ECOLOGY AND MANAGEMENT OF THE NUMBAT *Myrmecobius fasciatus*

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Description

In size, as well as in some of its actions, the number resembles a squirrel. Adults have a head and body length of 200-250mm and tail length of 150-180mm. Males attain slightly higher body weights than females (maximum 700g and 550g respectively).

The numbat's coat is distinctively coloured. The overall colour is reddish brown, the predominant colour of the head and upper back. There is distinct horizontal black stripe through the eye, however, and partway down the back, faint white bands cross the body. Towards the rump, these become stronger, and are accentuated by the progressively darker, and eventually jet-black bands between the white bands. The number of whate bands varies between four and eleven. The bands are often broken, the two halves offset along the midline. The pattern formed by these bands is unique to the particular animal, and may be used to identify individuals.

The hair on the underside of the body is off-white. The tail is covered with long brown hairs, many of which are tipped with white. The underside of the tail, near the body, is quite red in colour.

Distinctive features of the numbat's body shape include the pointed nose and elongate jaw, housing the largest number of teeth in any Australian land mammal. The tongue is exceptionally long, and can be protruded at least 5cm beyond the tip of the nose (about the length of the head). The teeth are poorly developed, and many do not protrude above the level of the animal's gums.

Distribution and Status

At the time of european settlement of Australia, the numbat was apparently found across much of southern Australia from the west coast to the semi-aris parts of western New South Wales (Figure 1). This knowledge is based on museum specimens, of which there are about 200, all collected since 1830, published accounts by reliable observers and information collected by trained interviewers from Aboriginal people who had earlier led nomadic lifestyles. There are no records of the numbat from Victoria but the species probably occurred in the north-west corner of that State. Aboriginal knowledge indicates that numbats were also found in the southern part of the Northern Territory (Friend et al. 1982). There is little information on habitat preference in the eastern part of this range, but in northwestern South Australia, Finlayson (1933) described the habitat as "mulga sand dunes", while Aboriginal informants told Firend et al. (1982) that walpurti were found in sand dune country, mulga country and spinifex country but not in rocky ridge country.

Krefft's account (1866) of mammals found near the Murray-Darling confluence in 1856-7 gives the impression that numbats were on the decline in that semi-arid country where cattle had already been

run for several decades. The most recent museum specimen from New South Wales was collected in 1900 from the border with South Australia. By that stage numbats had already disappeared from the vicinity of Adelaide, although they were to survive in the north-west of South Austrlia until well into this century, becoming extinct there between the 1930's and the 1950's (Finlayson 1961). In Western Australia the species was still quite widespread in the southern half of the State in the 1950's, although the clearing of land for agriculture was reducing its habitat rapidly. Calaby (1960) made the statement that the numbat was then probably the most abundant medium-sized mammal in the south-west of Western Australia.

Between the 1950's and the 1970's, numbats became extinct in the arid zone in Western Australia. The most recent account of the walpurti related to an animal sighted in the mid-1960's in the Gibson Desert (Friend et al. 1982). This extinction was part of the dramatic collapse of the mammal fauna of the arid zone that occurred between 1940 and 1960, and which is believed to be due to several factors. These factors include the change in fire regime following the demise of the nomadic lifestyle of the Aboriginal people, as well as the arrival of the fox. The rapid progress of land clearing greatly reduced available habitat in the last stronghold of the species in the semi-arid wheatbelt of Western Australia. Surviving populations, such as the well-known colonies at Dryandra Forest near Narrogin and the Tone-Perup area east of Manjimup, appeared health nonetheless.

In the mid-1970's, there was a dramatic decline in numbat sightings. The lowest population numbers appear to have been reached in 1975 at Tone-Perup and in 1979 at Dryandra (Christensen 1980; Friend 1990b). Both populations subsequently recovered, but others because extinct during this period. These included colonies at Boyagin Nature Reserve near Brookton, in the Pingaring area (including Dragon Rocks Nature Reserve) and soon after, at Tutanning Nature Reserve near Pingelly. Subsequent research has indicated that the decline of the numbat and simultaneous declines in other medium-sized mammals were due to increased predation by the introduced red fox Vulpes vulpes (King et al. 1981, Kinnear et al. 1988; Friend 1990b).

An experiment carried out at Dryandra in 1982-5 indicated that removal of foxes causes an increase in numbat numbers (Friend 1990b). The area of the forest subject to fox control was extended at the beginning of 1989, and the population continued to grow. The sighting rate on standard vehicle surveys has increased from 0.14 per 100km in 1979 to 7.8 per 100km in 1991 (Figure 2). Hill NR (north of Beacon) and to Tutanning NR, commencing in 1985, 1987 and 1990 respectively.

