1. TAXONOMY

COMMON NAME: Numbat
SCIENTIFIC NAME: *Myrmecobius fasciatus*

CLASS Mammalia
ORDER: Monotremata
FAMILY: Myrmecobiidae
OTHER COMMON NAMES: Banded Anteater, Walpurti, Striped Anteater,
RECENT SYNONYMS: None

1.1 DESCRIPTION

The numbat is a diurnal, terrestrial, termite-eating marsupial of approximately 500 - 700g with males being slightly heavier than females. The *dorsal aspect of the* coat is a red-brown colour, paler *ventrally*, with darker rump and prominent, white, transverse bars (Friend 1997).
The head is narrow with a sharp snout housing 50-52 teeth, the largest number recorded in any Australian land mammal (Friend 1994). Another distinguishing feature is horizontal eye-stripe. The tail has long hairs, which often stands erect to look like a bottlebrush. The tongue is very long, thin and can protrude several centimetres beyond the end of the snout (Friend 1994).

1.2 AFFINITIES WITH OTHER GROUPS

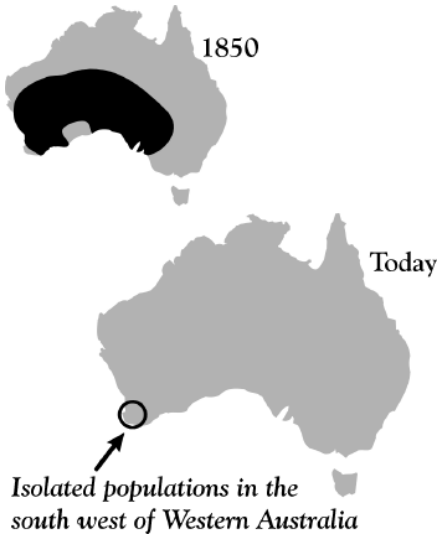
Waterhouse (1836) considered the numbat to be closely related to the family Dasyuridae (carnivorous marsupials) and it appears many of the anatomical differences that exist now between it and Dasyurids are the result of adaptation to a specialised diet of termites (Calaby1960) and (Friend1994).

6 WILD POPULATION DATA

2.1 DISTRIBUTION

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-arid parts of Western New South Wales (Friend1994).
It is currently restricted to a small area of south -west of Western Australia, where there are two surviving populations and colonies at four re-introduction sites, of which only one can be described as self- sustaining. In South Australia, a further release in an 1113 ha predator -fenced area in mallee woodland was undertaken in 1995. In 1998 captive bred and translocated numbats were released to a new site in the Dale Conservation Park south east of Perth. More recently, captive-bred and translocated wild numbats were also released to a new site in the Stirling Ranges National Park in the south - west of Western Australia between 1998-2001. Total numbers in the wild for this species do not exceed 1500 (Friend 1994).

Figure.1 Past and Present distribution (Perth Zoo graphics department)



2.2 HABITAT

A strong dependence on termites for food restricts the habitat of the Numbat to areas where these insects are reasonably abundant. Its present habitat is eucalypt forest, particularly areas dominated by Wandoo (Eucalyptus *wandoo*) or Jarrah (*E.marginata*), but was earlier found in Mulga (Acacia *aneura*) woodland.
An area with these vegetation types provide the Numbat with hollow logs and branches for its shelter and provide food and support for the termites on which it feeds (Friend and Kinnear 1983).
The most important feature is the abundance of termites in the soil. Where present, hollow logs are used extensively by numbats, but are not essential and at some semi-arid sites, hollow logs are uncommon or absent.
In the western wheat belt of W.A, the reduction of fox numbers by selective poisoning has been shown to cause Numbat populations to increase (Friend 1994).

2.3 STATUS:

IUCN: UCN (1996) Vulnerable
ASMP: Management Level 1a, Conservation Program (2001)

ANZECC:
Within its limited distribution the numbat is considered vulnerable having been down listed from endangered after establishing extensive fox baiting programs.

2.4 WILD POPULATION MANAGEMENT:

The recovery objective is to ensure that the species persist within its existing range.

This requires:
Control of exotic predators, especially foxes
Population monitoring
Habitat management research and implementation
For more information refer to CALM's Recovery Plan for the Numbat (Friend1994)

3. NATURAL HISTORY

3.1 REPRODUCTION AND DEVELOPMENT

Knowledge of the reproductive ecology of numbats is largely due to research in the Dryandra Forrest since 1981 (Friend, unpublished). The breeding of young 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 (Friend 1997).
The development of young while attached to the nipple is relatively slow compared to other marsupials. The female deposits the young into a nest or underground burrow in late July where she will continue to suckle them each night. In early September, the young come to the entrance of the burrow each morning after the female has emerged. During the first week the young often move no more than a few centimetres away from the burrow entrance, 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 themselves which may include moving up to 100 metres from the nest. In November, some young start to nest away from the mother and other siblings, within the maternal home range. By late November or in Early December all the young have dispersed from the maternal home range.

3.2 Timing of Breeding:

Mating period: Late December -February

Birth period : Jan - Feb with a possibility in March

3.3 Gestation Period: 14 days (Friend, Whitford 1988)

3.4 Number of Young Born: 1-4 (Friend 1997) suggests it is possible that more than 4 may be born, similar to some carnivorous marsupials.

3.5 Number of Young Surviving : Young that successfully attach to the nipple usually survive. It has been observed at the Perth Zoo between 4-6 weeks post birth a pouch young may be lost.
In the wild, females almost always carry 3-4 pouch young (Friend. Pers.comm).

3.6 Birth <u>Weight</u>: Weights at birth are unknown
<u>length :</u> 10mm (Friend 1997)
6.5mm approximately at 2 days old. (captive born)

4.0 Reproductive Status

4.0.1 Males
Male Numbats are sexually mature at approximately 2 years of age and maybe unable to reproduce before this age (Friend 1988).
Male numbats undergo a seasonal reproductive cycle beginning from October to February during which the male's sternum gland develops and enlarges. The gland discharges a sticky substance, reddish in colour, staining ventrally from the neck to the abdominal area. The maximum secretion occurs in late December and declines rapidly in January - February. The amount of discharge declines in older animals (Pers. obs)
Similarly, testes in the male begin to increase in size in early October with a maximum volume attained in late December - January.

Attempts were made in 1997 at the Perth Zoo to breed with a male 21 months of age, which resulted in no successful matings. This particular male produced sperm much later in the breeding season in comparison to other older males and had minimal accessory gland development.

Friend (1997) described a swollen area the accessory sex gland around the cloaca in the male Numbat during the breeding season, which was quiet prominent. This is believed to play a role in the fertility of the male similar to a postrate gland. The fluid filled gland is located under the testes and surrounding the cloaca. The gland develops for a short period in the breeding season from late December throughout January and declines in size rapidly in February.

Duration of sperm in the urine: Males generally produce sperm in their urine from late December through to late February. If a successful mating has occurred sperm will be in very low numbers and often absent in urine, for 1-7 days post mating (Power pers. comm.)

Fig.2 Male Numbat during breeding season

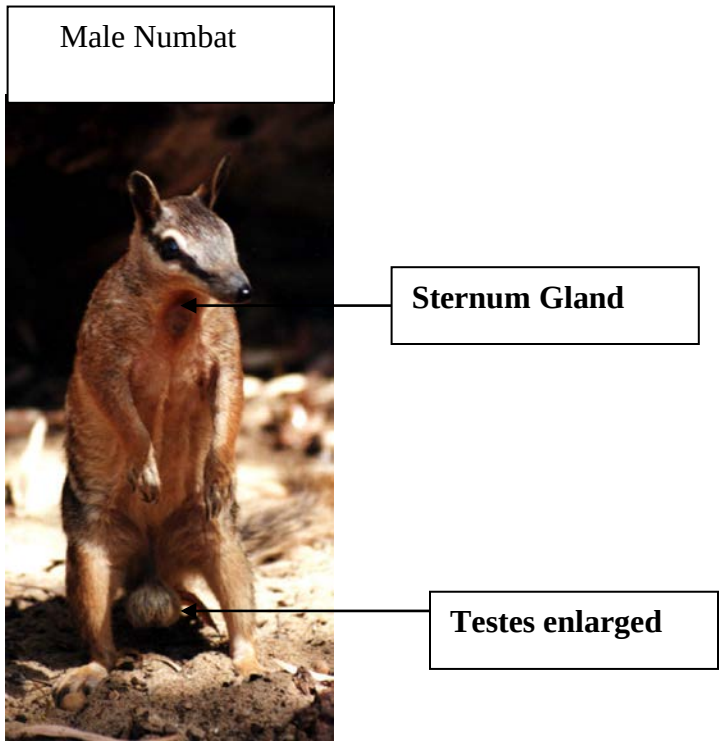


Photo: Power, V. 1997

4.0.2 Female

A study conducted by Friend and Whitford (1988) stated that female numbats are sexually mature and able to breed in their first year.

Pouch development

Female Numbats do not have a true pouch.

During the non-breeding period, there is just an indentation with no folds of skin hanging over the mammary area. All four nipples are clearly visible and the pouch may appear dirty with a dry exudate.

During the breeding season there is a gradual swelling of anterior skin folds and the inner thighs may swell slightly, forming an indentation where the young attach to the nipples. Long guard hairs hang down over this area offering some warmth and protection.

Prior to birth the tissue surrounding the teats develops a granular appearance which discharges moisture giving the pouch area a “sweaty look”. The nipples also appear to increase in size slightly and deepen in colour to red and there is slight swelling around the nipples, which form a ridge up to the nipples.

The tissue in the pouch area develops and changes with the oestrus or pregnancy cycle.

4.1 Length of Oestrus:

Females are receptive to males for approximately 2 days when cornified epithelial cell numbers are at their peak. Cornified cells appear in the urine of the females for ……days *(re check slides again*) Matings generally occur over a 2 day period . Matings can last as short as a few minutes or as long as an hour. A sperm plug passed by a female is indicative of a successful mating.

4.2 Age at Weaning: Friend (1994) states that in the wild pouch young continuously suckle from their mother until late October.
Captive young numbats are weaned onto a termite / artificial diet at 9-10 months of age. Early November they are gradually removed from their mothers two at a time so that the milk supply and nipples can slowly regress in readiness for the next breeding season.
An ideal body weight for release animals: 300-350 g.

4.3 Developmental Time Line:

Developmental time line of Female Numbat 100' s young.

6.5.1 Birth

100 days	Sexed
120 days	Soft fur growing
273 days	First deposited
274 days	Eyes still closed
278 days	Long guard hairs growing
288 days	First vocals heard
291 days	Young attached to nipple again
292 days	Eyes open first time
318 days	First emerged from box
340 days	First eats artificial diet
347 days	Weaned from mother

Growth in body weight of Numbats. See Appendix 1.

4.4 Age at Independence/dispersal:

In the wild Numbat young are independent at 11-12 months approximately. The dispersal time is quite short, rarely taking more than a week from departure to establish in the area where the Numbat will spend the rest of its life (Friend 1994).
Captive born young are weaned away from their mothers at 10 to 11 and half months of age. By then they are eating artificial diet and termites freely. At that stage young can weigh between 220-300g.

4.5 Age at Sexual Maturity:

Male	2 years	(Friend unpublished)1988
Female	1 year	(Friend unpublished)1988

4.6 Adult Weight:

Male	550 - 700 g	(Friend 1997)
Female	450 - 550 g	(Friend 1997)

4.7 Adult Measurements:

Head and Body Length (270mm) (Friend 1994)

Tail Length (200mm) (Friend 1994)

5.0 LONGEVITY

5.1 Wild (T.Friend,pers.comm):

Female	Maximum 4-5 years
Male	Maximum 4-5 years

Most animals do not achieve this age due to predation (Friend 1994).

