

Mammals of New South Wales: past, present and future

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ABSTRACT

A total of 131 non-marine species of native mammals, including the Dingo *Canis familiaris dingo*, has been recorded in New South Wales since the early days of European settlement in 1788. Twenty-nine of these species are now extinct in the State; 21 species remain extant beyond the borders of New South Wales while eight species are entirely extinct. Most losses (21 species) occurred before 1900, particularly in the arid western region of the State. Overall, State-level extinctions represent 39.3 per cent of native rodents (11 of 28 species), 27.0 per cent of marsupials (17 of 63 species) and 2.7 per cent of bats (one of 37 species). Forty-eight extant species of native mammals are considered to be presently endangered, including 20 species of marsupials, nine rodents and 19 bats; the distributions of most encompass eastern New South Wales. Three scenarios are presented for the State's native mammals for the year 2038, ranging from optimistic (16 species are added to the present list by discoveries and taxonomic revision) through maintenance of the *status quo* to pessimistic (48 presently endangered species disappear). Which scenario is realized will depend on whether appropriate programmes of research and management are implemented now.

INTRODUCTION

In his presidential address to the Royal Zoological Society of New South Wales in 1932, Ellis Troughton presented compelling evidence of mammalian declines and extinctions throughout much of southeastern Australia. He saw little hope that New South Wales might provide a sanctuary against further losses, but argued strongly for a sustained programme of survey and research as a first step in faunal conservation. Troughton's concerns echoed the earlier writings of John Gould (1863), Gerard Krefft (1866) and Frederic Wood Jones (1923–1925) that took the view that several species of native mammals were at risk and were vanishing under the onslaught of new European uses of the land. More recently, surveys of mammals throughout New South Wales have revealed losses of species in all regions (e.g., Marlow 1958; Lunney and Leary 1988; Goldney and Bowie 1990; Dick and Andrew 1993), particularly in the Western Division (Dickman *et al.* 1993; Dickman 1994). Listings of species of conservation concern under Schedule 12 of the *National Parks and Wildlife Act* 1974, as amended by the *Endangered Fauna (Interim Protection) Act* 1991, confirm that mammals have fared more poorly than other vertebrate groups in New South Wales since European settlement in 1788, with over half of the original species having declined or disappeared (Lunney *et al.* 1994).

Against this dismal background, the present paper has three objectives: to (1) review the current status of mammals in New South Wales, and quantify changes in status that have occurred since 1788; (2) identify which groups of native mammals and which regions of the State have experienced most changes; and (3) predict further change in the status of mammals into the twenty-first century.

METHODS

The information required for this study consists of locality records and dates of collection of mammals from 1788 to the present. Methods of collecting have been described in detail by Dickman *et al.* (1993) and Ellis and Etheridge (1993), and include accessing records from museums, published and unpublished literature, questionnaire surveys, faunal surveys, Aboriginal sources, and identification of remains in owl pellets and Fox *Vulpes vulpes*, Cat *Felis catus* and Dingo *Canis familiaris dingo* scats. In the course of compiling this information, care was taken to confirm the specific identities of old specimens and other early records. The classification scheme follows Walton (1988). Mammalian records have been entered into the Atlas of New South Wales Wildlife (Ellis and Etheridge 1993), and this has provided a valuable database for the present study.

RESULTS

1788–1993

A total of 129 non-marine species of native mammals has been recorded in New South Wales since 1788. This rises to 130 if the Dingo is included, and 131 with inclusion of the Long-eared Bat *Nyctophilus howensis*, which is endemic to Lord Howe Island of the State of New South Wales. Including *N. howensis*, 27 of these species have not been recorded in the last 50 years in New South Wales (Table 1) and can be considered extinct within the State (Lunney *et al.* 1994). Eight species are entirely extinct; 19 are still extant but occupy reduced ranges beyond the borders of New South Wales. A further two species, the Eastern

Quoll *Dasyurus viverrinus*, and Silky Mouse *Pseudomys apodemoides*, have not been reliably recorded in New South Wales for at least 30 years and hence may represent further State extinctions (Table 1). There is considerable doubt about the specific identity of the single specimen of *P. apodemoides*. If it is referable to the Blue-grey Mouse *P. glaucus* (see Dickman 1993; Dickman *et al.* 1993 for discussion), loss of this species would represent both a State and national extinction as the only two previous records of *P. glaucus* are from southern Queensland in 1892 (Troughton 1957). Overall, State-level extinctions represent 2.7 per cent of bats (one of 37 species), 39.3 per cent of rodents (11 of 28 species) and 27.0 per cent of marsupials (17 of 63 species); both species

Table 1. Native mammals that have become extinct in New South Wales since 1788, with date and region of last records.

