species to near extinction, the only indigenous Tasmanian mammal to do so since European colonization. By 1933, the last individual known was captured. It died in the Hobart zoo in 1936, the same year the thylacine was given a fully protected status (Guiler, 1985; Strahan, 1983).

Since 1936, the Tasmanian National Parks and Wildlife Service has recieved numerous reports of thylacines in the wild (Rounsevell and Smith, 1982). None of them have indicated conclusively that *T. cynocephalus* still exists.

Because of the paucity of data and many uncertainties over the thylacines habits, it was the only indigenous terrestrial mammal to be excluded from the Tasmanian

species density distributions. Simpson (1964) used a reconstruction of the former distribution of *Bison bison* from historical data. Although Guiler (1985) did something similar for *T. cynocephalus*, the data most likely reflect centers of bounty claims rather than any actual habitat preferences. Nix (1990) states the sightings have a high positive correlation with the favored sclerophyll and heathland habitats (Green, 1974).

Family Peramelidae. *Perameles gunnii* (Eastern Barred Bandicoot)

This marsupial, which averages 640 grams in weight, appears to spend most of its active time foraging for annelids, ground dwelling insects, and fruit (Heinsohn, 1966; Strahan, 1983). *P. gunnii* thrives on pastoral lands, preferring indigenous and introduced grasslands to sedgeland, forested areas, and alpine zones (Green, 1974; Heinsohn, 1966; Rounsevell and Taylor, unpublished). *P. gunni* generally rests in a shallow nest excavated in the soil and lined with vegetation, although they have also used abandoned rabbit burrows (Heinsohn, 1966). Heinsohn's (1966) population densities averaged 34.4 individuals per 100 acres of study area in the northwest of Tasmania. The absence of the fox (*Vulpes vulpes*) in Tasmania may account for this bandicoots common status in preferred areas, compared with its decreasing mainland populations (Grainger, et al, 1987; Strahan, 1983).

Isoodon obesulus (Southern Brown Bandicoot)

Though more secretive than *Perameles gunnii*, *I. obesulus* also spends most of its active time in search of annelids, other soil invertebrates, and occasional berries (Heinsohn, 1966). Females average 700 grams and males 850 grams (Strahan, 1983). They have a preference for low scrub, and heathlands, where small fires maintain diverse insect populations (Heinsohn, 1966; Strahan, 1983). During the day these bandicoots rest in nests which are lined with vegetation and tend to be well concealed (Strahan, 1983). The Tasmanian populations still remain common in suitable habitats, though fewer small scale fires and increased pastureland has reduced their available habitat (Grainger, et al, 1987; Strahan, 1983).

Family Vombatidae. *Vombatus ursinus*
(Common Wombat)

This large grazing mammal, averaging 26 kilograms, is the only semi-fossorial marsupial in Tasmania (Green, 1974; Strahan, 1983). Wombats may construct a complex of burrows, some up to 20 meters in length, and used by more than one individual at a time. Emerging from the burrow to feed on native grasses, sedges, shrubs and succulent roots, *V. ursinus* may travel several kilometers per day (Grainger, et al, 1987; Strahan, 1983). Populations may be found in all habitats, ranging between sea level and subalpine elevations, but they are most common in dry sclerohyll

forests and coastal heathlands (Green, 1974). Except for the reduction in available habitat through land clearance *V. ursinus* remains unthreatened in Tasmania (Grainger, et al, 1987).

Family Phalangeridae. *Trichosurus vulpecula*
(Common Brushtail Possum)

The thick fur of *T. vulpecula* may be silver-grey, black, reddish, or golden in color. Tasmanian individuals of this indigenous species average 3.5 kilograms (Grainger, et al, 1987). Though hunted for its fur population densities remain high (Green, 1974). In areas of indigenous forests *T. vulpecula* feeds on grasses, herbs, ferns, acacias, eucalyptus and myrtles. *T. vulpecula* has adapted to agricultural and residential areas where it is also known to take meat (Grainger, et al, 1987).

Family Petauridae. *Pseudocheirus peregrinus*
(Common Ringtail Possum)

Highly arboreal, *P. peregrinus* generally moves from tree top to tree top if possible, rather than to venture to the ground (Green, 1974). The species averages 950 grams (Strahan, 1983). *P. peregrinus* feeds on the flowers, fruits, leaves and young shoots from a variety of shrubs and trees, but prefers *Eucalyptus* spp. Though a decline in numbers occurred during the 1950's, the species is now common and widely distributed in suitable Tasmanian forests (Green, 1974; Grainger, et al, 1987).

Petaurus breviceps (Sugar Glider)

P. breviceps is the only indigenous Australian mammal whose Tasmanian origins remain in doubt. From 1834, records indicate that individual *P. breviceps* were brought to Launceston, Tasmania from Port Phillip, Victoria as pets. Gunn (1845, 1851) first noticed a feral population in 1845 and believed it to be expanding. Gunn indicated that *P. breviceps* was not indigenous to Tasmania prior to the arrival of the Port Phillip specimens. This European origin for the Tasmanian population of *P. breviceps* is largely, but not entirely, unquestioned today (Green, 1974; Guiler, 1968; Grainger, et al, 1987; Strahan, 1983).