Knowledge of the present distribution of the numbat was gained through surveys during the 1980's based on recent museum speciments and reports from the public in response to appeals in the media. All reports were followed up with a search for the distinctive diggings near the sighting location. These surveys revealed that numbats were confined to Dryandra Forest and some small reserves nearby, parts of the jarrah forest between Great Eastern Highway and the Tone-Perup area, and a small area of uncleared land on the Swan coastal plain on the southern fringes of Perth near Jandakot (Connell & Friend 1985).

Since then, it appears that most or all of the northern jarrah forest populations and the Jandakot population have become extinct. Given home range size and overlap detailed below, this remnant distribution (Figure 2) represents a maximum numbat population of 2000, and probably closer to 1200 animals.

Surviving numbat populations occur mainly on land under CALM's management. This land includes State Forest, Conservation Parks and Nature Reserves. Other land tenure types on which numbats are found include water reserves and private land. More than 90% of the world population of numbats, however, exists on CALM estate.

In 1973 the eastern form of the numbat (Myrmecobius fasciatus rufus) was declared to be "fauna which is likely to become extinct, or is rare" under Section 14(2)(ba) of the Wildlife Conservation Act 1950, Western Australia. This classification was extended to the full species in 1983 after the decline in remnant numbat populations during the 1970's. The numbat is on the ANZECC List of Endangered and Vulnerable Vertebrates (1991) in the Endangered category, and is listed as Endangered in the IUCN Mammal Red Data Book (IUCN 1984).

Habitat Requirements

Known numbat populations occupy several different habitat types, but only a small porportion of the range of habitat types previously occupied by the species. The habitat types occuped recently are:

Dryandra Forest and Boyagin NR.

Woodland on valley floors and slopes, dominated by Eucalyptus wandoo and E accedens (powder-bark), with an understorey of shrubs including Gastrolobium species. Numbats also use adjacent upland vegetation types to a lesser extent, as well as mallet plantations.

Northern Jarrah forest and Tone-Perup area:

Forest dominated by E marginata and E calophylla, with open lower canopy of Banksia grandis and understorey of shrubs Bossiaea etc.

Jandakot area:

Banksia attenuata and B menziesii woodland with emergent E Marginata and E todtiana.

Karroun Hill NR:

A range of vegetation types including: Eucalyptus loxophleba and Callitris columellaris open woodland with an open understory. Tall closed shrubland of Allocasuarina acutivalvis, Melaleuca uncinata and Acacia?. Acacia ? closed shrubland. Eucalyptus salubris woodland.

Biology

Diet and feeding activity

Many of the characteristic features of the numbat are a result of its adaptation to a specialised diet of termits (Isoptera). While ants (Formicoidea) are also taken, there is little doubt that the feeding activity is essentially a hunt for termites. Numbats show no strong preference for any species of termite, taking each species roughly in proportion to its abundance (Calaby 1960).

During a feeding session, a numbat moves around an open area, nose to the ground, every now and then stopping to investigate a spot, then often digging rapidly with both forefeet, while sitting on its haunches. After making a small excavation, the numbat puts its nose into the hole, which has breached a shallow termite gallery, and extracts termites by pushing its tongue rapidly and repeatedly into the gallery. Termites within reach stick to the numbat's tongue, and are pulled into the slightly open mouth. The jaws are then closed and the insects are held in the mouth by the slightly ridged palate, as the tongue is protruded again. The extraction of termites from a gallery, from the first excavation to the end of feeding, takes about 2 seconds (Friend, unpublished observation). The excavations are distinctive in appearance, and are shallow-conical, rarely over 50mm in depth, and of a similar diameter.

Numbats appear to spend much of the day feeding, and observations of captive animals show that each individual consumes between 15,000 and 20,000 termites each day. This corresponds to approximately 10% of the body weight of an adult animal (Friend, unpublished).

A feature that sets the numbat apart from almost all other marsupials, and other Australian mammals, is its strictly diurnal nature. Although their daily activity pattern changes during the year, numbats do not emerge from their night refuges until well after dawn, and return to one of their nests before dark. In summer, numbats are active throughout the morning, but there is a period of inactivity between midday and late afternoon, followed by an active period before dusk. In winter, there is only one active period, of between 4 and 6 hours from mid-morning to mid-afternoon. This pattern of activity corresponds closely to the availability of termits in the upper soil layers, as these insects respond to the temperature of this environment (Friend, 1985).

Home range and interactions

Numbats are solitary and territorial. They occupy home ranges which are exclusive of other individuals of the same six. Once a juvenile numbat has established its home range after dispersal, that animal remains in or close to that area for the rest of its life.