		Date of last record ¹	Region of last record ²
Marsupialia:			
Mulgara	<i>Dasyercus cristicauda</i> ³	~1800	NW
Western Quoll	<i>Dasyurus geoffroii</i>	1857	SW
Eastern Quoll	<i>Dasyurus viverrinus</i>	1964	Coast
Red-tailed Phascogale	<i>Phascogale calura</i>	1857	SW
Numbat	<i>Myrmecobius fasciatus</i>	1900	W
Pig-footed Bandicoot	<i>Chaeropus ecaudatus</i>	1880	SW
Golden Bandicoot	<i>Isoodon auratus</i>	1857	SW
Western Barred Bandicoot	<i>Perameles bougainville</i>	1866	SC
Bilby	<i>Macrotis lagotis</i>	1912	SC
Northern Hairy-nosed Wombat	<i>Lasiorhinus krefftii</i>	1909	SC
Tasmanian Bettong	<i>Bettongia gaimardi</i>	1910	Coast
Burrowing Bettong	<i>Bettongia lesueur</i>	1892	C
Brush-tailed Bettong	<i>Bettongia penicillata</i>	1906	Coast
Northern Bettong	<i>Bettongia tropica</i>	~1840	NC
Eastern Hare-wallaby	<i>Lagorchestes leporides</i>	1890	NC
Bridled Nailtail Wallaby	<i>Onychogalea fraenata</i>	1924	C
Crescent Nailtail Wallaby	<i>Onychogalea lunata</i>	1857	SW
Rodentia:			
White-footed Rabbit-rat	<i>Conilurus albipes</i>	1846	NC
Lesser Stick-nest Rat	<i>Leporillus apicalis</i>	1883	SW
Greater Stick-nest Rat	<i>Leporillus conditor</i>	1857	SW
Fawn Hopping-mouse	<i>Notomys cervinus</i> ⁴	1845	NW
Dusky Hopping-mouse	<i>Notomys fuscus</i> ³	~1800	NW
Long-tailed Hopping-mouse	<i>Notomys longicaudatus</i>	1845	SW
Mitchell's Hopping-mouse	<i>Notomys mitchellii</i>	1857	SW
Silky Mouse	<i>Pseudomys apodemoides</i>	1956	NC
Plains Rat	<i>Pseudomys australis</i>	~1840	NC
Desert Mouse	<i>Pseudomys desertor</i>	1857	SW
Gould's Mouse	<i>Pseudomys gouldii</i>	1857	SW
Chiroptera:			
Lord Howe Long-eared Bat	<i>Nyctophilus howensis</i>	pre-1900	LHI

¹Sources are: Marlow (1958), Caughley (1980), Hermes (1980), Ashby *et al.* 1990, Ellis (1992, 1993, in press), Dickman (1993), Dickman *et al.* (1993). ²Sources as in ¹Codes represent geographical regions within New South Wales: Coast = coastal strip, LHI = Lord Howe Island, NW = North-west, NC = North-central, SW = south-west, SC = south-central, W = western, C = central. ³Disappearance of these species can be dated only approximately from sub-fossil material (Ellis 1992, in press). ⁴This species is included here as extinct in New South Wales as no specimens have been obtained since 1845. Circumstantial evidence for its continued existence in the State is given by Dickman (1993). The Large-footed Mouse-eared Bat *Myotis australis* (Dobson 1878) is not listed due to uncertainty about its identity. The date of extinction of *Nyctophilus howensis* is unclear; it is known only from a skull of unknown age collected in 1972 (McKean 1975).

Table 2. Extant native mammals listed as "threatened" and "vulnerable and rare" in New South Wales on Schedule 12 of the *Endangered Fauna (Interim Protection) Act 1991*.