This glissant marsupial averages 120 grams and is presently widespread and common in most forested areas (Green, 1974; Grainger, et al, 1987). *P. breviceps* lives in community or family groups residing in nests within hollow limbs and trunks (Ride, 1970). Nocturnal, *P. breviceps* forages on flowers, nectar, invetebrates, small birds and gum produced by acacias (Green, 1974; Grainger, et al, 1987). The only apparent threat to the species is clear felling of forests, especially of the trees with nesting cavities (Grainger, et al, 1987).

Family Burramyidae. *Cercartetus lepidus*
(Little Pygmy-possum)

The smallest of Tasmanian mammals, *C. lepidus* ranges from 6 to 9 grams (Grainger, et al, 1987; Strahan, 1983).

C. lepidus builds temporary nests close to the ground, composed of strips of bark. The use of abandoned nests of *Pseudomys novaehollandiae* and of simple cavities in decayed logs have been observed by Green (1979). *C. lepidus* forages mainly on insects, arachnids, and small lizards but may consume nectar as well (Green, 1979). *C. lepidus* stores fat when food is in abundant and becomes torpid for days at a time when food is scarce (Green, 1974). *C. lepidus* has been found in wet sclerophyll forests and sedgeland, but prefers dry and open sclerophyll forests. The species has never been collected in rainforests and may be in competition with *C. nanus* where their distributions overlap. While predators, including feral cats, pose unknown threats to *C. lepidus*, it is through continued habitat removal, primarily by woodchipping available forests, that *C. lepidus* faces its greatest danger (Green 1979).

Cercartetus nanus (Eastern Pygmy-possum)

The diet of this small marsupial may vary with its spatial and temporal distribution. *C. nanus* is known to feed on nectar, and pollen from banksias, eucalypts, and bottle brushes. It also eats insects and arachnids (Strahan, 1983). Grainger, et al (1987) notes that *C. nanus* becomes torpid for at least two weeks when food is scarce. *C. nanus* weighs between 15 and 43 grams. As with

C. lepidus, *C. nanus* also builds nests with strips of bark (Strahan, 1983). *C. nanus* is restricted to rainforests and sclerophyll forests (Green, 1974). In Tasmania, *C. nanus* is threatened by clearing of forests, especially of mature forests with nesting cavities (Grainger, et al, 1987).

Family Potoroidae. *Potorous tridactylus*
(Long-nosed Potoroo)

P. tridactylus inhabits dry and wet sclerophyll forests, fern gullies, and sedgelands that receive more than 760 mm of rainfall per year (Green, 1974; Strahan, 1983). They require a thick cover of vegetation for protection from predation (Ride, 1970). The Tasmanian population varies considerably in individual coloration and size. Females range from 660 to 1350 grams and males range from 740 to 1640 grams. Venturing forth at dusk, *P. tridactylus* forages on roots, tubers, fungi, and soil invertebrates, but does not stray far from cover (Strahan, 1983). Since a dense vegetation cover is required, *P. tridactylus* will not inhabit land cleared by agriculture, burning, or forestry practices (Green, 1974; Ride, 1970; Grainger, et al, 1987; Strahan, 1983). Though available habitats have been reduced, *P. tridactylus* remains common in suitable areas (Grainger, et al, 1987; Strahan, 1983).

Bettongia gaimardi (Eastern Bettong)

The mainland populations of *B. gaimardi* are believed to be extinct and the Tasmanian population is presently the only secure one for the entire genus. The species feeds upon fungi, seeds, roots, bulbs, and possibly gum from acacias. Insects have been found in the stomachs of *B. gaimardi*, but may only be consumed incidental to its foraging of vegetation and fungi. *B. gaimardi* weighs from 1.2 to 2.25 kilograms (Strahan, 1983). The eastern bettong prefers the open, dry sclerophyll forests of eastern Tasmania (Green, 1974; Grainger, et al, 1987). Though this mammal is still common in some areas, its preferred habitat is threatened through forest clearance, and populations do not repopulate areas of reforestation (Grainger, et al, 1987).

Strahan (1983) states

It has often been suggested that bettongs survived in Tasmania because foxes have not become established there. An alternative or contributory factor may be the relatively low density of rabbits on the island and the consequent preservations of the grassy habitat which the bettongs require for cover.

Family Macropodidae. *Thylogale billardierii*
(Tasmanian Pademelon)

This small wallaby once ranged over southeastern mainland Australia, but it is presently endemic to Tasmania and the larger Bass Strait islands (Green, 1974; Strahan,

1983). Females average 3.9 kilograms and males average 7 kilograms (Strahan, 1983). *T. billardierii* ranges widely over a variety of vegetation types, including rainforests, sedgeland, wet and dry sclerophyll forests, and any scrub land where there is dense undergrowth (Green, 1974; Grainger, et al, 1987; Strahan, 1983). It feeds on leaves, herbs, and native and introduced grasses (Green, 1974; Strahan, 1983). Though partly protected, *T. billardierii* continues to be hunted and destroyed as a pest in Tasmania because of its deprivations on certain agricultural crops, its palatable flesh, and the economic value of its fur (Green, 1974; Grainger, et al, 1987; Strahan, 1983). Even so, large numbers continue to be observed in forested and agricultural areas (Grainger, et al, 1987).

Macropus rufrogriseus (Bennett's Wallaby)

Though Green (1974) notes a preference for the dry sclerophyll forests, *M. rufrogriseus* may be found in a number of habitats from sea level to sub-alpine zones, including the edge of rainforests, heathlands, and pastureland bordered by vegetative cover. Females average 14 kilograms and males average 19.7 kilograms. *M. rufrogriseus* is a grazing mammal and feeds on grasses and herbs (Strahan, 1983). The species has adapted well to agricultural and forestry operations and is common in many areas of Tasmania (Grainger, et al, 1987).