The male pattern of adjacent home ranges overlaps the female pattern. Although use of habitat by each sex changes during the year (females contract their area of movement in summer, males in winter), the overall result is that there is approximately one pair of established adults per 50ha of high-quality habitat. These data were obtained by radio-tracing 15 numbats in wandoo woodland in Dryandra Forest and Boyagin Nature Reserve, but the results of tracking to numbats in the Perup Forest indicate a home range size of the same order in Jarrah forest (Christensen et al. 1984). If 50 animals is taken as a minimum viable population, and if it is assumed that 50% of a given area is suitable habitat, the minimum area which can support a population is 2500ha. Tutanning NR is near this minimum size, as is each of the two separate sections of Boyagin NR (total 5,000ha).

Reproduction and dispersal

Knowledge of the reproductive ecology of numbats is largely due to research in Dryandra Forest since 1981 (Friend, unpublished). Details are provided here in order to demonstrate the importance of various components of the habitat, and to provide a timetable for the critical events of the numbat's year.

Production of young by numbats is a highly synchronised event. At Dryandra, all young are born in January or early February, and most in the second half of January. Development of the young while attached is relatively slow compared with other marsupials. The femal deposits her young in a nest (usually in a burrow) in late July and continues to suckle them each night. In early September, the young come to the entrance of the burrow each morning after the female has emerged, often before she has left on her daily foraging trip. During the first week or so, they do not move more than a few centimetres from the burrow mouth, but as time goes on, they make longer excursions. By mid-October, the young numbats are supplementing their mother's milk with termites that they dig up for themselves, and moving up to 100 metres from the nest, still within their mother's home range. The female often moves her litter to a succession of nests in logs, trees or other burrows, particularly after the loss of any young to predators.

In November, some young start to nest away from the mother and their siblings, within the maternal home range. Later that month or in early December, all young leave their maternal home range and disperse. The dispersal movement is quite rapid, rarely taking more than a week from departure to establishment in the area where the number will spend the rest of its life.

Dispersal appears to take place as straight-line movements, while the animal is moving through bush. A numbat at Dryandra was followed over several days, during which time it moved 4 kilometres from its natal area straight to the edge of farmland. It then moved along the forest-farmland boundary for two kilometres before reaching the area in which it established its home range. Radio-tracking other dispersing numbats has shown that they rarely cross farmland, but often end up in forest

at the edge of the reserve. This evidence indicates that the farmland-forest interface is an important barrier for dispersing numbats, and suggests that corridors of native vegetation will be used by dispersing young, as they follow the edge of the bushland.

Females breed in their first year, while males do not become sexually mature until their second year. From September, established males begin to move outside their winter home ranges. At this stage, the male pre-sternal gland becomes active, exuding an oily liquid that stains the animal's ventral surface red-brown. As the height of the mating season approaches, the male's testes enlarge as they begin to produce sperm, reaching a peak in late December. The male scrotal region swells with the enlargement of the accessory glands. By January, male numbats are ranging widely and traversing the home ranges of a number of females.

Females come into oestrus during January. In captive animals, the onset of oestrus has been established by monitoring the sudden increase in epidermal cells in the urine. If mating does not occur during the next 48 hours, young are not produced. The gestation period is 14 days, after which the young are born, pink, hairless and measuring about 10mm in total length, and attach themselves to the four teats (Friend & Whitford 1985).

Refuge and nesting requirements

Numbats use hollows and burrows for a number of different purposes. These include nesting at night, resting during the day and as refuges when under threat of predation. When the young are too large to be carried by the mother on her daily foraging trips, they are left in nests in hollows or burrows during the day, and suckled there at night. In areas that lack logs, or in summer, some numbats rest during the day under shrubs and fallen foliage. They sometimes even take refuge from threat under this kind of cover, but there has been no record of numbats nesting at night in such a position.

Numbats construct their own burrows. A typical burrow consists of a single, gently sloping shaft 1-2 metres long widening out into a roughly spherical, terminal chamber. A nest fills the chamber, and consists of readily available plant material such as grass, leaves or shredded eucalypt bark (Glauert 1935; Christensen 1980; Friend and Burrows 1983; Christensen et al. 1984;). Nests of similar materials are also made in nest logs.

Predation

Causes of mortality in numbats have been established by four methods, as follows;

a) direct observation,
b) evidence provided by the condition and/or location of remains of radio-collared numbats and by marks on the radio-collars,
c) monitoring population change in areas with and without fox-baiting,
d) notes accompanying specimens forwarded by the public.

a) Direct observation

The only recorded observation of a numbat being taken by a predator concerned a collared sparrowhawk or a brown goshawk (Friend & Burrows 1983).

b) State of retrieved radio-collars

This is the most objective measure of the relative importance of different causes of death within a population. It still shows only the final cause of death, however; it is impossible to tell whether the animal was weakened by some other influence, in some way before death.