5.2 Captive

Female	Maximum 7 year (died carrying 4 young)
Male	Maximum 11 years

6. WILD DIET

Numbats have adapted to a specialised diet of termites (Isoptera) and have also been known to ingest ants (Formicoidea) while foraging for termites. An individual numbat consumes between 15 000 and 20 000 termites a day which corresponds to approximately 10% of the body weight of an adult animal (Friend,unpublished 1988).
Calaby (1960) states that Numbats show no strong preference for any species of termite, taking each species roughly in proportion to its abundance. At the Perth Zoo the numbats are fed *Coptotermes* and *Nasutitermes* species, as this species is readily acqired from traps. Other species known to be eaten by numbats include *Heterotermes, Amitermes, Microcerotermes, and Paracapritermes* and *Occasitermes*.

6.1 HABITS

Diurnal, can climb trees, dig burrows as primary nesting sites but use several hollow logs as resting sites during the day. Observations have shown that Numbats in the wild enjoy lying out basking on logs in the sun, with the ventral side of the body lying flat on the log with limbs and tail out stretched (Calaby 1960). This thermoregulartory behaviour is quite notable in captivity particularly in the winter mornings prior to feeding. Numbats generally enjoy sun basking early in the mornings and late afternoon.

6.2 BEHAVIOUR:

Numbats are one of the only species of Australian mammals, with the other being the musky rat kangaroo *Hypsiprymnodon moschatus*, to be active strictly during the day (Christensen *et al.* 1984; pers obs). When awake numbats are generally on the move, foraging for termites and ants, and retreating to hollow logs when alarmed or disturbed (Christensen *et al*. 1984). *In summer they dig in the ground to find termites and are active in the morning and late afternoon to avoid the heat of the day, and during the autumn they are active mid morning to mid afternoon when it is warmer and the termites are more active, and turn over small pieces of wood to find food (Christensen et al. 1984; Friend & Burrows 1983). Re read references again needs to be reworded!!*
Numbats sleep within hollow logs on the forest floor and burrows (Christensen *et al*.1984). Through out the year female numbats occupy home ranges that are exclusive of other females with males occupying small home ranges between the larger home ranges of females (Friend

1988).* From September males begin to move beyond their winter home ranges, at which time the sternum gland on the males throat becomes active and smears on sticks, rocks and logs (Friend 1988). * In captivity it has been observed particularly in the colder months that some numbats under go a torpor state. This is currently the subject of a PhD investigation by Christine Cooper at UWA.
Due to the territorial nature of these animals, numbats in captivity are housed individually until the breeding season commences.

6.3 Aggression:
Though males are housed individually year round, during the breeding season it is recommended to separate captive males as far as possible from other males. A screen erected between the enclosures to limit visibility is advisable. Male numbats can become aggressive towards each other at this time of year.

Aggression has been noted between newly paired animals during the breeding season and that careful monitoring would be required.

Examples of negative or aggressive behaviour from either sex are as follows:
- Constant chasing with an aggressive interaction once animals have made contact.
- Tumbling together or male constantly jumping on female's back.
- Female refuses to sleep with male.
- Dominance by either animal at feeding time, not allowing the other to eat. To control food quantities and different diets the animals should be separated at feed time.

Types of injuries sustained from these aggressive interactions eg. torn ears, torn nails, lesions on back of neck and inflamed cloaca. I f any of these injuries occur a veterinarian should be consulted and the animals separated.

6.4 Vocalization
Calaby (1960) reported that numbats, when handled or disturbed, often produced a low throaty growl, with the mouth closed. This sound has often been heard in captivity from both sexes when handled or if a female is rejecting the advances of a male during the breeding season. Male and female numbats in captivity vocalise to each other during the breeding season. The vocals are a soft series of clicks not to be confused with an aggressive growl described by Calaby (1960).
The only other vocals noted are between mother and young once they have emerged from the burrow (which are a soft chirping sound).

6.5 Drinking:
In the wild numbats rarely drink water, however animals in captivity consume more water particularly in summer due to the increase in temperature and associated sexual activity.

6.6 Common captive problems (stereotype behaviour)

- **Fence pacing**

In captivity some numbats can develop a pacing behaviour. This can be rectified by the provision of fresh leafy branches along a fence line. This allows them to climb and explore in their environment and breaking up the area being paced. The provision of fresh browse will stimulate the animals to investigate their environment.

- **Fence Hanging**

Numbats are naturally very inquisitive animals and have been observed on occasions to hang on the wire mesh scanning adjoining enclosures. This has been observed during the warmer months which corresponds with increased activity during the breeding season.
In captivity, this has been difficult to stop. Great care should be taken not to frighten an animal if they are hanging on the mesh as they can suffer nail injuries or sustain broken bones, if they take flight from the fence.
Currently, under consideration is to attach a metal lip around the enclosure, similar to the type used to keep Koalas from escaping their enclosures. Regular trimming of nails helps reduce the severity of nail injuries.

7. CAPTIVE MANAGEMENT

- **CAPTIVE DIET**

A significant breakthrough in keeping numbats in captivity for extended periods was the development of the artificial diet (Friend & Whitford 1988). Numbats can consume daily up 20,000 termites (Friend & Whitford 1988) which can prove quite difficult to supply on a regular basis. Another significate break through was the development of a reliable termite trapping technique to supply breeding females with a 100% termite diet. This resulted in 100% success rate in conception / fucundity rates (Pers. obser).
At the Perth Zoo we can only consistently trap and supply two species of termites, *Coptotermes sp. and Nasutitermes sp.* It has been observed that some lactating females if given a choice, had a preference for *Coptotermes* species at certain periods of the year. Some individual Numbats in the past had refused to eat *Nasutitermes* species during the winter months resulting in significant weight lost. To address this situation we currently bulk freeze surplus *Coptotermes* termites so that there is a ready supply during the winter months.

See Appendix 2: Artificial diet preparation

7.2 Current Artificial Diet for Numbats 11-12 animals
Digestelact milk formula (low lactose formula)

Preparation of food:

- Add 360g eggs to 680 mls of water and whip with beaters. Add 151g of Digestelact to whipped eggs and blend.
- Place custard mix into a stainless steel bowl and place onto a double boiler on the stove and allow to cook for 20 mins on low temperature, stir regularly. The consistency should be of thick custard.
- Over cooking caramelises the custard and it becomes unpalatable to Numbats so should be discarded.
- Once cooked transfer to a stainless steel bowel and store in the fridge to be used the next day.
- Add SF40 vitamin supplement and Ca Co3 (calcium carbonate) and add termite mound powder to custard mix 1 scoop (30 g).

Blend mixture to a smooth consistency.
Fresh water provided daily.

7.3 Preparation of termite mound powder:
In 1992 washed sand was replaced with sterilised termite powder on recommendation by the author and after consultation with the Veterinary Department. This was due to the incidence of

blood found in the faeces of numbats on a regular basis and sand impaction in the lower bowel. Termite mound was considered a less abrasive material to used in the diet. When numbats forage for termites in the wild they ingest quantities of mound material incidentally, which passes through the digestive tract along with digested termites to form a paste like faecal pellet.

Preparation

- Spent termite mound discarded from traps is collected and stored in a bin, after removing all debris.
- Mound material is placed into a pot with a small amount of water.
- The mound is boiled for 30 mins until the majority of water has almost evaporated.
- It is then tipped onto a baking tray and oven baked until dry, approximately 150 degrees for 1 hour.
- The mound is then crushed into a powder using a hammer and a sifter and stored in a air tight container.
- It is important to make sure it is thoroughly dried before placing in container as it can grow mould very quickly.

7.4 Dietary supplements:

1/2 teaspoon $CaCO_3$ (calcium carbonate powder)
1/4 teaspoon SF40 (multivitamin supplement)
1 scoop (30 gs) Sterilised termite mound powder to artificial diet when cooled.

Mounds with termites are given as an additional activity feed during the day.

7.5 Weighing and presentation of Food: Some Numbats have a tendency to gain weight, so food quantities should be weighed out accurately before feeding. Electronic scales to weigh artificial diet and live termites are recommended.
Small plastic bowls 90 mm in diameter and 40 mm in height are suitable for feeding numbats. It is very important to use feeding bowels that have a water barrier included in the design or place the bowel inside another full of water. This is to create a water barrier to ants, which are very attracted to Numbat food. On wet rainy days numbats often won't eat and can go with out food for several days.

During the winter months the appetite of some captive numbats (particularly some lactating females) significantly decreases, so it would be advisable to weigh the remaining food left over as a way of monitoring food consumption and signs of illness.

An average food portion would be 35-40g artificial diet plus 5g live termites twice a day. Quantities should be reviewed on a monthly basis or be determined by the body weight of an individual.
Numbats will not eat their food if contaminated with ants.

7.6 Feeding time: Feeding times correspond with the seasonal activity of termites.

Winter 10.00 am and 1.30 p.m.

Summer 8.30 am and 2.00 p.m.
Termite mound and crumb to be added during the day for activity feed.

7.7 Breeding season diet:

Historically, there has been mixed success breeding numbats on the artificial diet. As a result the diet is modified in November, at least one month before the on-set of the breeding season. The diet is modified by increasing the numbers of live termites. This depends on the availability of termites, however a minimum of 60-100 % live termite diet is optimum for females and 10% for males. The remaining proportion of food is made up with artificial diet (AD) for males or additional frozen termites may be used.
Females with pouch young continue on the high termite diet for 3-4 weeks post birth and are then weaned slowly back onto the maintenance diet of 10% termites.
Any other major changes to the diet should be discussed with the Animal Health Department.

7.8 SUSTAINABLE TERMITE HARVESTING TECHNIQUES AT THE PERTH ZOO

The basic principle for collection is to lure termites into an open-topped drum packed with Karri wood (one of their favourite foods). Once the wood has been infested with termites, it is then brought back from the bush to a place where the termites can be separated from the wood. Nests are not destroyed, and when yields start to diminish, the termite drums (traps) are removed, allowing the nests to recover. Perth Zoo has established 5 collection sites that are mainly at water catchment areas with limited public access. It is essential to have many sites established in the event of a natural disaster or destruction of the drums. This guarantees a back up supply of termites.

INTRODUCTION

Live food propagation plays an important role in the maintenance of many species held in captivity. This is particularly important for the Numbat, which is an obligate termite feeder. A reliable termite supply is therefore essential if Perth Zoo's Numbat Breeding Program is to remain successful.

A method of collecting and storing termites from the wild that is sustainable and viable for Zoos and Wildlife agencies has been developed. There are 2 species of termites which are common around the Perth region that are readily trappable, these being *Coptotermes acinaciformis raffrayi* and *Nasutitermes exitiosus.*

HISTORY OF TERMITE HAVESTING FOR NUMBATS

At the commencement of the Numbat Breeding Program at the Wildlife Research Centre (CALM) in 1986, the method for the collection of termites was described by Friend and Whitford (1988). This involved the removal of part of the Nasutitermes mound and storing it in a large plastic bin with a tightly fitting lid. To maintain the colony over a period of weeks or months one or two slabs of timber such as karri, *Eucalyptus diverscolor* were sprayed with water regularly and layed on top of the mound. Termites would congregate under the wood and these could then be knocked off the wood into a collecting tray. Bird breeders also used this method to supplement their breeding birds.