		Status ¹	State distribution ²
Marsupialia:			
Kultarr	<i>Antechinomys laniger</i>	T	C,W
Tiger Quoll	<i>Dasyurus maculatus</i>	VR	E
Southern Ningau	<i>Ningau yvonneae</i>	VR	C,W
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	VR	E
Common Planigale	<i>Planigale maculata</i>	VR	NE
White-footed Dunnart	<i>Sminthopsis leucopus</i>	VR	SE
Striped-faced Dunnart	<i>Sminthopsis macroura</i>	VR	NW
Southern Brown Bandicoot	<i>Isodon obesulus</i>	T	SE
Rufous Bettong	<i>Aepyprymnus rufescens</i>	VR	NE
Long-footed Potoroo	<i>Potorous longipes</i>	T	SE
Long-nosed Potoroo	<i>Potorous tridactylus</i>	VR	E
Black-striped Wallaby	<i>Macropus dorsalis</i>	T	NE
Parma Wallaby	<i>Macropus parma</i>	VR	NE
Brush-tailed Rock-wallaby	<i>Petrogale penicillata</i>	VR	E
Yellow-footed Rock-wallaby	<i>Petrogale xanthopus</i>	T	NW
Red-legged Pademelon	<i>Thylogale stigmatica</i>	VR	NE
Mountain Pigmy-possum	<i>Burrhamys parvus</i>	VR	SE
Yellow-bellied Glider	<i>Petaurus australis</i>	VR	E
Squirrel Glider	<i>Petaurus norfolcensis</i>	VR	E
Koala	<i>Phascolarctos cinereus</i>	VR	All
Rodentia:			
Forrest's Mouse	<i>Leggadina forresti</i>	VR	NW
Broad-toothed Rat	<i>Mastacomys fuscus</i>	VR	SE
Bolam's Mouse	<i>Pseudomys bolami</i>	T	SW
Smoky Mouse	<i>Pseudomys fumeus</i>	T	SE
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	VR	NE
Sandy Inland Mouse	<i>Pseudomys hermannsburgensis</i>	VR	NW
Hastings River Mouse	<i>Pseudomys oralis</i>	T	NE
Pilliga Mouse	<i>Pseudomys pilligaensis</i>	VR	NE
Long-haired Rat	<i>Rattus villosissimus</i>	VR	NW
Chiroptera:			
Queensland Tube-nosed Bat	<i>Nyctimene robinsoni</i>	VR	NE
Black Flying-fox	<i>Pteropus alecto</i>	VR	NE
Queensland Blossom Bat	<i>Syconycteris australis</i>	VR	NE
Large Pied Bat	<i>Chalinolobus duyeri</i>	VR	NE
Hoary Bat	<i>Chalinolobus nigrogriseus</i>	VR	NE
Little Pied Bat	<i>Chalinolobus picatus</i>	VR	C,W
Baverstock's Bat	<i>Eptesicus baverstocki</i>	VR	C,W
Troughton's Bat	<i>Eptesicus troughtoni</i>	VR	NE
Great Pipistrelle	<i>Falsistrellus tasmaniensis</i>	VR	E
Golden-tipped Bat	<i>Kerivoula papuensis</i>	VR	E
Little Bent-wing Bat	<i>Miniopterus australis</i>	VR	NE
Common Bent-wing Bat	<i>Miniopterus schreibersii</i>	VR	E
Large-footed Mouse-eared Bat	<i>Myotis adversus</i>	VR	E
Northern Long-eared Bat	<i>Nyctophilus bifax</i>	VR	NE
Greater Long-eared Bat	<i>Nyctophilus timoriensis</i>	VR	C,W
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	VR	E
Beccari's Mastiff-bat	<i>Mormopterus beccarii</i>	VR	NE
Eastern Little Mastiff-bat	<i>Mormopterus norfolkensis</i>	VR	NE
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	VR	All

¹T = Threatened, VR = vulnerable and rare; as defined under the *National Parks and Wildlife Act 1974* as amended by the *Endangered Fauna (Interim Protection) Act 1991* and documented in Lunney *et al.* (1994). In addition to the extant species listed here, all extinct species given in Table 1 are also listed formally as threatened on Schedule 12. ²Distributions follow Parnaby (1992), Dickman (1993) and Ellis and Etheridge (1993). Codes represent geographical regions within New South Wales: C = central, E = eastern, W = western, NE = northeastern, SE = southeastern, NW = northwestern, SW = southwestern, All = state wide.

of monotremes that were originally present, and the Dingo, are still extant.