Most of the retreived collars showed that a predator was involved, and that birds and

mammals took approximately equal numbers. Of the avian predation events, two were probably Little Eagles and two were Wedge-tailed Eagles. From observation of the birds in the vicinity of numbat nursery burrows, the most important avian predators are almost certainly Collared Sparrow-hawks and Brown Goshawks, particularly of newly emerging number young. These birds are very competent at taking prey on the ground beneath the tree canopy.

Mammalian predators were all fox and cat, with the exception of one instance of predation by a dingo at Karroun Hill NR. Fox predation was prevalent at Dryandra and Boyagin, but cats are significant predators at Karroun Hill NR. Reptilian predators were all carpet pythons (Python spilotes). Calaby (1960) suggested that Gould's monitor (Varanus gouldii) was a likely predator of young numbats, but no supporting evidence was found in this study.

Only one numbat out of 10 known to be in three prescribed burns was killed by the fire.

c) Experimental manipulations

Poisoning foxes by the use of 1080 poison while monitoring the numbat population size showed that removal of foxes caused a dramatic increase in numbat numbers (Friend, 1990b). Given other evidence of fox predation, this result indicates that predation by foxes regulates numbat populations, and that a regime of fox baiting will allow numbat numbers to rise until they reach limits imposed by other factors (e.g. food supply, refuges and cover from other predators).

d) Information associated with specimens

The only causes of death revealed from data accompanying specimens were vehicle collison and "fox kill" (WA Museum Specimen MO2245). Roadkills are not considered to be a significant cause of mortality in any known numbat population.

Management for Conservation

The need for management.

The world population of numbats is at a critically low level. Even generous estimates pub maximum numbers at only 2000 animals, while if we acknowledge the patchy nature of the occurrence of the species and assume that core home ranges never overlap, the estimate is below 1500. At present, the Dryandra population is the most secure, and it numbers less than 500 animals. While recent research has defined the threats to the species and limited management has shown how these threats can be reduced, loss of populations is still proceeding.

Fox Control

The numbat population at Dryandra, and the successfully re-established population at Boyagin Nature Reserve have been protected from fox predation by monthly baiting with 1080 in meat baits, laid at a density of 15 baits per hectare. Lower baiting intensities may be effective in other areas, but this is yet to be tested.

Fire

The effect of fire on numbat habitat depends on intensity and season. Removal of understorey thickets exposes numbats to greater risk of predation by birds of prey and cats, even if fox control is in place. Studies at Dryandra have shown that a fire in spring caused a nett loss of logs, whereas fires in autumn resulted in a nett gain over the same period. Fire needs to be used at long intervals in order to ensure that thickets are regenerated. At Dryandra the interval is of the order of thirty years (Burrows and Maisey 1987).

Timber harvesting

A study of a thinning operation in mallet plantation at Dryandra showed that the main effect on the numbats was the disturbance caused by the presence of men and vehicles. Resident animals cease to use the area using the operation, but return soon after. By opening the canopy, a clear-felling operation exposes numbats to a higher risk of avian predation. The long-term (ten years or more) may be positive, in that an increased amount of wood remains on the ground for hollow logs and termite food (Christensen & Maisey 1984). Pre-logging surveys are recommended in areas where numbat populations are suspected, to establish the importance of the proposed coupe for the numbat population in the area. As a rule of thumb, no more than 10% of the local population should be put at risk.

Re-introduction

The survival of the numbat depends on protection of existing populations and the establishment of new populations in suitable previously occupied habitat. A program of re-introduction is proposed as part of the recovery plan currently being prepared for the numbat. Various areas are being considered as re-introduction sites. It is considered that the smallest area that can contain a viable population is about 2000ha.

Successful re-introduction requires the translocation of a sufficient number (15 or more) individuals of about even six ratio, each year for two or three years. Fox control and if possible cat control need to be implemented from the outset. Animals should be moved in November or December, after the young are weaned but before the mating season.

Re-introductions have to date depended on animals from the wild, although three out of four released from a captive colony survived and established home ranges.

Genetic management

The future scenario for the numbat is that its survival will depend on a number of discrete, managed populations on conservation estate, with some other small colonies in zoos or fenced areas. To prevent inbreeding and loss of genetic variability, it will be necessary to transfer individuals between colonies on a regular basis (Friend 1990). This may require the movement of only one or two animals per population every two or three years, but it will be necessary to institute a program of transfers to ensure that all populations are linked genetically.

References

Available from the author.