A second method of collecting termites (*Coptotermes species*) was developed by Dr. Geoff Kirkman whom was assisting Dr. Friend with the supply of termites for the Numbat program. Dr. Kirkman obtained advice from Dr. Tony Watson of CSIRO Division of Entomology on methods for trapping these termites. This formed the basis of the current technique, which is used at the Perth Zoo and is described below.

Both methods of trapping termites as described by Friend and Whitford (1988) were used initially at the Perth Zoo, however the latter method was preferred and modified to increase efficiency.
Modifications included replacing pine slats with Karri slats, and drums were replaced with much smaller drums, for occupational health reasons. Instead of inserting a large block of wood into the side of the drum to lure the termites, many holes were made into the base to allow greater access to the bait wood.
This refinement has resulted in quicker infiltration of drums, and yields of termites per drum have increased. In the peak of summer we have had yields as high as 900-1000 g per drum, though 500g is the average.

French and Robinson (1981) describe a similar method where they used wetted toilet rolls packed into large steel drums with detachable lids. This method proved not very efficient for obtaining large numbers of pure termites due to the difficulty in separating the damp cardboard material from the termites.

HOW TO FIND TERMITES

1.
Nasutitermes exitiosus is Australia's best known species of termite (Watson and Gay 1981). It occurs across southern mainland Australia, from the southern half of Western Australia east to the Pacific coast, but is absent from Tasmania (Watson and Abbey 1985).
The mounds of *N. exitiosus* near the coast in sandy low rainfall areas are low, 20-40 cm and thin skinned, but smooth and domed shaped with most of the nest underground (Eutick, 1983). On the Swan Coastal Plain mounds have been noted as high as 1 metre making them very easy to find. (pers. obs)

Depending on the size of the mound, each could house over a million insects and are usually easy to identify in the bush.

Gay and Wetherly (1970) conducted a study into" the population of a large mound of *Nasutitermes exitiosus*" and found this particular nest housed the largest recorded numbers of insects, 2.5 million and weighed over 11.05 kg.
At certain times of the year trapping *Nasutitermes* can often be more productive than trapping *Coptotermes* if you locate a large enough nest. These nests are usually productive during the winter months when the activity of *Coptotermes* nest have slowed down (pers. obs).

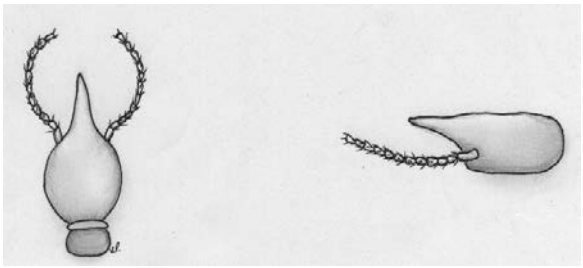
I n summer we concentrate our trapping efforts on *Coptotermes* as larger quantities are consistently trapped.

Fig.6
Nasutitermes mound

Photo: V. Power 1998

Fig.7
Distribution of *N. exitiosus*

Fig.8 Nasutitermes species: Head of soldier



Drawn by V.Power 2000

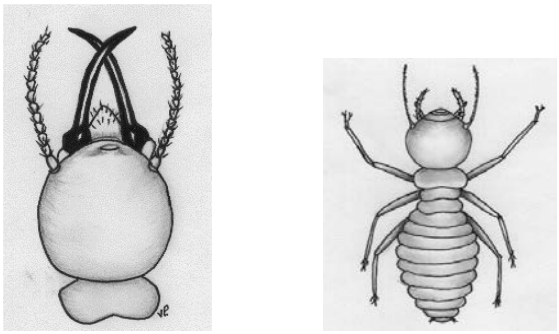
Nasutitermes soldiers when disturbed excrete a strong smelling fluid as a defence mechanism, which Numbats find unattractive. It is recommended to sweep away as many soldiers as possible before removing the trap. This species is smaller and darker in colour than Coptotermes.

2.

"Coptotermes acinaciformis is a common and widely distributed termite species in Western Australia and is certainly the most abundant and destructive species in the southern part of the state" (Calaby and Gay 1956). Both species trapped are found in the Perth Metropolitan area, but neither are trapped in these areas due to possible use of pesticides.

These termites have underground nests and may only be detected by locating their feeding galleries, which radiate out from the nest. The galleries can be found by turning fallen dead-wood over and looking for termite activity, or by placing pieces of Karri wood (baits) on the ground and returning a few weeks later to check for activity. It doesn't matter what size this bait-wood is (80mm x 40mm x 30 cm lengths are good), but it is important to wriggle them into the ground well so they make good contact with the dirt. Fallen bark at the base of trees, and under small clay mounds or bumps at the sides of trees are also good places to look for termites. *Coptotermes sp.* is often found in gravel or loamy soils in Jarrah, Marri or Wandoo woodlands. *Amiterms* species are sometimes found cohabiting with Coptotermes in mound material attached to trees, but only Coptotermes species will enter the traps readily (Pers.obs).

Fig.9. Distribution of *C. acinaciformis* **Fig.10 Soldier Worker**



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PREPARING THE TERMITE DRUMS (TRAPS)

Obtain some open-topped drums (15-20litres), and drill 8 x 12mm holes in the bases.

Obtain some Karri wood, preferably about 10mm thick, but certainly no more than 20mm. These slats can be about 50 – 120mm wide, and should be cut to lengths of about 450mm. This makes them long enough to protrude from the drum, but short enough so that the whole packed drum can fit into a normal sized garbage bag. The wood should also be fairly clean free of debris, fungus etc.

The drums can now be packed with the Karri slats. It is very important to take care when packing, as a neat well-packed drum will create a more attractive environment for termites, rather than one that has wood jammed in willy-nilly. The best method is to lie the drum slightly towards you and pack the wood one slat at a time with the broad sides of each slat facing down, thus creating as few gaps as possible. When the drum is nearly full, stand it up to fit the final pieces. The wood must be tight enough so that it does not slop around in the drum.

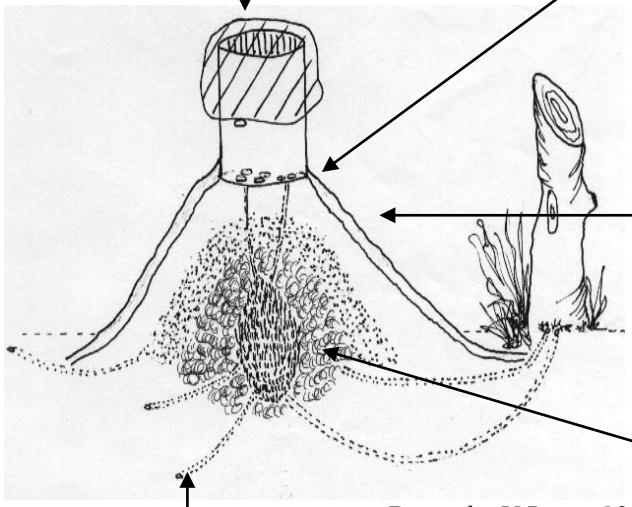
SETTING THE TERMITE DRUMS

Ants are a threat to termite nests, and great care must be taken when setting drums, to avoid leaving the nests or galleries being exposed to infiltration. The soldier termites can repel a few ants, but whole nests can be destroyed if ant numbers are great. It is therefore important that you have everything you need to set up a drum on hand before you expose any termites.

1. Trapping methods for Nasutitermes species

Use a spade to cut the top off the mound. Make a flat surface for the drum to sit on, which is slightly larger than the drum. This will allow room to push dirt around the base of the drum, avoiding gaps for ants to get into the mound or under the drum and into the wood.
Once all gaps around the base of the drum have been sealed, splash about 500ml to 1 Litre (more in summer, less in winter), over the wood. Put a heavy- duty garbage bag over the drum and pull it down to about halfway. Exclude air from the bag and twist the excess plastic around the drum and tuck it under, giving the bag a nice tight fit. The moisture and plastic bag combine to create a humid environment, which is attractive to termites. In some cases, when water is splashed into a drum it washes the soil away from around the base, so it may be best to water the drum before you set it in place.

Fig.11 Trapping techniques for Nasutitermes



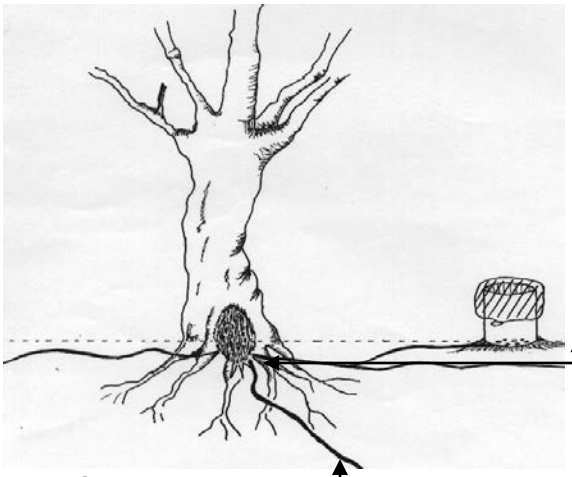
Drawn by V.Power 2000

2. Trapping methods for Coptotermes Species

Trees are the favoured nesting sites of Coptotermes, the existence of such colonies is often difficult to establish, as they do not obviously manifest themselves in the immediate vicinity of the tree (Hadlington,P.1987).
Once galleries have been located (you can see the honey-comb looking holes they use), drums are simply placed on top of them. Dirt or mud is built up around the drum to seal it, and water and a plastic bag are applied as for the *Nasutitermes sp.* mounds. During the summer months large numbers of Coptotermes are found in the traps, so we predominantly trap this species. Lactating female Numbats, if given a choice, prefer this species although they will eat the Nasutitermes.

Fig.12 Trapping techniques for Coptotermes

Many termite traps can be set around a termite-infested tree.



Termite trap packed with moistened bait wood and sealed with plastic bag.

Coptotermes sp. nesting within hard wood tree. Nest area is of a hard woody honeycomb-like carton material. (Calaby and Gay 1956)

Drawn by V.Power 2000

Termite galleries leading out of nest chamber.

REPLACING THE DRUMS WHEN FULL

Beneath the garbage bag, a very full drum may be completely encased in mud by the termites, so even the wood slats are not visible. *Nasutitermes sp.* drums do not usually become caked over like this. Drums do not necessarily need to be caked over to yield good quantities of termites.

Termites are very active in summer, and a good site may yield a full drum within 2-3 weeks. In winter, a drum on the same nest may take a couple of months to fill.

When replacing drums, remove the plastic bag covering the full drum and open it out on the ground. Carefully lift the drum and sit it in the bag pulling the sides up and tying the bag tightly so that the drum is enclosed. Use a new bag if the old one has small holes or tears in it. A good drum can be stuck quite solidly to the ground and may need a bit of force to get it off.

Put a replacement drum immediately back onto the nest or gallery, and ensure that the base is quickly sealed with dirt or mud to exclude ants. Apply water and a plastic bag as described earlier.

STORING FULL DRUMS

If necessary, drums of termites may be stored for up to a week before separating the termites from the wood. However, they must be kept out of the sun and wind, and stored on ant-proof tables. To prevent drums from drying out ,the drums should be stood on top of damp karri slats inside a plastic tray. Tables must be free-standing, and can be made ant-proof by spreading a thick grease barrier (about 60mm long) around each leg. It is important that nothing is leaned against the tables either, as the ant-barrier will be broken. Even a broom or leaves caught in a cobweb may create a bridge that will allow ants onto the table. A bridge like this can permit

enough ants onto the table to infiltrate and ruin the termite drums within a few hours. Do not us pesticides for ant control – the termites may die too!