Macropus giganteus (Forester Kangaroo)

The largest indigenous terrestrial mammal in Tasmania, *M. giganteus tasmaniensis* has some slight differences in build, skull and pelage from the mainland populations. Adult males may stand more than 180 cm in height and weigh up to 66 kilograms, while females may weigh up to 32 kilograms (Green, 1974; Strahan, 1983). Though found in grassy plains, coastal heath and up to the subalpine zone this grazing marsupial prefer the open, dry sclerophyll forests of eastern Tasmania. It feeds on grasses, including those in introduced pastures. (Green, 1974; Grainger, et al, 1987). Currently attempts are being made to protect the species from further depletion that occurred from past hunting and land clearance (Grainger, et al, 1987).

Order Rodentia. Family Muridae. Hydromys chrysogaster (Water Rat)

H. chrysogaster is an aquatic murid, endowed with a water repellent fur and partly webbed hind feet. Water rats are distributed throughout water systems, ranging from the highland lakes to coastal estuaries (Green, 1974; Grainger, et al, 1987). Females average 606 grams and males average 755 grams (Strahan, 1983). *H. chrysogaster* scavenges and preys upon a wide variety of available invertebrates and vertebrates, including small mammals and water birds (Green, 1974: Strahan, 1983). The population

is considered secure in Tasmania and has a wide distribution throughout the eastern, northern and southwestern Australian mainland and New Guinea (Grainger, et al, 1987; Strahan, 1983).

Pseudomys higginsii (Long-tailed Mouse)

This small murid averages 70 grams and is found in the wetter Tasmanian habitats (Grainger, et al, 1987). Taylor, et al (1985) found the population densities for *P. higginsii* to be nearly three times higher in rainforest habitat compared with wet scrub, eucalypt scrub, and sedgeland which had relatively equal densities. Alpine habitat had the lowest densities of *P. higginsii*. *P. higginsii* has an omnivorous diet which includes fungi, seeds, fruit, insects, and spiders (Grainger, et al, 1987; Strahan, 1983). Since population densities are high in preferred areas this Tasmanian endemic should survive as long as rainforests and other wet habitats remain (Strahan, 1983).

Pseudomys novaehollandiae (New Holland Mouse)

Once thought extinct, populations of this small rodent have been discovered existing in patchy distributions in mainland Australia and Tasmania. Its diet varies spatially and temporally and consists of invertebrates, seeds, leaves, flowers and fungi. *P. novaehollandiae* weighs between 20 to 24 grams and, prefer barren, sandy soils with short perennials (Strahan, 1983). It is common in dry

sclerophyll forests and heathlands which have been subject to fire a year or more previous to colonization by *P. novaehollandiae*. Restricted by its habitat preferences, *P. novaehollandiae* is vulnerable to clearance of heathlands and dry sclerophyll forests as well as changes in the fire frequency (Grainger, et al, 1987; Strahan, 1983).

Mastocomys fuscus (Broad-toothed Rat)

Grasses form the bulk of this species food, with seeds, sedges, and leaves and bark of shrubs forming the remainder (Grainger, et al, 1987; Strahan, 1983). Its weight averages 122 grams (Strahan, 1983). *M. fuscus* has been found in subalpine heathlands and drainages in wet sedgeland, bordering rainforests (Green, 1968; Strahan, 1983). Green (1968) indicates that limited habitats restrict it to western Tasmania, though it has been collected from near sea level to nearly 1,000 meters elevation. Even in the confined areas of suitable habitats, *M. fuscus* appears uncommon and is probably vulnerable to fires, feral cats, and competition from other indigenous rodents (Grainger, et al, 1987; Strahan, 1983).

Rattus lutreolus (Swamp rat)

The Tasmanian population averages 104 grams in weight compared with 122 grams for the mainland Australian population (Strahan, 1983). Insects, fungi, ferns, grasses and sedges form the majority of its diet (Grainger, et al,

1987; Strahan, 1983). Taylor, et al (1985) found population densities of *R. lutreolus* to be higher in areas of shrubs 1.3 meters or taller, compared with areas of lower or no shrubs. It can be found in heathland, rainforests, wet scrub, eucalypt scrub, sedgeland and at a much lower density in alpine areas (Grainger, et al, 1987; Taylor, et al, 1985). Presently, *R. lutreolus* may be the most widespread and abundant indigenous mammal in Tasmania (Grainger, et al, 1987).

Order Chiroptera. Family Vespertilionidae.
Chalinolobus gouldi (Gould's Wattleed Bat)

Varying in weight from 10 to 18 grams, this mammal is an opportunistic feeder of available insects (Strahan, 1983). An uncommon species, *C. gouldi* roosts in hollows of trees in mature forests, usually in colonies of up to 30 individuals and hibernates in winter (Hall, 1979; Grainger, et al, 1983). This bat inhabits all forest types except in southwestern Tasmania, where a cooler, wetter climate may be too thermally expensive or lacking in a sufficient food supply (Grainger, et al, 1987; Taylor, et al, 1987). All species of Chiroptera in Tasmania were found to have populations that were more dense in regenerated forests, probably due to an increase in insect densities. However, Tasmanian bat species roost primarily in old growth trees and continued clearcuts of Tasmanian forests will likely result in a severe loss of local bat populations (Taylor,

et al, 1987), and a consequent reduction of insect predation.