The records indicate that most of the species now extinct in the State had disappeared by the turn of the present century, with only two persisting beyond 1950 (Table 1). The pattern of early disappearance is particularly evident among rodents. For many of these species it is possible that final losses occurred after the last records shown in Table 1 because of the sporadic and often cursory nature of biological collecting in most regions. In accord with previous studies (Marlow 1958; Dickman 1994), regional losses have been greater in western New South Wales than in either coastal or central regions (Table 1). The processes creating the patterns of species losses have been much discussed (e.g., Allen 1983; Mansergh 1983; Dickman *et al.* 1993; Lunney *et al.* 1994). The losses have been caused by changes in land use, especially pastoralism, predation from feral carnivores, competition from feral herbivores such as rabbits and goats, altered fire regimes and direct human persecution, with particular combinations of these factors predominating in different regions.

In addition to the outright extinctions of mammals from New South Wales, it is evident that many extant species have changed in population size or distribution since 1788. A few species have apparently fared well. For example, larger kangaroos such as the Red Kangaroo *Macropus rufus*, Eastern Grey Kangaroo *M. giganteus*, Western Grey Kangaroo *M. fuliginosus* and Wallaroo *M. robustus* have probably increased in pastoral areas due to pasture improvement and provision of watering points for stock (Frith and Calaby 1969; see also Barker and Caughley 1992, 1994). However, most other species have declined, or have relatively small distributions in New South Wales, and can be considered at risk within the State. A convenient summary of these species is provided on Schedule 12 of the *National Parks and Wildlife Act 1974*, as amended by the *Endangered Fauna (Interim Protection) Act 1991* (Table 2). Under the definitions of the Act, the term "threatened" refers to species that are considered to be most seriously at risk of future extinction (or are actually extinct), whereas "vulnerable and rare" refers to species that are at some risk due to reduced population size or distributional range or are under threat from severe adverse factors throughout the range (Lunney *et al.* 1994).

A total of 48 extant species are considered endangered in New South Wales (Table 2);

this would increase to 49 if the Dingo was considered to be a native mammal. The listings represent 43.5 per cent of the extant marsupials of the State (20 of 46 species), 52.9 per cent of the rodents (9 of 17 species), and 52.8 per cent of the bats (19 of 36 species); neither species of monotreme is considered endangered (Fig. 1). In contrast to the patterns of extinction, most presently-endangered species ($n = 37$, 77.1%) have at least part of their State distribution in eastern New South Wales. Eleven species occur along the length of the coast or inland to the Great Dividing Range, 18 species have State distributional strongholds in the north-east, while a further six species are concentrated in the south-east (Table 2). Five of eight threatened species also have predominantly eastern distributions.

In combination, 37 species of mammals can be considered to be threatened in New South Wales, with 29 of these being extinct within the State. A further 40 can be considered vulnerable and rare. This represents 59 per cent of the State's original mammalian fauna.