SEPARATING THE TERMITES

Termites are very delicate, and will crush easily if roughly handled. They also dehydrate quickly, so the plastic bag surrounding the drum should always remain intact. Dust masks should be worn during termite separation, and gloves (rubber or thin cloth) can be worn to protect against bites from the soldier termites, but is usually not necessary.
Using a 'bashing tool', take one karri slat at a time from a drum and hit the end of it in a downward motion, so the termites fall into a large plastic tray. Keep doing this until you have 'bashed' all the slats. There will now be termites plus a lot of dirt in the plastic tray.

To separate the termites from the mound material, tip the whole lot onto a 'platform', which is sitting in a large plastic tray (design of Gay et al 1955).
The termites don't particularly like the light and will quickly run around, and most will eventually fall off the edge of the 'platform', into the plastic tray beneath. The pure termites can then be tipped into an ice-cream container (or similar). Ice-cream containers are good because the sides are slippery, and the termites cannot climb out.
If the termites are very slow and don't look like they are going to move, then you can take a very thin, light slat, spray it lightly with water, and place it gently on top of the termites and dirt. The termites should congregate on the underside of the slat, and can be tapped off directly into a tray and then into an ice-cream container. Do not put more than about 25mm of termites into a container, or the bottom ones may crush.
If there are many of termites and a lot of dirt in a drum, you may need to use 2 'dividers' and 2 plastic trays – don't let the termites and dirt pile up too high, as the weight of it will crush the termites at the bottom.

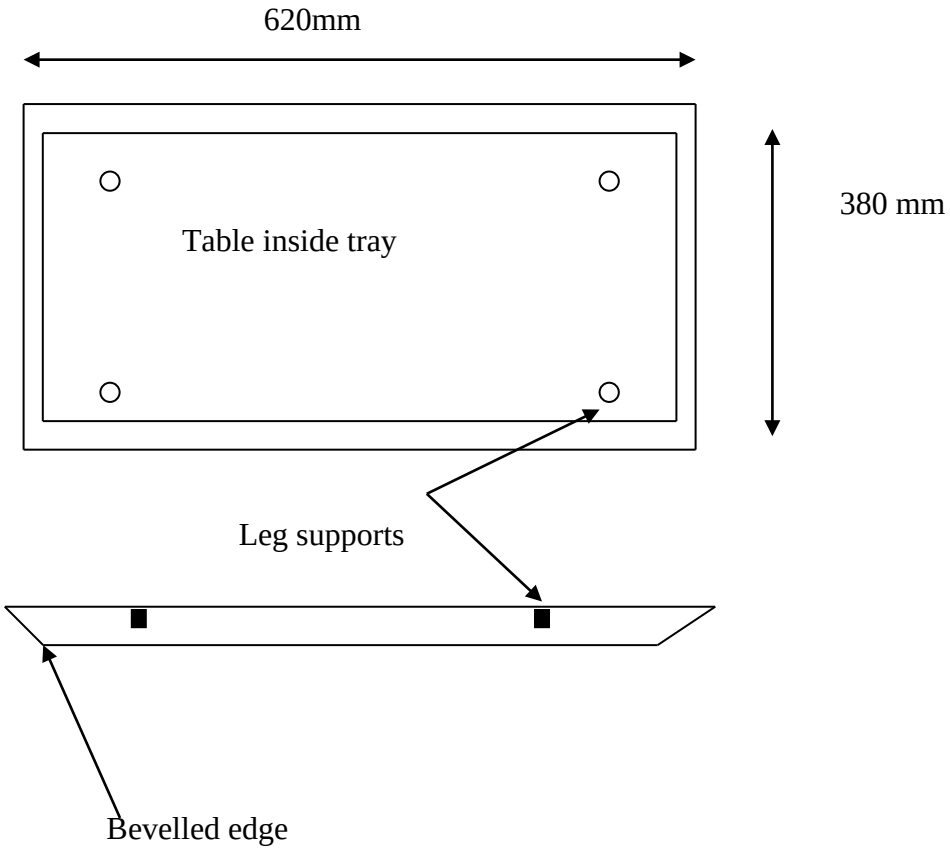
Once you have bashed out all the termites from a drum, there will still usually be a large number remaining in the dirt in the bottom of the drum. To collect these, take 3 or 4 wide slats, spray them with water, and place them - so there are no gaps between them - back in the drum and close the plastic bag around it. The termites will move out of the dirt and up onto the slats, and can be bashed off a short time later. This 'milking' of the remaining termites in the drum may continue a number of times over a couple of days until most termites have been collected.
Similarly, at the end of a session, there will probably still be some termites on the 'dividers' in the plastic trays that haven't run off the sides yet. Tip this dirt/termite mix back into the drum it came from, and they can then be milked out along with the other termites that were left in the bottom of the drum.
Do not ever leave termites on dividers or in trays overnight, or even a few hours in hot weather, as they will dehydrate and die very quickly. In hot weather it is advisable to place damp paper towels over the top of the delicate termites on the trays while you work on other drums.

It is important not to mix termites from different drums (even it they're the same species), as the soldiers from different nests may fight.

All equipment, but particularly the trays, dividers and ice cream containers must be kept clean. Accumulated excreta gives the termites something to climb up, allowing them to escape.

Fig. 13 Dividing tray for separating termites from mound material. Taken from Friend and Whitford 1988 and Gay *et al.* (1955)

TERMITE – SEPARATING PLATFORM
Constructed of Perspex



FREEZING THE TERMITES

Nutritional analysis of frozen termites was conducted by Professor Stanley Urliyak at the Curtin University in 1997. This information has shown that termites can be frozen for future use without losing their nutritional value or palatability to Numbats. The sooner they are frozen after separating the better, but if necessary, they can be stored for a day before freezing in their ice-cream containers in the fridge. Plastic zip-lock bags are good, and all air should be excluded from the bag before sealing. Label the bags with the date and weight (100g portions are ideal). It is important to have pure termites only – careful separating will ensure that all debris is removed.

EQUIPMENT FOR TRAPPING TERMITES

- Open- topped drums. We use 15 - 20 Litre drums, which are between 300 and 400 mm high
- Karri slats
- Heavy-duty garbage bags
- Water container
- Spade

EQUIPMENT FOR SEPARATING TERMITES

- Ant-proof table for storing termite filled drums.
- Large plastic trays (700mm x 450mm x 90mm high).
- Metal 'dividers' – thin pieced of sheet metal (600mm x 350mm), with bolts put through on each corner and one in the middle, to act as legs. The divider should stand about 35mm high.
- Rubber or thin cotton gloves – you can also use padded gloves, to provide some shock absorption for when you're bashing.
- Dust masks.
- Water spray bottle.
- 'Bashing' tool. Use whatever size and weight that fits best into your hand, but it does need to have a little weight behind it. We us a solid metal rod with a diameter of 13mm, and is 350mm long. One end can be flattened (like a screwdriver) and slightly bent, to aid in levering slats out of the drums. The other end should be covered in a shock-absorbent rubber or foam.
- Ice-cream containers.
  Zip-lock plastic bags.

This particular work could pose some repetitive strain injuries to a person who continues to do only this work. It is advisable to rotate staff regularly so to minimise this risk. Wearing a support glove on the hand that takes the impact from metal bashing tool is recommended.

7.9 ENCLOSURE DESIGN:

Numbats at the Perth Zoo are maintained in 3 different types of enclosures.

1. Breeding enclosures **2.Winter facility** **3. Display**

Numbats have been successfully maintained in these enclosures over 12 years. All of the enclosures are landscaped to mimic their natural environment, with hollow logs and various low bushy shrubs. Hollow logs with entrance dimensions of approximately 70 - 120 mm are used by numbats as refuges when frightened in the wild (Calaby 1960). It is particularly important to provide the logs to animals that are intended for release. Under ground burrows are also used by numbats particularly in winter to insulate them from the cold. Nests are used by both sexes and are made from finely shredded bark, grass, & eucalyptus leaves and can be found in both hollow logs or burrows (Christensen et al. 1984).

Planting schedule for the Numbat display

1.	XANTHORREA	Priessi
2.	KENNEDYA	Prostata
3.	DRYANDRA	Ploycephala
4.	CALOTHAMNUS	Quadrifidus
5.	GREVILLIEA	Thelemaniana
6.	ISOPOGON	Formosus
7.	MELALEUCA	Trichophylla
8.	KUNZEA	Macromera
9.	HIBBERTA	Racemosa
10.	HYPOCALYMMA	Angustifolia
11.	ACACIA	Pulchella
12.	PATTERSONIA	Accidentalis
13.	GREVILLEA	Species
14.	DAMPIERA	Diersifolia
15.	KINGIA	Australis

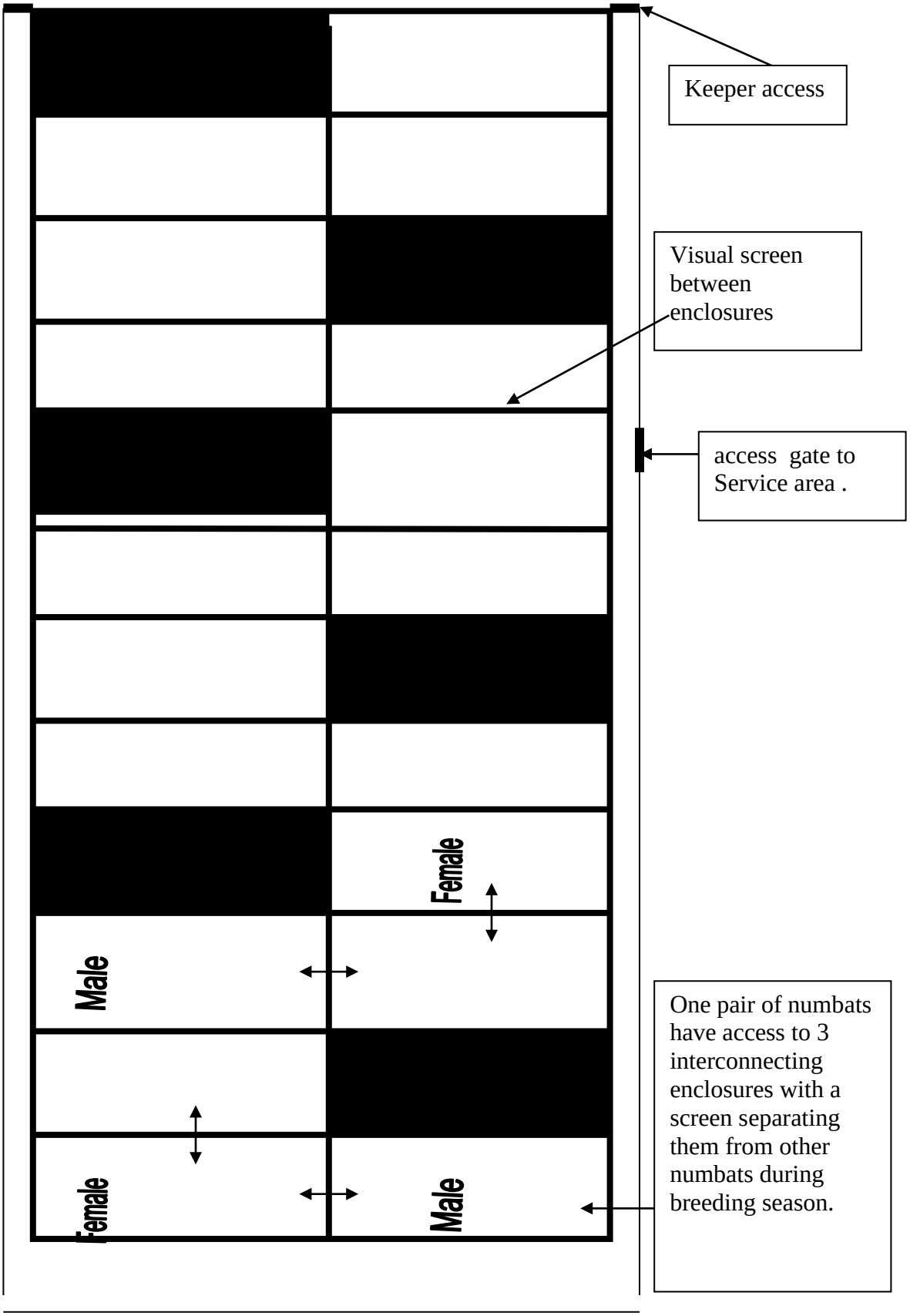
Plants are replaced as needed.