Chalinolobus morio (Chocolate Wattled Bat)

C. morio varies in weight from 6.7 to 13.7 grams and feeds on insects within the forest canopy (Grainger, et al, 1987). This bat roosts communally in forests with colonies of up to 20 individuals (Hall, 1979). *C. morio* has a shorter period of winter torpor than do other Tasmanian species, which allows for a period of feeding with reduced competition (Grainger, et al, 1987; Strahan, 1983). *C. morio* is widely distributed over Tasmania, it inhabits all forests types with mature stands of trees (Grainger, et al, 1987; Taylor, et al, 1987).

Eptesicus sagittula (Large Forest Eptesicus)

Varies in weight from 3.7 to 5.6 grams and feeds upon insects within the forest canopy (Grainger, et al, 1987). Little is known of its communal tree roosts, though two mainland colonies had 18 and 60 individuals, respectively (Hall, 1979). Studies of mainland populations indicate that they come out of torpor on mild winter nights to forage (Strahan, 1983). *E. sagittula* appears to be widespread and common in a variety of forest habitats with mature stands of trees (Grainger et al, 1987; Taylor, et al, 1987).

Eptesicus regulus (King River Eptesicus)

E. regulus varies in weight from 3.8 to 7.7 grams and preys upon insects at the upper limit of the forest understorey (Grainger, et al, 1987). This bat roosts in the hollows of trees may consist of solitary individuals, though colonies of up to 9 bats have been found (Hall, 1979; Strahan, 1983). *E. regulus* appears to be widespread and common in a variety of forest habitats with mature stands of trees (Grainger, et al, 1987; Taylor, et al, 1987).

Eptesicus vulturnus (Little Forest Eptesicus)

The smallest, and perhaps the most numerous, Tasmanian bat, *E. vulturnus* varies in weight from 3.7 to 5.6 grams (Green, 1966; Grainger, et al, 1987). It is an opportunistic predator on insects between the forest canopy and 2 meters off the ground (Strahan, 1983; Taylor, et al, 1987). This forest inhabitant may roost in the hollow of trees individually or in colonies of up to 50 (Strahan, 1983). Though *E. vulturnus* appears to be widespread in Tasmanian forests, there is a noticeable preference for lowland dry sclerophyll forests (Taylor, et al, 1987).

Falsitrellis tasmaniensis (Tasmanian Pipistrelle)

Weighing between 16.2 and 24.1 grams, *F. tasmaniensis* is the largest Tasmanian Chiropteran (Grainger et al, 1987). It preys at the upper forest canopy or above

primarily for moths and beetles, but will take other insects. *F. tasmaniensis* becomes torpid during the cooler months, and roosts in the hollows of trees, possibly communally (Hall, 1979; Grainger, et al, 1987). The Tasmanian distribution of this uncommonly collected species appears to exclude the western portion of the island (Rounsevell and Taylor; unpublished).

Nyctophilus geoffroyi (Lesser Long-eared Bat)

N. geoffroyi varies in weight from 6.8 to 12.2 grams (Grainger, et al, 1987). It preys opportunistically on insects, particularly Lepidoptera, capturing them close to the ground (Grainger, et al 1987; Taylor, et al, 1987). Torpid during winter, *N. geoffroyi* roosts singly or in groups which rarely exceed four individuals (Grainger, et al, 1987; Hall, 1979). Since it adapts well to buildings, agricultural and urban areas may have led to an increased population density of this species (Strahan, 1983).

Nyctophilus timoriensis (Greater Long-eared Bat)

N. timoriensis varies in weight from 9.8 to 18.9 grams (Grainger, et al, 1987). *N. timoriensis* has not been collected in southwestern Tasmania, but appears to inhabit a wide range of forests across the rest of the island (Grainger, M., et al, 1987; Taylor, et al, 1987). It is believed to roost in mature trees singly or in pairs, and goes into torpor during winter (Grainger, M. et al, 1987;

Strahan, 1983). It preys on insects, which are often collected on vegetation or on the ground (Grainger, M. et al, 1987). Much of its natural history of this uncommon, little collected species remains uncertain (Grainger, M. et al, 1987; Strahan, 1983).

CHAPTER III

MATERIALS AND METHODS

Distributional maps for the mammals of Tasmania have recently been compiled (Rounsevell and Taylor, unpublished). These maps contain approximately 10,000 records and include all indigenous terrestrial mammals of Tasmania except for *Thylacinus cynocephalus*. The maps show the presence or absence of each species within a network of 100 square kilometer grids.

Simpson (1964) examined the species density distribution of North American terrestrial mammals and compared this with geographic trends, including latitudinal and topographic gradients. Using the recent distributional maps of Rounsevell and Taylor (unpublished) I produced a species density distribution for Tasmanian mammals. Following Simpson's (1964) approach, I compiled individual species' ranges into a distribution comprised of 34 indigenous terrestrial mammals of Tasmania. Binomial nomenclature of the mammalian species was taken from Strahan (1983).