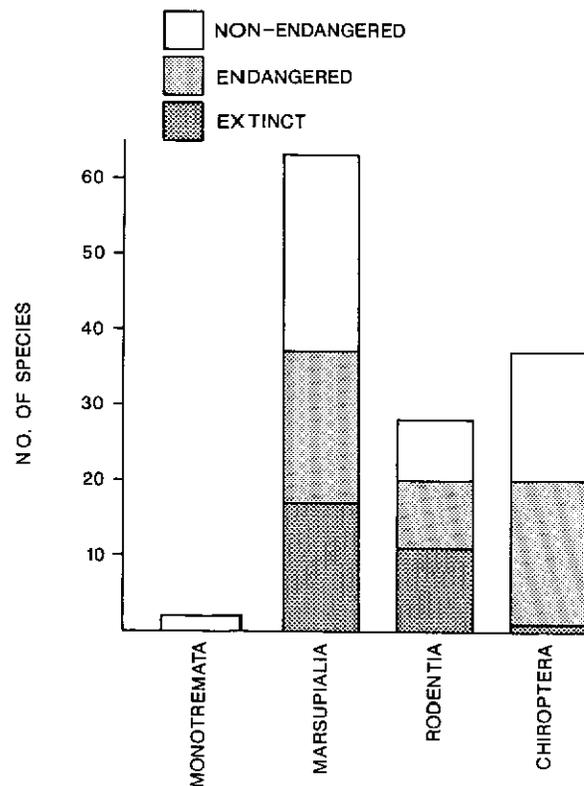


Figure 1. Numbers of species of native mammals in New South Wales classified in 1993 as extinct, endangered and non-endangered. "Extinct" refers to species that have not been seen alive in the State for 30 or more years, "endangered" to species that are listed as threatened or vulnerable and rare under Schedule 12 of the *National Parks and Wildlife Act 1974*, as amended by the *Endangered Fauna (Interim Protection) Act 1991*. The Dingo *Canis familiaris dingo* is not shown.