7.9.1 Breeding enclosures

A series of 24 interconnecting enclosures has been designed for breeding purposes. 5m x 3m x 2 m with 25 mm x 12.5mm mesh is used for walls, floor and roof. There is a safety race surrounding the entire complex. The mesh in the floor is buried to 1-meter depth allowing the Numbats to escavate burrows. Each enclosure has access gates that can be opened to allow animals access to adjoining enclosures.

To provide protection from the excessive heat a 90% shade cloth panel covering half the roof can be added.

Fig: 14 Breeding enclosures



7.9.2 Numbat wintering facility for females with young.

Female numbats with young are moved to an indoor facility for the duration of winter. This is necessary due to heavy rains and the inability of the substrate to drain adequately, causing underground nests to become damp during winter. There is a degree of risk of burrows collapsing, causing the death of animals. Mothers and young are better managed inside this facility as they can be inspected daily in their special maternity boxes. Medical treatments can be administered if necessary and food consumption noted accurately. The roof of the wintering facility is made of a heavy duty plastic canvas and has clear panels inserted in the roof and sides to allow natural sunlight into the building.
Animals are transferred outside when the weather has warmed and pouch young start eating live food usually in the month of October.
Enclosure dimensions as follows:
Each enclosure - 2m x 4m – 10 cm of white washed sand for the floor substrate, furnished with hollow logs, rocks, wood chips over 3/4 of the enclosure. The branches of Peppermint or Eucalyptus are added for cover and provide a source of enrichment. A heat lamp is also suspended over the top a basking log. There are sliding doors between each enclosure so that the mother can spend time away from her young if required. UVA/ UVB lights are also installed in the wintering facility above all the enclosures and are operated 9 hours day during the winter months.
A special maternity nest box is provided so that mothers can deposit young into the inner chamber. This nest box is maintained at 26-27 degrees using a 25 watt light bulb.

Fig.15 Winter facility

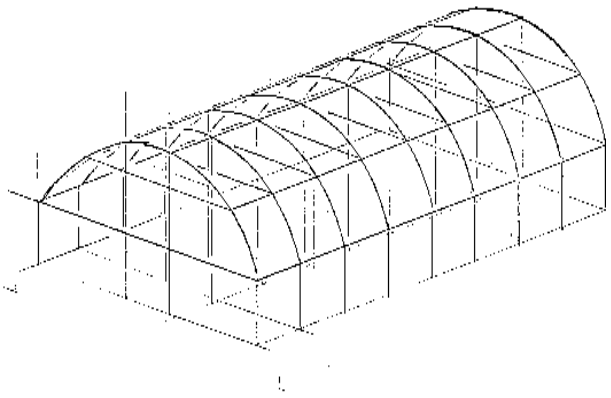
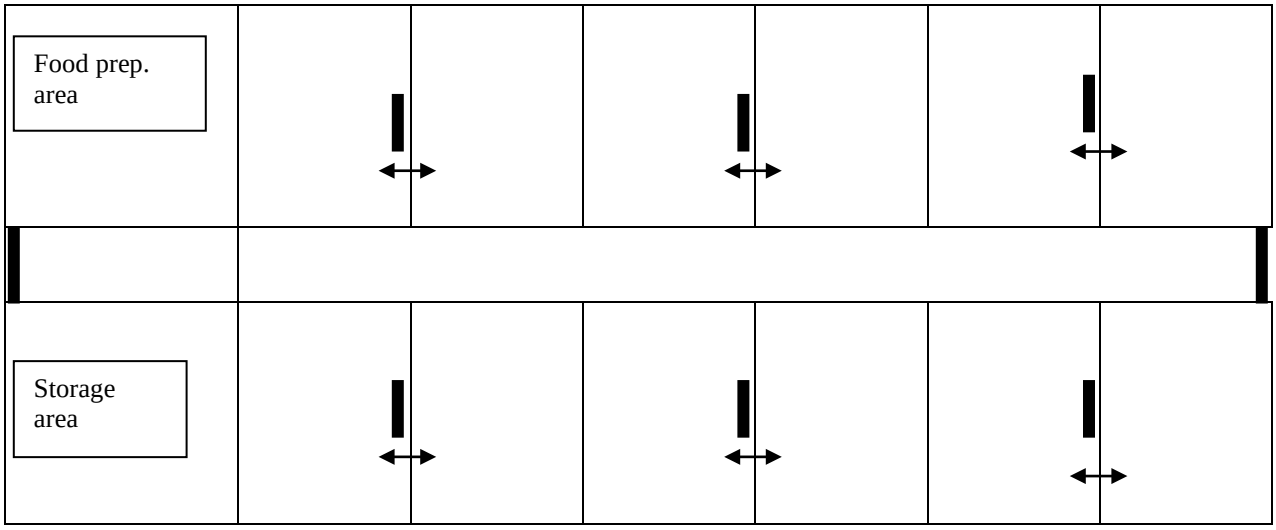


Fig.16 Winter facility inside

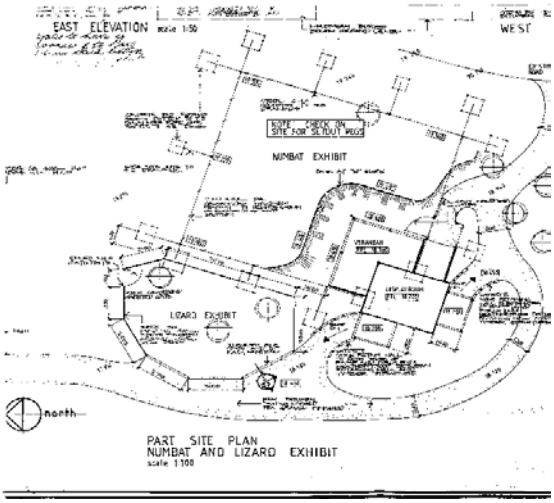
12 interconnected enclosures with slide doors between each enclosure.



7.9.3.Display Enclosure

A large semi enclosed naturalistic area was designed for educational purposes with emphasis on public viewing visibility. The enclosure includes the same landscape materials used in the other enclosures except for the inclusion of large granite rocks and very large hollow logs resting in a vertical position so as to allow the numbats to climb to an elevated position.
The enclosed portion of the display is covered with a aluminium mesh 25 x12.5mm
Dimensions as follows:

Fig.17 Display enclosure



7.10 Spatial requirements:
See EAPA (Exhibited Animals Protection Act, NSW) requirements:
Currently no requirements listed.
Refer to the current handbook for the Exhibited Animals Protection Act, NSW.

7.11 Position of enclosures.
The position of the enclosure is very important, as basking in the sun appears to be an important feature of the thermoregulation of numbats (Friend & Whitford 1988).
Ideally, Numbat enclosures should be orientated towards the North to allow in a maximum amount of sunlight particularly during the winter months. A gentle slope to allow good drainage, or sump wells installed into the substrate, is recommended. No ponds or flowing water streams in the exhibit are recommended as increased moisture can cause animal health issues eg. Dermatitis

7.12 Base: A well draining substrate base of mainly heavy sand with some
Laterite /soil blend. No clay base.

7.13 Substrate: A well draining substrate eg. River Sand 20 cm deep is suitable. The substrate should be soft enough for the animals to excavate a burrow but firm enough not to collapse. Suitable native plants grown in the exhibit will reinforce burrow stability, as Numbats generally dig along the side of a log or an established root system.

7.14 Weather protection:

Summer:
In the off display enclosures shade cloth of 90% density and 2 meters wide are used to cover half of each enclosure, as temperatures in Perth can exceed 45 degrees at the height of summer. The hot air can escape from the uncovered portion of the roof. The shade cloth can be rolled up to the side and stored on the roof during winter.

Winter:
In the breeding enclosures a portion of the roof above the nest boxes can be covered with a clear perspex (not UV blocked) which allows sunshine through but offers some protection from the rain.

During winter females with young are transferred to a wintering building and males remain outside. Some animals excavate burrows at this time of year and use them exclusively, which is consistent with wild behaviour. In general numbats prefer hot drier climates and do not tolerate cold wet climates.
Dampness rather than the cold can be detrimental to health of Numbats in captivity.

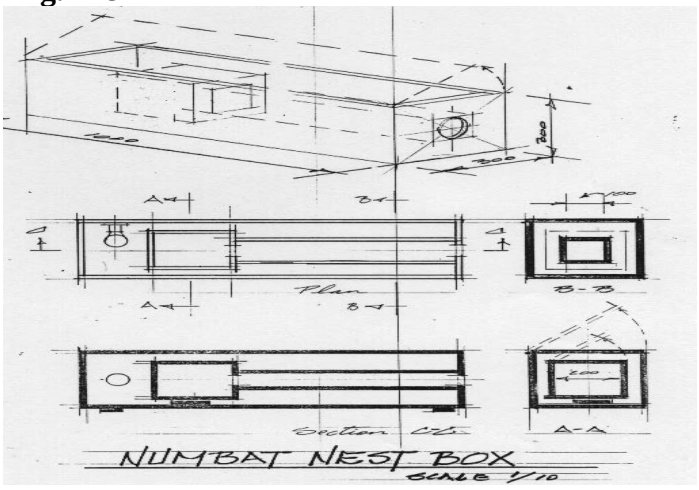
4.8 Water:
Reticulation is operated manually and used sparingly, keeping moisture in the substrate to a minimum. Planting of water retaining species of plants is advisable. During the heat of the day animals will use underground burrows to escape the heat. Misting the substrate has offered some relief with some of the numbats lying under a shrub in the damp area to cool off. Misting should be used sparingly.

4.9 Heating:
Heating is not needed if animals have excavated a burrow and are provided with a dry nest box with adequate nest material (sea grass preferably).
Females with pouch young are encouraged to use a heated nursery box during the winter months, which is turned on overnight. A 20 watt globe will maintain a constant temperature of 24-27degrees.
Females with young are more easily managed in a nest box rather than in a burrow.

4.10 Shelters:
<u>Types</u>

There are 3 different types of nest boxes used, one for lactating females Type 1 the design allows for easy access to evaluate growth of pouch young. Type 2 is used for general use in breeding and display enclosures, which also features a hinged lid allowing access. Type 3 box is used for transport purposes only.