The 100 square kilometer grids from the species range maps had a transparency overlaid on them, and the total

number of species present in each quadrat (species density) was recorded. Species density distributions were made using quadrats of 100 and 900 square kilometers on each side. The quadrats of 100 square kilometers was the same size as that used by Rounsevell's and Taylor's (unpublished) presentation of Tasmanian mammal ranges and contained the greatest possible resolution of currently known distributional patterns. The quadrats of 900 square kilometers were compiled to search for possible patterns in mammalian distributions which may not be apparent using the quadrats of 100 square kilometers. A total of 711 and 92 quadrats covered the island in areas of 100 and 900 square kilometers, respectively.

A quantitative comparison, using simple linear regression analysis, of topographic relief (elevation change within a quadrat) was performed with the 900 square kilometer quadrats to look for correlations between topographic relief and species densities (Table I). The data for topographic relief were obtained from Davies (1965); changes in elevations were rounded to the nearest 1,000 feet.

TABLE I

LIST OF THE NUMBER OF MAMMALIAN SPECIES AND TOPOGRAPHIC RELIEF (MEASURED IN 1000' INTERVALS) IN 49 QUADRATS OF 900 SQUARE KILOMETERS USED IN A LINEAR REGRESSION ANALYSIS

Quadrat	Number of Mammalian Species	Topographic Relief (feet)
1	18	>1,000
2	14	>1,000
3	25	>2,000
4	9	>2,000
5	15	>2,000
6	17	>3,000
7	16	>3,000
8	28	>1,000
9	28	>1,000
10	20	>3,000
11	25	>3,000
12	13	>2,000
13	19	>3,000
14	28	>3,000
15	23	>3,000
16	26	>3,000
17	16	>2,000
18	20	>3,000
19	16	>3,000
20	19	>2,000
21	10	>3,000
22	19	>2,000
23	14	>1,000
24	18	>3,000
25	15	>3,000
26	17	>2,000
27	17	>2,000
28	14	>3,000
29	22	>2,000
30	15	>2,000
31	16	>3,000
32	16	>3,000
33	24	>1,000
34	20	>3,000
35	7	>3,000
36	17	>3,000

TABLE I

LIST OF THE NUMBER OF MAMMALIAN SPECIES AND TOPOGRAPHIC RELIEF (MEASURED IN 1000' INTERVALS) IN 49 QUADRATS OF 900 SQUARE KILOMETERS USED IN A LINEAR REGRESSION ANALYSIS
(continued)

Quadrat	Number of Mammalian Species	Topographic Relief (feet)
37	14	>2,000
38	16	>2,000
39	20	>2,000
40	19	>1,000
41	19	>2,000
42	23	>3,000
43	25	>2,000
44	15	>1,000
45	16	>2,000
46	14	>3,000
47	20	>3,000
48	22	>3,000
49	6	>3,000

The distribution of species within the quadrats of 100 square kilometers was so random as to make a quantitative analysis meaningless. The random distribution may largely be due to the lack of comprehensive mammal surveys over the entire island of Tasmania, which is a reflection upon the inadequacy of the current data to present an accurate indication of mammal distributions. A species was recorded as present in a quadrat if its distribution included any portion of the quadrat. Regardless of the species' density. Not all the quadrats have an equal amount of area within their boundaries. Those overlapping with the coast have less than the 900 square kilometers of the inland quadrats and were not used in the quantitative comparison

with topographic relief. A total of 49 inland 900 square kilometer quadrats were used in a linear regression comparison between species densities and topographic relief. Quadrats larger than 900 square kilometers appeared to offer little additional information on distributional trends and resulted in a loss of data through decreased resolution and the number of quadrats.