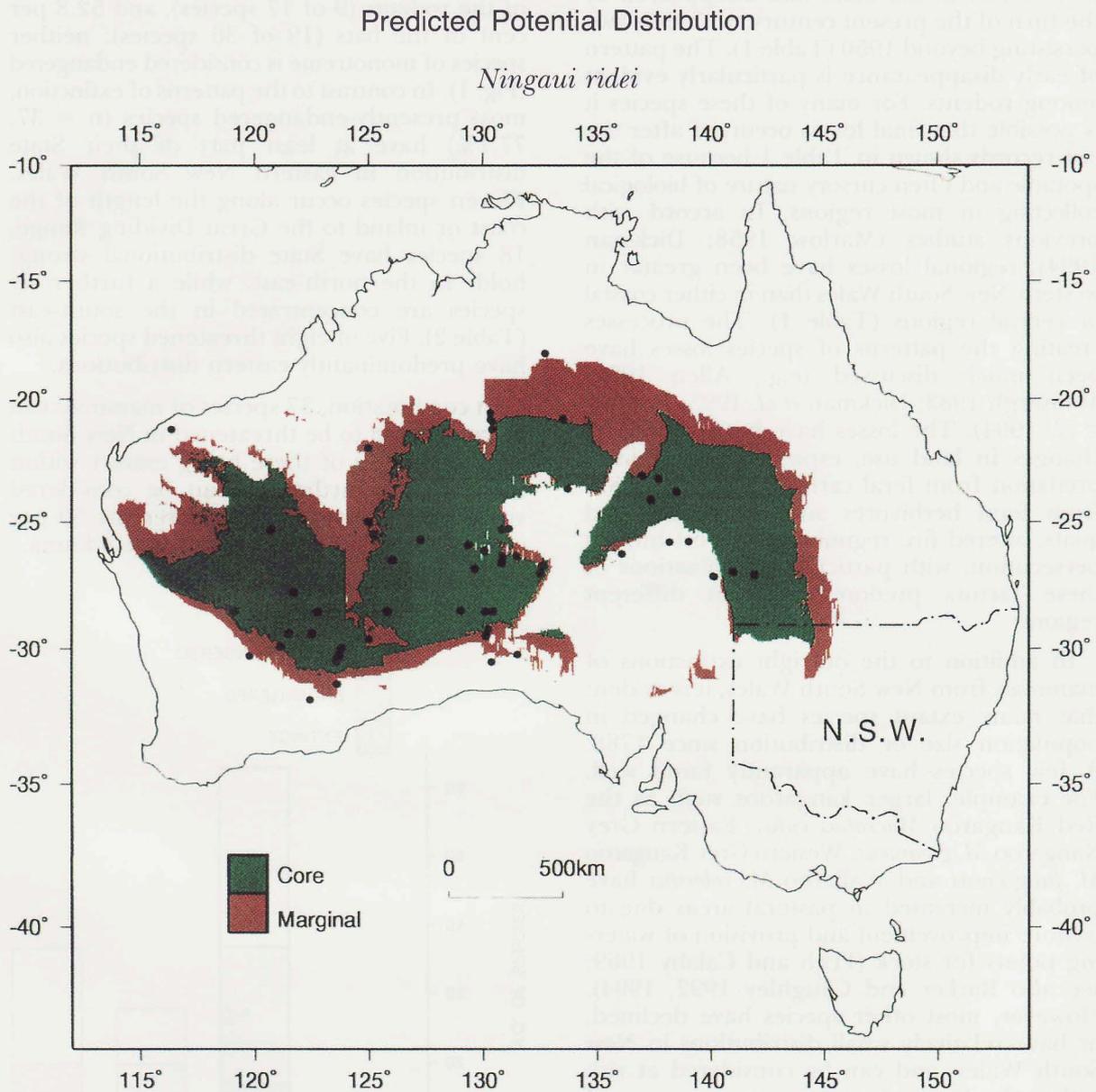


Figure 2. Predicted distribution of the Wongai Ningai *Ningai ridei* in Australia, showing potential occurrence in New South Wales. Dots represent locality records obtained from listings of State and Territory museums, shading represents distribution predicted using the programme BIOCLIM. Red shading (marginal prediction) represents the maximum potential distribution predicted using all climate records from known localities, green shading (core prediction) represents a reduced potential distribution predicted from within the range of 10–90 per cent of the minimum and maximum climate records.

The Future

The above overview paints a bleak picture for native mammals of New South Wales since 1788. Can we expect that further losses of species will continue into the future, or are there signs that the extinction cascade is finally abating? Although making firm predictions about the future can be fraught with danger, I will take the year 2038 and consider three divergent scenarios that reflect the most optimistic to pessimistic possibilities for changes of status of the State's remaining mammals. The year 2038 was chosen because it marks the end of the first quarter-millennium of European settlement in Australia. This projection, of 45 years into the future, is meaningful in terms of presently-foreseeable events, and also within the time scale of 5–100 years that some conservation biologists advocate for defining extinction probabilities (Mace and Lande 1991).

In the most optimistic scenario, the native mammals of New South Wales will increase by 15.8 per cent from the present 101 species to 117 species in 2038 (Table 3). This sanguine assessment assumes that no further extinctions will occur, that "new" species will be recorded for the State and that "old" ones will be rediscovered. New species most likely to be recorded are those that occur near State borders (i.e., within 100 km), and which may be detected in New South Wales when surveys are carried out. These include three species along the southern border with Victoria, the Western Pygmy-possum *Cercartetus concinnus*, Little Pygmy-possum *C. lepidus* and Leadbeater's Possum *Gymnobelideus leadbeateri*, and three species along the State's northern and western borders, the Agile Wallaby *Macropus agilis*, Spinifex Hopping-mouse *Notomys alexis* and False Water-rat *Xeromys myoides*. The likelihood that the two species of *Cercartetus* and *N. alexis* will turn up in New South Wales is high due to the availability of suitable habitats (Dickman *et al.* 1993), but low for the other three species due to insular distributions or habitat disjunction (Lindenmayer *et al.* 1991; Van Dyck and Longmore 1991).

A further four species could be expected to occur in New South Wales using the predictive modelling system BIOCLIM (CRD, unpub.). These are dasyurid marsupials, the Kowari *Dasyuroides byrnei*, Wongai Ningau *Ningau ridei*, Hairy-footed Dunnart *Sminthopsis hirtipes* and Ooldea Dunnart *S. ooldea*. BIOCLIM works by estimating the climate prevailing at localities where a species is known to occur, and then mapping all areas of similar climate

beyond these. If the distributional limits of a species are determined by climate, the mapped areas represent the predicted distribution (Busby 1991). An example of this approach is given for *N. ridei* (Fig. 2). At present, predicted distributions have been modelled only for dasyurids; further species will probably be predicted to occur within New South Wales when modelling is completed (CRD, unpub.; M. Predavec, University of Sydney, pers. comm. 1993).

Finally, there is little doubt that several taxa currently considered to be single species will prove to be species complexes with further taxonomic study. These include the Greater Long-eared Bat *Nyctophilus timoriensis* and Little Mastiff-bat *Mormopterus planiceps*; further unnamed species occur within *Mormopterus* and *Scotorepens* (Parnaby 1992).