<u>NEST -BOX 1:</u>
Heated nursery nest box used by female and pouch young during winter. Made from 20mm marine plywood. It has a hinged lid for access to the inner nest chamber, which also has a hinged lid.
Fig. 18



NEST -BOX 2:

Nest boxes are designed to simulate a hollow log, with benefits of accessibility. This box is used outside in breeding and display enclosures. Each numbat is given at least 2 nest boxes. Materials – marine ply 20mm. An entrance diameter of

Fig.19

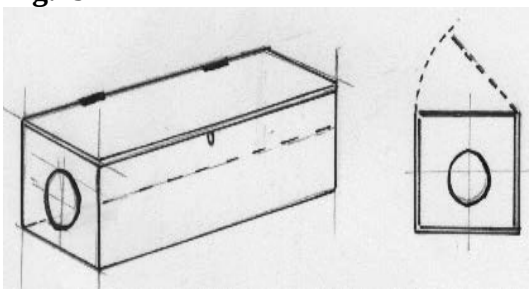


Figure 19 shows the nest box with a hinged lid and an opening at one end. A perspex cover on an aluminium frame 1/2 circle in shape is placed over the box for added protection from wind and rain.

The nest boxes are placed on both sides of the exhibit so that the animals have a choice of location so they can utilise both AM and PM maximum sunshine. Hollow logs can be provided but are not necessary.

4.11 Furniture: Landscaping furniture should include species of plants found in their natural environment which are used for shade and cover (see plant list in Enclosure design). Branches should be arranged in such a way that it allows the animals to climb. Tree stumps cut off into flat steps and large ironstone make excellent sun basking platforms. 2 or 3 placed though out an enclosure would be utilised by the Numbats. Tussocks grasses, though not native, provide a good cover but should be used sparingly as it becomes difficult to sight animals in an overgrown enclosure.

4.12 Nest Material: Couch grass grown in small quantities in the enclosure is often plucked for nesting material by the Numbats. Dried sea grass is a very good and inexpensive nest material which can be packed directly into the nest box or placed nearby. Numbats will utilise anything soft to line a nest. They have been known in captivity to collect flowers of native plants and even women's stockings to line nests.

4.13 Interspecific compatibility:

A single male Numbat is currently being housed on display with 1 Rainbow Bee - Eater and 3 Wellcome swallows and 2 Spelndid fairy wrens.

4.14 Things to avoid:

- High humidity, damp substrate and nest material, should be avoided as numbats in captivity have a predisposition to skin problems (Dermatitis). See Veterinary section.
- When meadow hay is in seed , it should not be used as a nesting material. The seed pods can lodge into the eyes and cause ulcerations. They also can lodge into the coat and feet.
- Over feeding.

4.15 Occupational Health and Safety Issues:

Toxoplasmosis has been observed in numbats on 3 occasions at the Perth Zoo during the late 1980s,however this is of low significance due to the life cycle. Salmonella has also been

detected in the numbat colony in more recent times. Rubber gloves should routinely be worn when handling faeces and urine.
When handling termites, gloves and a dust mask should be worn to prevent inhalation of dust and fungal spores from the wood.

4.4 CAPTURE FROM THE WILD:

Preferred time of capture: Early in the morning while still asleep in their underground burrow so they can be caught as they emerge for the day.

Capture equipment and techniques: Numbats are very difficult to catch and require CALM officers to follow them into a hollow log and catch them manually by hand when they emerge from the hollow log to feed. Soft bag nets are used.

Triage and Baseline data
The type of information gathered from wild animals includes weight, breeding condition of females (pouch development), and a variety of measurements including:

- ear length
- head length
- scrotal length and width
- pes length

Depending on CALM requirements, animals to be released may have a sample of skin taken from the ear for future DNA analysis.

Release: Animals that are to be released as part of a captive bred / release program should be release into a suitable hollow log at dusk so they can settle for the night with out the threat of aerial predators.

4.5 SEXING TECHNIQUES:

In captivity Numbats are visually sexed approximately 4-5 months of age. It is possible to determine the sex at a earlier stage but it is recommended not interfere with pouch young in the early developmental stages as pouch young can dislodge from the nipple.
The male's scrotum is quite dark in colour and very obvious as is the female's pouch at a early age. Do not apply pressure to the head of young when inspecting.

4.6 IDENTIFICATION:

Transponder implants:

Silicon microchips are the preferred method of identification. They are usually implanted into the dorsal scapular area at the time of weaning. To date there have been no problems with this position. (10 months of age approx.)

Ear tags: not used
Tattoos: Have been used in the past but now considered not useful.
Ear notches: nil
Bands: nil

Visual Identification
Historically, this method of identification was used when the numbat breeding program was transferred to Perth Zoo in 1985. The band markings across the back of each animal is a unique finger print for that individual. Photographing each individuals bands and tattooing was discarded when transponder implants were introduced.

4.7 GENERAL HUSBANDRY:

Cleaning routine:
Dishes to be collected daily and washed, soaked in Milton solution. Food preparation area to be cleaned daily. Animal faeces to be removed daily from all enclosures.
Nest material inspected and replaced if damp.
Maintain termite separating area eg. Keep Drums moistened and sealed, grease table legs to maintain ant barrier, sweep area.

Changing of substrate / furniture:
Numbats usually defecate and urinate in an isolated area making it reasonably easy to remove. In the wintering facility it is recommended to remove faeces by sifting sand through a large mesh scoop every 2-3 days. Entering the enclosure every day to remove faeces would be too stressful for some of the more flighty animals. The Display and Breeding enclosures are open and exposed to the elements allowing the faeces to biodegrade, therefore don't require such an intense cleaning regime.
Large cage furniture eg. large logs for climbing on should be replaced yearly.
Gum branches used for shelter should be replaced every 2-3 weeks (before they degrade).
Inside the winter building the river sand substrate should be replaced yearly, it is approximately 10 cm deep.

Enclosure maintenance: The outside mesh enclosures are designed to be of low maintenance, though a yearly inspection for structural deterioration is recommended. Particular attention should be paid to the mesh if it is pulling away from poles buried underground. Roof inspected for holes. Display enclosure should be inspected routinely every month for signs of damage as the public daily frequents this area, eg. holes in the roof , doors not closing properly.

Routine animal checks: The Numbat is a diurnal animal so it can be visually checked (at each feed time, morning and afternoon). All animals are weighed fortnightly and their physical condition can be evaluated at this time.

Moulting: Captive Numbats moult and presumably this also occurs in the wild. It appears to occurr in summer. It is most obviously seen starting on the back of the head and around the ears and then spreads down the neck and shoulder area with the forearms included.

Animal introduction:
- New animals are introduced to a new enclosure early in the morning so they can be observed throughout the day for signs of stress or injury. Similarly, when animal are paired for breeding purposes they are paired early in the morning.
- When a male is introduced to a new female he is transferred with his nest box to her enclosure. He generally spends the first day scent marking his territory within the female's enclosure, with brief chasing of the female in between..

Behavioural enrichment:

The inclusion of live termites within mounds is an important source of enrichment and may also help to maintain the feeding skills for those due for release. Allowing the Numbats to work through the mounds assists with the wearing down of the toenails which would normally happen in the wild.
Any new cage furniture stimulates the highly inquisitive numbat.

4.8 HANDLING:

Handling bags:
Pillow cases are ideal for catching and transporting numbats in for short distances. Bag nets are not recommended as animals become very stressed if chased with a net and particularly if not caught on the first attempt.

When to handle: Numbats are inactive early in the morning and usually remain in their nest boxes, which makes it easier to catch them. During the heat of the day numbats often take a siesta and may also be found in their nest box.

Capture techniques: The ideal way to catch a numbat is early morning while it is cool and on some occasions can be in a torpor state. First, block off the entrance to the box with a pillow case. The lid can then be lifted slightly and the hand slipped in over the animal's shoulder area to restrain it, and the other hand can then restrain the hind legs. The animal should quickly be removed and placed into a pillow case. In some instances a a soft bag net may be required if the animal is hanging on the fence.

Weighing:
Animals are weighed fortnightly on digital scales as part of the regular husbandry routine. Lactating females are weighed 3 weekly. Animals which are not eating properly or sick animals, are weighed as deemed necessary by Animal Health.

Restraint: The method used to restrain a numbat is to pin the animal down by the neck /shoulder area while still in the pillow case. Using the other hand to slide into the bag this hand can then replace the outer hand to restrain the neck/shoulder area. Once the animal feels secure the free hand can then slide into the bag to hold the hind feet together firmly as they can kick. The animal can then be lifted out of the bag. This method allows the underside of the body to be examined . Some numbats are particularly nervous when handled , so if the head is not required for examination it would be recommended to keep covered. This method has proved less stressful as they tend to struggle less.
Numbats have a rather thick neck, which doesn't enable them turn and bite easily.
Young
During breeding season the female's pouch is inspected one or two days after a 14 day gestation. If a mating has not been observed, but there was evidence that a mating may have occurred eg. wet neck, pouch inspections are carried out 2 days after the 1st possible birth date . To minimise stress on the female, it is advisable to keep the females head covered exposing only the pouch area. In some females the pouch area is quite hairy and may require blowing of the hair to make young visible.
Photos of pouch-young. See Appendix: 1
Body weight of pouch-young. See Appendix: 1a

Special needs:
Captive numbats require nail trimming periodically due to the lack of activity.

Artificial Rearing and Surrogacy:
Barlow (1998) describes the supplementary feeding techniques used to rear 3 very emaciated baby numbats at the Perth Zoo in 1996. In 1997 another baby numbat was orphaned when his mother 's milk dried up resulting in his siblings dying. This particular mother was one of the young supplementary reared by Barlows 1998. This female lost a second litter in the following year from the same problem. It is interesting to note that this genetic line including the grandmother and all of the young supplementary reared by Barlow (1998) had to be released due to lactation and rearing problems in captivity.

In August 2001, 3 young numbats were orphaned when their mother was euthanised after developing a herniated bowel. These three pouch young were supplementry fed for 3 weeks. Theyoung were 7 and half months old and were reared following the established guidelines described by J.Cowie (2000) with some modifications.
As these animals were intended for release we aimed to minimise the human impact by introducingthe young to a surrogate non-lactating female for numbat socialisation during the third week of feeding. It was anticipated that the wild adult female may demonstrate to the young normal behaviours such as nest building activities and flight/ fright responses and feeding/ foraging activities.
It was noted during early October that the smallest male was collecting nest material ,which is the first time a baby numbat this young had been observed nest building.

Some supplementry feeding of young has been undertaken to fast track the weaning process if the mother is showing signs of stress eg. weight lost. When supplentry feeding has been warrented only one or two days is required until young accept the artificial diet.

See Appendix 6. **Artificial feeding formula and guidelines**.

Rehabilitation and Release procedures:

History
As a member of the Numbat recovery Team, Perth Zoo has a responsibility to captive breed numbats for reintroduction back into areas of former distribution. Unfortunately, many Numbats from the Perth Zoo following release into the wild by CALM, have suffered from predation. This has highlighted the need to address this issue and the need for a predator recognition conditioning program prior to release. During 1998-2001, Numbat Keepers have been developing a protocol for preparing captive Numbats for reintroduction which will hopefully increase their survival.Numbats have many predators which include foxes, cats, carpet pythons and birds of prey. It appears that birds of prey are one of the main causes of fatalities in young juvenile numbats particularly when they are at weaning age and starting to venture from the safety of their underground burrows (Thomas, pers.comm.).

Based on recovery team information, it was decided to concentrate on the main predator (Birds of prey) likely to be causing the deaths of the captive numbats. In 1998 a small trial was conducted by the author to determine if firstly, young captive born numbats had an instinctive fear response and secondly, if there was a learned response from the presence of the mother. The first trial was conducted inside the wintering tunnel at the time young would first be emerging from the underground burrow/nest box in the month of September.
It was determined from this information it does appear numbats have an instinctive fear response. These behaviours included freezing, running and hiding.
From this investigative preliminary work, further trials were conducted in late 1999 and 2000 to finetune a workable protocol which could be experimentally evaluated at a later date.