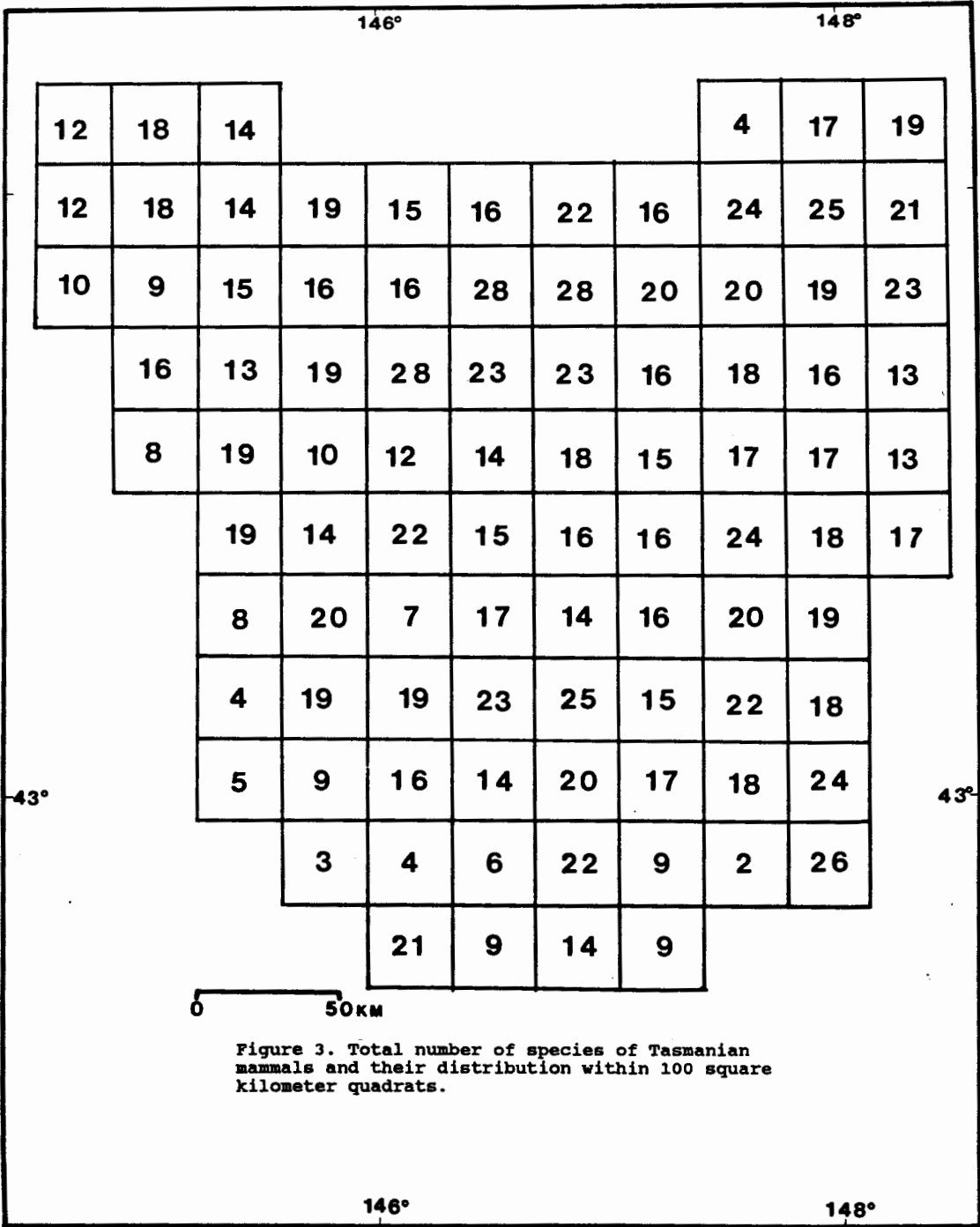
The two most important limitations to this method of distributional analysis are those involved in the accuracy and comprehensiveness of the data, and the biases inherent within the quadrats. The distributional data are limited by the accuracy and extent of information. In Tasmania, several regions, particularly in the west, have had only a few faunal surveys or studies of the indigenous species (Norton, 1983; Taylor, et al, 1987). The ephemeral spatial and temporal characteristics of the fauna and, on a longer scale, of their habitats create what may at best be a portrait of their distributions for a limited time. This may be particularly compounded by the use of much smaller quadrats than Simpson (1964), Wilson (1974), and Schall and Pianka (1978) used, though they were looking at distributions on a continental scale.

CHAPTER IV

RESULTS

Linear regression of the species densities on the 900 square kilometer quadrats (Figure 3) with topographic relief yielded no significant correlation ($r = -.12$). The slope for this comparison between species densities and topographic relief is $-.001$.

Compilation of species densities within the 100 square kilometer quadrats (Figure 4) revealed extensive areas of Tasmania in which no species had been recorded. This area is equivalent to 12.66% of the total number of quadrats (90 out of 711). 62% of the quadrats within which no species are recorded lie in Tasmania west of 146° . The largest continuous distributional groupings of recorded species have been from the central and eastern portions of Tasmania. These, and the north western and central western distributional records for mammalian species, largely coincide with roads and the centers of human population. Though a lower level of human activity, relative to the rest of Tasmania, is one possible reason for an absence of species recorded in any particular quadrat, a lack of recorded species within the 100 square kilometer quadrats