Rediscovery of species thought to be extinct in New South Wales is considered unlikely, but two species, *D. viverrinus* and the Bilby *Macrotis lagotis*, are frequently rumoured to still persist (Caughley 1980; Dickman *et al.* 1993).

In combination, discoveries, rediscoveries and descriptions of new species could add substantially to the current list of the State's mammals. If we were to be still more optimistic and hope that some of the agents of past extinctions, such as feral predators and herbivores, were effectively controlled by 2038, the native mammal fauna of New South

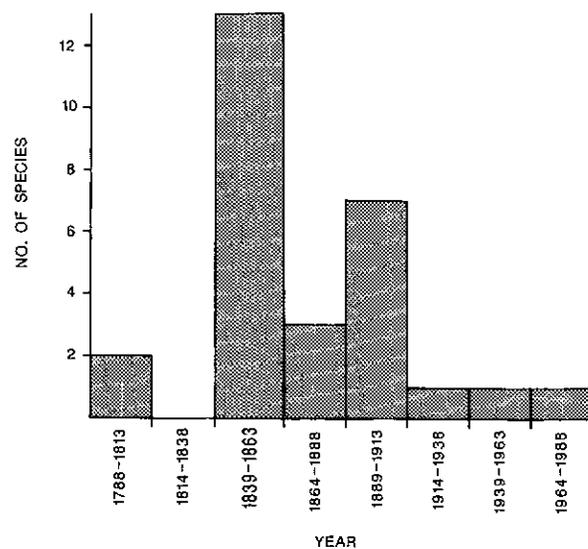


Figure 3. Dates of last records of native species of mammals in New South Wales, in intervals of 25 years since European settlement. *Nyctophilus howensis* is not included in the figure.

Wales could be elevated still further by re-introductions from other states. This possibility is presently remote, but has been discussed for several species of dasyurids and native rodents (Dickman and Read 1992; Dickman 1993).

A second scenario for the status of native mammals in 2038 is that of no change (Table 3). A plot of the dates of last records (\equiv extinction) every 25 years since settlement indicates that the rate of extinction has slowed (Fig. 3), and provides grounds for hope that no further losses should occur before 2038. If taxonomic studies of mammals continue to receive little attention, if field survey work continues to have low priority, and if rediscovery of "extinct" species does not occur, then the present *status quo* will be maintained.

Table 3. Numbers of species of native mammals in New South Wales in 2038 under three different scenarios.

	Number of species (% change from 1993)		
	Scenario 1	Scenario 2	Scenario 3
Monotremata	2 (0)	2 (0)	2 (0)
Marsupialia	56 (+22)	46 (0)	26 (-43)
Rodentia	19 (+12)	17 (0)	8 (-53)
Chiroptera	40 (+11)	36 (0)	17 (-53)

The third and most pessimistic scenario is that all extant species currently listed as endangered in New South Wales (Table 2) will have disappeared from the State by 2038 (Table 3). This would reduce the richness of native species to 60.8 per cent of their current numbers and to 40.8 per cent of the numbers prevailing at the time of European settlement. This apocalyptic scenario could be expected if threatening processes (e.g., clearing, competition and predation from feral species) are allowed to escalate or continue unabated. For example, rampant development on the north coast of New South Wales will be deleterious for many species of mammals (Milledge 1991). This region is the State stronghold for almost half of the species listed as currently endangered, and is especially important for bats (Table 2). Increased clearing, grazing by stock and predation from foxes and cats could similarly be expected to affect many of the endangered species in the State's central and western regions (Dickman 1994).

It is difficult to specify which of the three scenarios is most likely to be realized, because this depends in large part on whether appropriate research and management practices are implemented. There is considerable agreement about the magnitude of the

conservation task, and the economic, legislative and practical measures required for management of the State's native mammals have been much canvassed (e.g., ANPWS 1989; Recher 1990; Dickman 1993; Lunney *et al.* 1994). However, effective research and management is unlikely to be initiated unless the past, present and future alternatives for the fauna are appreciated by both the public and politicians. Ellis Troughton's concerns for the native mammals of New South Wales, voiced so cogently and eloquently in the first half of the twentieth century, will remain no less urgent for the first half of the twenty-first century.

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