Progress Report

Preliminary results from the 2000 release to the Stirling Ranges National Park were very promising with a bias of trained animals being still alive 5 months post release (Friend.pers comm).

This program will be conducted for several years so it can be evaluated scientifically.

Fig. 20: First Anti-Predator trial in 1998

Photo: V. Power 1998

Other preparation prior to release include:

- The young numbats have their diet changed to 100% termite diet a few weeks prior to release. Diet and body weight monitored closely and not to exceed 350g in bodyweight, as there may be difficulty in fitting the radio collars. If animals are too fat when collared the collars may slip off or cause injury if they lose weight post release.
- Termite mound is fed in daily for enrichment and to stimulate activity.
- All young undergo pre-release physical. See Veterinary section.

4.9 TRANSPORT:

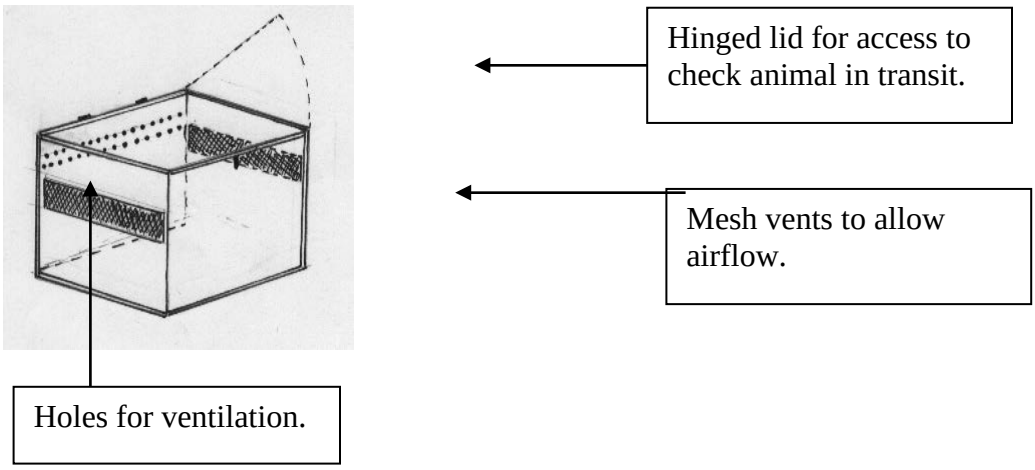
IATA requirements: See Appendix.

No listed requirements in handbook for Numbats.

Box design: It is recommended a small animal box 35 x 40 x 20 cm, made from marine ply or similar material.
The animal is placed inside a pillowcase and into wooden box full of sea grass. Holes are drilled into two sides of box for airflow and a hinged lid

for easy access to animal. Internal transport within the zoo is in a pillowcase.

Fig.21 Transport Box



Nest material: Sea grass (meadow hay has been trialed in the pass but seedpods lodge in eyes and coat). Dried couch grass can be used safely.

Animals per box: one

Identification: Perth Zoo uses Trovan passive transponders implanted in the dorsal scapular area.

When to transport:
During the summer months animals should be transported in the cool of the day. Winter transport should be in the warmth of the day.

Maximum transportation period: Less than 24 hours preferred.
Significative weight loss noted in animals over 36hrs in transport without food and water. (Haigh, pers.comm.)

Water and food: nil

Release from box: Animals being released by CALM staff into release sites are usually directly into a hollow log in the late afternoon. If animals are transferred to another captive institution they can be released immediately into their enclosure.

4.10 POPULATION MANAGEMENT:

Compatibility with own species: Numbats are solitary animals and are housed singularly most of the year. Male and females are usually compatible with each other during breeding season, though this needs to be closely monitored. Two females have successfully been housed together for display purposes when introduced together to a new enclosure. This minimises a dominance behaviour occurring. On some occasions there has been some aggression between females, so this also has to be monitored, particularly over food.

Compatibility with other species: Bee-Eaters, Splendid Fairy wrens, Welcome swallows have proven to be compatible in a large display enclosure.

6.6 CAPTIVE BREEDING:

A captive breeding protocol was established in 1997 after conducting an experimental design to establish the oestrus cycle of the numbat. The results were presented at the 1997 ARAZPA Conference NZ by the author.

In captivity, animals are paired when early pro-oestrus is detected in the female and sperm is detected in the urine of the male.
Initially, urine samples were collected fortnightly from both male and females in early December. More recently, swabbing the vaginal sinus tract has been implemented, as it is more accurate. Males generally start to produce sperm in the urine from mid December though this varies from year to year slightly, then disappears towards the end of February. To determine the oestrus cycle an examination of the shed epithelial cells in the urine is required. Though numbats can undergo several oestrus cycles in a breeding season, in captivity the majority of matings occur in month of January or early February.
See Appendix 4: Lab procedures
Female numbats may be swabbed weekly leading up to peak breeding periods eg. any time after Christmas day. When there is a dramatic increase in neucleated and cornified epithelial cells the animals are paired. The majority of matings occur when there is an absence of neutrophils and a majority of cornfield epithelial cells.
Based on the information gathered over the years observing the breeding behaviour and combining the lab oestrus works, animals can be bred relatively easily in captivity.

The animals remain paired until pouch young are found or males are rotated if no matings have occurred at the detection of next oestrus cycle.

In non–breeding season periods they are housed individually with a screen erected around all the enclosures to restrict sight and smell of each other.

6.7 Reproductive behaviours:

Breeding animals respond to each other in a variety of different ways when first introduced. The more extroverted animals usually exit their nest boxes eagerly to promptly explore the new enclosure. Generally, males spend the first day scent marking the females' enclosure. If an encounter with another Numbat occurs there can be a loud altercation with growling vocalisations by one or both animals, usually it is from the female. Males will often attempt to mount a female during these first encounters, which often leads to tumbling together on the

ground and growling from the female. Some chasing or following by the male is a good thing but if a female chases the male excessively this may be indicative of an incompatible pairing or she is not ready to mate. Under these circumstances, it is recommended to remove the male and replace with another appropriate male. A good indication that a compatible pairing has been established is feeding from same food bowl and sleeping together and generally spending time a lot of together.
The perimeters for selecting pairings are based on unrelatedness of individuals and appropriate body weights; larger males are generally paired with smaller females or at least evenly matched body weights. On some occasions, a pair may show no interest in each other at all often sharing the enclosure but ignoring each other. This may indicate the female is not reproductively ready or it's an incompatible pairing.

Matings have been observed over a 48-hour period and a seminal plug may be passed 24 hours after the first mating. Seminal plugs are indicative of a successful mating. To confirm that a mating did occur a urine sample from the male may reveal very little sperm or none at all. It may take several days for the sperm to reappear in the urine. Copulation times range from a few minutes to an hour.
Some matings have occurred out of view and the only evidence of mating has been a wet neck. The seminal fluid with the plug is distinctive from other discharges, as it is a white, waxy gelatinous substance. This substance can contain sperm and cornified epithelial cells.
Post- mating, females may have wet necks and ruffled fur around the cloacal area near the tail base.

An example of typical reproductive behaviour is as follows:

- Male constantly following the female.
- Male paying particular attention to the cloacal region of female.
- Male sternum gland marking enclosure and particularly marking the females urine and faeces.(Males may have faecal material attached to their sternum glands)
- Female urinating and urogenital marking her enclosure.
- Sleeping together in nest box.
- Attempted mountings by male.
- Vocalising to each other. Females have been observed calling on the day of oestrus. Some females during the period of oestrus have been heard to vocalise loudly when pacing the fence line adjacent to males.

- **Physiological changes in the female just before and at birth :**
- **The following may occur.**
- Increased moisture in the pouch. Sweaty looking.
- A granular appearance of pouch tissue several days before birth.
- Increased colour (redness) and swelling of the nipples, swelling around nipples can form ridges.
- A curled cover position may be observed on the day of birth, with the appearance of cleaning the cloaca area.
- Some females may become inactive and not feed the day before or on the day of birth.

6.8 Breeding strategy:
In captivity, Numbats are paired at the onset of early pro-oestrus and when males are producing sperm in the urine. They remain paired until pouch young are found.
The majority of observed matings have occurred in the open enclosure with a few exceptions of matings occurring inside a nest box.

The Numbats are also given several nest boxes to use for shelter during the breeding season. It is important that the female has many refuges to escape to if a male persistently tries to mount her.

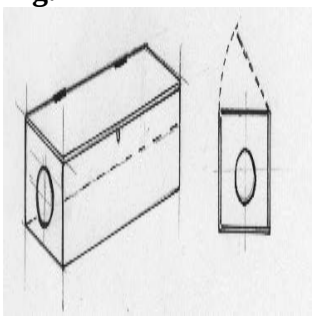
6.9 Enclosure size: See enclosure design in 4.2

Females require more area so they can escape the advances of a male if necessary. This is very important as a female in a past breeding season was trapped in a nest box by a male and was repeatedly mated causing her reproductive tract to rupture. Providing additional nest boxes throughout the enclosures is essential.

6.10 Nesting requirements (nest boxes, nesting materials etc.)

Long thin box 66 cm L x 14 cm W x 12cm H constructed of marine ply with hinged lid for easy access and open entrance at one end. See attachment diagram

Fig.22



6.11 Cover (visual barriers, hiding areas, runways etc.)

Visual barriers are very important particularly during breeding season. Eucalyptus branches lent up against mesh walls provide shelters and hides for the animals. Shade cloth is recommended around the end of enclosures where pouch young are housed, particularly if the area is frequented by staff.

6.12 Breeding group size: 1.1.0

6.13 Introduction: Male numbats are given access to the female's enclosure at the point the females are in pro-oestrous and the male is producing sperm in his urine.

6.14 Pairing duration: Paired when females are in pro-oestrus and until pouch young are found then separated.

6.15 Aggression: Some aggression has been observed in incompatible pairs eg. constant chasing by male and loud vocals from female with direct physical contact. If this behaviour lasts longer than a day the male should be replaced with another.

6.16 Removal of parents: At weaning the young are removed from mother.

6.17 Animal checking: Daily

6.18 Pouch checking: 14 days gestation- pouch checking on 15-16 day.

Age estimation (including growth charts if available)

6.19 Juvenile diets: Numbat young intended for release are weaned onto a termite & artificial diet but this is changed one month prior to release to a termite crumb feed so that foraging feeding behaviours are heightened

Fig.23
An example:
Female with pouch young attached body weight fluctuations during the year.

8.0 RECORD KEEPING

8.1 Daily record keeping: A good record system is important so that the reproductive status, health and condition of the captive numbat population can be monitored.
Records should include: daily food consumption, medical treatments, behaviour changes or problems, breeding research data, births, deaths, weights and measurements, transfers of individuals between enclosures or institutions.

8.2 Identification: All animals are Trovan micro-chipped in the dorsal scapular area.

8.3 ARKS reports: ARKS allows for the collection of historical information on individuals to be transferred to other institutions, greatly enhancing a co-operative approach to data collection amongst institutions.
The record officer allocates individual accession numbers to individual numbats.

8.4 SPARKS reports: Are a breeding studbook for a species. Currently the numbat program is managed by studbook keeper- Vicki Power, Perth Zoo.

8.5 Record updating frequency: Daily

8.6 Stud book (in house, national, regional, international)
Numbats are only held in institutions within Australia so an in-house and national studbook exists only.