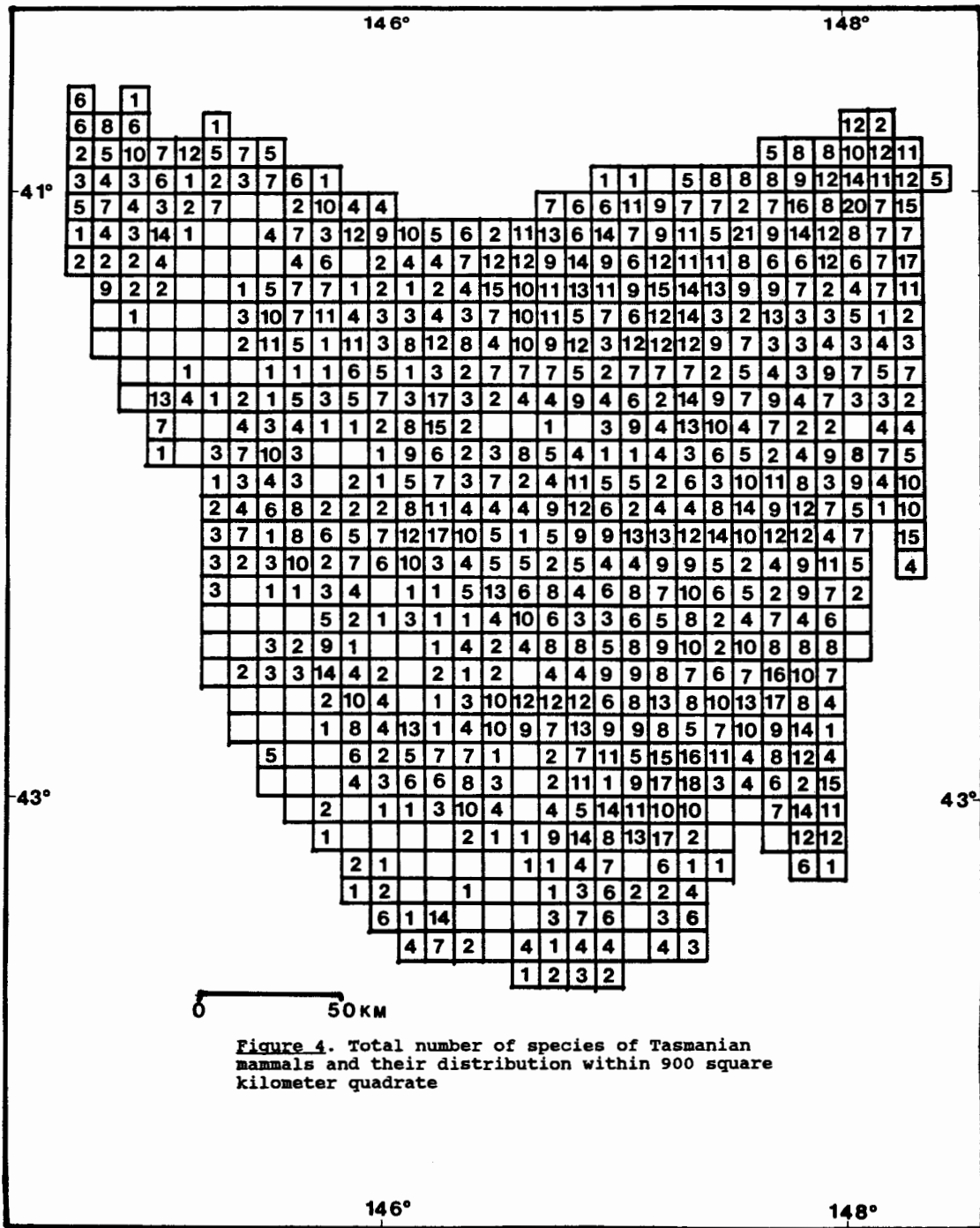


Figure 4. Total number of species of Tasmanian mammals and their distribution within 900 square kilometer quadrate

happens to be most extensive in habitats consisting of rain forest and sedgeland (Figure 2). Though Simpson (1964) was investigated latitudinal trends in mammalian distributions across North America, none are apparent in Tasmania, which encompasses less than 3 degrees of latitude.

CHAPTER V

DISCUSSION

Species densities of Tasmanian mammals showed no significant correlation ($r = -.12$) with topographic relief. Looking at a continental and regional scale Rogers (1976), Simpson (1964) and Wilson (1974) suggested much stronger correlations between mammalian species densities and topographic relief. Simpson (1964) suggested that an increase in habitats with increased topographic relief was the factor involved in higher species densities. An increase in altitude alone would be predicted to have the opposite trend in species densities. Simpson (1964) also speculated that the greater species diversities associated with areas of topographic relief may, in part, be a consequence of speciation within geographically isolated regions.

There are several possible reasons behind the lack of correlation between species densities and topographic relief in Tasmania. The varied topographic relief found throughout most of Tasmania may have reduced any significant effect within specific areas. Faunal surveys conducted at various altitudes, within similar habitats, could be made to test this possibility. Rogers (1976) found a strong

negative correlation between topographic relief and salamander species in Texas even when there was little altitudinal variation or range of topographic relief within the quadrats (125-1675 feet and 250-1600 feet). Most of the 900 square kilometer quadrats I examined fall within, or exceed, such topographic relief and altitudinal variation. Of 49 quadrats not overlapping with the coast line (to disregard any effect of unequal areas), 77.6% have a topographic relief greater than 2000 feet. Another possibility is that the data for topographic relief and/or the species density data is too coarse to permit any significant analysis. The effect of speciation in mountainous areas, which Simpson (1964) discussed, is unlikely to be seen in Tasmania. Although the island is topographically complex, and this could lead to isolation of populations, all of the current indigenous mammalian fauna have or have had representatives on the Australian mainland during the Holocene. The separation from the mainland only 10,000 to 15,000 years ago (Hope, 1974) has allowed very little time for speciation in the mammalian fauna to occur, though there are several populations with subspecies endemic to Tasmania (Green, 1974; Strahan, 1983).

Across Tasmania there is an apparent randomness in the distribution of species densities (Figures 3 and 4). This may represent the mosaic of habitats found in most areas of

Tasmania. Possibly, disturbance of native vegetation from human activities has produced disjunct pockets of populations of some mammalian species, which presents the appearance of a random distribution. More likely it is representative of the patterns of human activities involved in mammalian records. Figure 4 shows an absence of any species in several quadrats, and low numbers (<3) in many nearby quadrats. The majority of these empty quadrats are in western Tasmania. Western Tasmania has the largest region of rainforest and sedgeland vegetation (Figure 2). Green (1974) associates the drier sclerophyll forests as a preferred habitat of many Tasmanian mammals, and Taylor, et al (1985) recorded eight species in their survey in western Tasmania to be uncommon. However, a total of nineteen indigenous mammal species which were surveyed by Taylor, et al (1985) were recorded in more than one vegetation type (which included rainforest, wet scrub, eucalypt scrub, sedgeland, and alpine). This suggests that further faunal surveys in western Tasmania should reveal a much more widespread distribution of many of the mammalian species. Bats are the least surveyed of the mammalian groups, but are believed to have a widespread distribution in Tasmania.

Several suggestions for quantitative comparisons of species distributions with geographic components other than topographic relief have been made by my committee.

Unfortunately, available sources, and constraints within

this thesis, do not presently allow for further analysis. These geographic variables include: mean elevation and topographic complexity; human activities and disturbances; major vegetation types and the habitat diversity; and average and extreme precipitation and temperatures within each quadrat. A comparison of the range of each of the 34 individual mammalian species with each other may reveal distributional patterns affected by competition.

Mammals currently indigenous to Tasmania evolved largely in sclerophyll forests dominated by *Eucalyptus* spp. throughout Australia (Archer, 1984). The preference and higher population densities of several Tasmanian species for drier sclerophyll forests, compared with rainforests and sedgeland (Green, 1974; Taylor, et al, 1985), may be due to previous adaptations to these environments. Bats are the least surveyed of the mammalian groups, and are believed to have a widespread distribution in Tasmania. Present range maps (Rounsevell and Taylor, unpublished), however, are unable to confirm this.

Perhaps the most useful information of the species density distributions (Figure 4) is an indication of those areas still in the greatest need of faunal surveys.

CHAPTER VI

CONCLUSIONS

Although studies of species distributions on continental scales (Kiestler, 1971; Schall and Pianka, 1978; Simpson, 1964; Wilson, 1974) and regional scales (Rogers, 1976) found correlations with geographic trends, I was unable to do so for mammals in Tasmania. It may be that such patterns are not apparent on smaller scales. The impoverished fauna of Tasmania, relative to mainland Australia (Strahan, 1983), may present different dispersal patterns through decreased species competition or a reduction in habitat types. The mosaic pattern of vegetation in Tasmania may be responsible for the apparent randomness of mammalian faunal distributions. Another possibility is that the species data is too coarse at this point to reveal any geographic trends.

Lack of correlation of the species density distributions with topographic relief is of little consequence, and may have been predicted by Simpson's (1964) discussion of the use of small (<less than 100 square miles) quadrat sizes. While my 900 square kilometer quadrats were larger than this, they were much smaller than

Simpson's (1964) quadrats of 22,500 square mile (60,250 square kilometers).

Many areas in Tasmania are threatened with habitat loss or alteration through logging, pastoral clearance and burning. Information on which habitats and which regions are critical to the survival of indigenous mammals, several of which are endemic, is needed for their continued preservation. What may be of the most importance in this study is the indication of which areas of Tasmania, in terms of the 100 square kilometer quadrats, appear to lack indigenous mammalian species. Since the majority of the quadrats which are noted for an absence of recorded species occur in rain forest and sedgeland vegetation, further studies of such habitats are vital to obtaining a more complete understanding of the ecology and evolution of Tasmanian mammals. Studies in these areas may reveal large adaptive differences between the Tasmanian and mainland Australian populations of conspecifics, since no similar vegetation types are to be found on the mainland. Future surveys of such regions of faunal uncertainties are important to determine how critical these areas may be to the survival of indigenous Tasmanian mammals.

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APPENDIX

Species List

1. *Ornithorhynchus anatinus* (Platypus)
2. *Tachyglossus aculeatus* (Echidna)
3. *Dasyurus maculatus* (Spotted-tailed Quoll)
4. *Dasyurus viverrinus* (Eastern Quoll)
5. *Sarcophilus harrisii* (Tasmanian Devil)
6. *Antechinus minumus* (Swamp Antechinus)
7. *Antechinus swainsonii* (Dusky Antechinus)
8. *Smithnopsis leucopus* (White-footed Dunnart)
9. *Thylacinus cynocephalus* (Thylacine)
10. *Perameles gunnii* (Eastern Barred Bandicoot)
11. *Isoodon obesulus* (Southern Brown Bandicoot)
12. *Vombatus ursinus* (Common Wombat)
13. *Trichosurus vulpecula* (Common Brushtail Possum)
14. *Pseudocheirus peregrinus* (Common Ringtail Possum)
15. *Petaurus breviceps* (Sugar Glider)
16. *Cercartetus lepidus* (Little Pygmy-possum)
17. *Cercartetus nanus* (Eastern Pygmy-possum)
18. *Potorous tridactylus* (Long-nosed Potoroo)
19. *Bettongia gaimardi* (Eastern Bettong)

20. *Thylogale billardierii* (Tasmanian Pademelon)
21. *Macropus rufrogriseus* (Bennett's Wallaby)
22. *Macropus giganteus* (Forester Kangaroo)
23. *Hydromys chrysogaster* (Water Rat)
24. *Pseudomys higginsii* (Long-tailed Mouse)
25. *Pseudomys novaehollandiae* (New Holland Mouse)
26. *Mastocomys fuscus* (Broad-toothed Rat)
27. *Rattus lutreolus* (Swamp Rat)
28. *Chalinolobus gouldi* (Gould's Wattled Bat)
29. *Chalinolobus morio* (Chocolate Wattled Bat)
30. *Eptesicus sagittula* (Large Forest Eptesicus)
31. *Eptesicus regulus* (King River Eptesicus)
32. *Eptesicus vulturinus* (Little Forest Eptesicus)
33. *Falsitrellis tasmaniensis* (Tasmanian Pipistrelle)
34. *Nyctophilus geoffroyi* (Lesser Long-eared Bat)
35. *Nyctophilus timoriensis* (Greater Long-eared Bat)