9.0 HEALTH AND VETERINARY CARE OF THE NUMBAT

Quarantine

A minimum thirty-day quarantine period applies to all numbats coming into Perth Zoo. This period may be extended if any conditions are found which warrant treatment or further testing. During the quarantine period, the following procedures are carried out:

Faecal sample examination: A total of three faecal samples, collected at weekly intervals, are examined from each individual (or cohabiting groups of individuals). The samples are examined for the presence of internal parasites (protozoal organisms, worm eggs or larvae). To be released from quarantine, each of the three faecal samples must be negative for other organisms requiring treatment. Parasite eggs are found only rarely in Numbat faeces. Strongyle eggs have been detected in the past. If a numbat is found to be infected with a parasite warranting treatment, it shall be treated with the appropriate antiparasitic drug, and a follow up faecal will be obtained 7-10 days after treatment. The animal will not be released to the section until this follow-up is obtained and cleared.

Regardless of faecal examination result, all numbats are treated with appropriate antiparasitic drugs (Ivermectin) to treat for the Acanthocephalan worm (Thorny Headed Worm), prior to release from quarantine. As this parasite can be difficult to detect on faecal examination, a negative result does not constitute a negative infection. The life cycle will be discussed in further detail at a later stage.

Import physical examination: each numbat is examined under anaesthesia by a veterinarian to check its general health status. The following parameters are included in the examination: eyes, ears, nares, teeth, feet, nails cloaca, integument and fur, abdomen, thorax and limbs. Physical examination of females will also include a pouch examination. Previously, blood was collected for routine complete blood count, biochemistry and toxoplasmosis testing. As the majority of tests have yielded no blood abnormalities, routine blood collection no longer occurs. Currently, blood is only collected when there is considered a cause to do so.

Microbacterial swabs are taken from the cloaca of all new arrival animals and tested at a laboratory for routine microbacterial culture including Salmonella.

The animal is weighed at least twice during the quarantine period: once at the start of quarantine (usually at the time of physical examination), again at the time of transfer to the section, and possibly once in between.

Identification microchips are implanted at the time of physical exam ie under general anaesthetic. These are placed subcutaneously, in the skin fold in the dorsal midscapular region. The hole created in the skin is either glued or sutured close, but suturing is preferred due to more secure closure of the hole.

Temperature control

See general husbandry manual for details.

Numbats in quarantine are routinely provided with a basking lamp and it is noted that in almost all circumstances, numbats will make use of this heating source. At Perth Zoo, numbats in quarantine are housed in doors and during this time, they will also be offered an UV light source.

Sick, injured or debilitated numbats are usually provided with an external heating source to allow them to maintain preferred body temperature. Provision of heat is decided according to needs and problem of the individual.

Major diseases

Disease problems with numbats are relatively infrequent. In most cases they are individual problems, and form no species specific disease pattern. The most commonly observed disease conditions are listed below:

Skin problems

Previously at Perth Zoo, a skin condition characterised by scurf, scale, redness and serum ooze occurred in a number of individuals. The skin changes occurred in various areas of the body and particularly involving the ventral surface and skin fold areas. Diagnostic testing was inconclusive. Eventually substrate was changed to the more common sand substrate now employed at Perth Zoo and skin conditions of a similar nature have not recurred. As most skin cases occurred in the winter, it was presumed that the original clay substrate did not allow adequate drainage and the substrate became too moist. In addition, it appeared that numbats could not burrow adequately in this substrate.

Toxoplasmosis

Numbats are considered moderately to highly susceptible to toxoplasmosis. Over a number of years, a number of animals have been detected with toxoplasmosis cysts on post

mortem examination. Recent routine blood testing from 1996 to 1999 however, has not detected any animals with positive toxoplasma serology. This low incidence of disease in captivity could perhaps be attributed to the increased awareness of the numbat susceptibility to this disease and the preventative measures that have been taken in captivity.

Acanthocephalan Parasite Infection

A new genus and species of parasitic worm from the phylum Acanthocephala (thorny-headed worms) has been associated with gastrointestinal pathology in wild caught numbats from Dryandra in Western Australia (Haigh and Friend, 1999). The worm has been named *Multisentis myrmecobius* (L. Smales 1997)

The life cycle of acanthocephalans is indirect, and involves ingestion of an intermediate arthropod host by the definitive host. In the case of infected numbats, the intermediate host is presumed to be termites. It is assumed that the termites ingest eggs, which are passed in numbat faeces, then the eggs develop to the infective stage within the termite over 1-3 months. The numbat is infected when it ingests the infected termite. The parasite then matures in the small intestine of the numbat, developing into an adult worm over 5-12 weeks. The female worms then produce eggs, which are voided in the faeces where they are ingested by termites.

This acanthocephalan worm has been found to cause severe gastrointestinal pathology and has been associated with inguinal hernias and gastrointestinal torsion.

Acanthocephalan infestations in numbats can be treated using Ivermectin at 200ug/kg PO or S/C. It has been recommended to treat animals 2-3 times in the 3 months prior to release, using only "clean" termites the during this time to break the cycle. However, since the parasite is already present in the termite population of Dryandra, it may not be effective to worm animals prior to release into this area. It may be prudent however, to treat incoming individuals with two doses of ivermectin, one during the quarantine period and the second three months later, in order to prevent the parasite causing problems within the collection.

It is intended that further studies will be conducted on the presence of the intermediate stages in termites collected from various regions. As our current treatment and termite collection protocol only covers numbats and termites from Dryandra, it is hoped that this information will determine whether termites from all areas present a potential risk to numbats, or whether the risk is localised.

In summary: Currently the Perth Zoo protocol is:

Numbats for export:	no treatment required
Numbats for import:	ivermectin @200ug/kg PO during the quarantine period, then repeat this dose in three months.

Tumours

Tumours are not uncommon in aged numbats and various different types of tumours have been diagnosed. There does not however, appear to be any predisposition to any particular type of tumours or locations. Adenocarcinomas and squamous cell carcinomas are amongst the types of tumours that have been detected.

Salmonella

Salmonella, of varying serotypes, has been diagnosed on routine faecal culture in new arrival and longer-term numbat residents. Although Salmonella has been implicated in a death of a very small number of individual numbats, in most cases, salmonella has been an incidental finding on routine culture. In a few cases however, the clinical presentation included mucoid

and malodorous faeces. Treatment using antibiotics has been attempted but usually has not cured the infection. In most current cases, treatment is not attempted; instead, routine hygiene techniques are employed to reduce zoonotic risk and contamination to other numbats. It is presumed that the salmonella sheds during periods of stress, however it has not been possible to ascertain any particular pattern of salmonella shedding.

Mycobacterium infections

Acid fast bacteria have been reported from a lung abscess in one aged numbat. The author knows of no other reports of mycobacterium infections being reported in numbats.

Tail trauma

Numbats appear moderately susceptible to spinal trauma as a result of tail base injuries. The cause of the injuries has not been determined but is presumed to be associated with individuals that climb, and possibly have fallen to the ground from a significant height. The few cases that have now been seen have resulted in partial or complete loss of tail function, seen as drooping tails. Anti-inflammatories have been tried with moderate success. The drooping tails do not appear to cause any short term problems, however complete loss of innervation may necessitate amputation. None of the cases seen at Perth Zoo have required amputation and the impact/effect of tail amputation is unknown. Consideration is being given to preventing captive numbats from having access to the upper reaches of their wire wall enclosures.

Examination

Anaesthesia of the numbat.

Numbats are manually restrained and induced using a 5% isoflurane solution via an appropriately sized facemask. Anaesthesia is usually maintained using 1.5% to 3% isoflurane depending upon the individual. Anaesthesia by injection is generally not employed however wild numbats have been anaesthetised with zoletil at a dose rate of 5 to 9 mg/kg IM. The author has no direct experience using zoletil in numbats.

At Perth Zoo, blood is always collected under general anaesthesia. The strength and behaviour of a manually restrained numbat makes blood collection without anaesthesia virtually impossible. The most successful sites have been the femoral vein and the brachycephalic vein, which could also be described as the distal jugular near the junction of the clavicle and the shoulder.

Hand rearing

There have been very few opportunities to hand rear numbats, however the one numbat attempted at Perth Zoo has been successfully reared to adulthood.

The animal was 6 ½ months old weighing 26.8g, and was raised on Wombaroo >0.7 kangaroo milk replacer at 50% increased concentration. The concentration of the formula was increased to the 50% level in an attempt to produce consistent weight gain. The animal was fed approx/ 5-8 feeds per day times per day and converted over to an artificial diet approximately one month after rearing. It would be considered that further experience is required in this area to develop a standard approach to handraising. Further information on this handraised case can be obtained in the article produced by Jo Cowie (2000).

Rehabilitation/First Aid

[Please see "Preparation for Release" for further information]

Symptomatic rehabilitation/first aid treatment consists of:

- Immediate provision of a warm (30-32 degrees Celsius), secure environment, as well as food and fluids

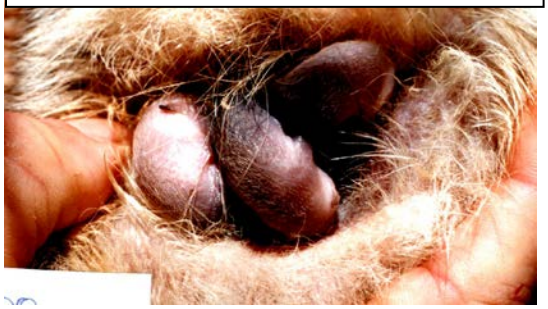
- Fluid therapy with subcutaneous warmed fluids (Hartmans or 2.5% glucose) if there is evidence of dehydration, or if the animal refuses to eat
- Oxygen support, including oxygen tank therapy, if required.
- Treatment of obvious injuries; this may have to be delayed if the animal is debilitated
- Antibiotic therapy by intramuscular injection, if indicated.
- Further diagnostic work under anaesthetic may be indicated once the animal has stabilised.

5. APPENDIXS:

Appendix 1: Growth Development of Numbat Pouch young

Female 100 pouch young 25.3.98

Female 100 pouch young 14.5.98



Female 100 pouch young 26.6.98

Female 100 pouch young 16.7.98

Female 100 pouch young 31.8.98

Appendix :1a Body weight of pouch young from date of deposit

Appendix 2: Artificial Diet Preparation

EGG CUSTARD QUANTITES

# of animals	water(mls)	Weight of eggs	Weight of Digestelact	CaCo	SF40	Termite mound
7-8	450 mls	240g	104gm	1/2 tsp	1/4/tsp	1 scoop (50g)
9-10	570 mls	300g	123gm	1/2 tsp	1/4 tsp	1 scoop
11-12	680 mls	360g	151gm	1/2 tsp	1/4 tsp	1 scoop
13-14	800 mls	420g	180gm	1/2 tsp	1/4 tsp	1.5 scoop
15-16	910 mls	480g	198 gm	3/4 tsp	1/2 tsp	2 scoops
17-18	1020 mls	540g	227 gm	3/4 tsp	1/2 tsp	2 scoops
20	1140 mls	600g	246gm	1tsp	1/2 tsp	2 scoops

Appendix 3: Example of Diet Prior to Breeding Season

Example of feeding routine for females with young prior to next breeding season and preparation of young prior to release. As the release date approaches the %termites are increased in the female numbat's diet.

The following 3 females were on a 100**% TERMITE DIET** for the duration of the breeding season November - March.

100 % TERMITE DIET

114 F	**100** % Termite	a.m	40 gm
		p.m.	30 gm
Young		a.m	80 gm A.D + 10 gm termites in 1 bowl
		p.m.	80 gm A.D + 10 gm termites in 1 bowls
101 F	100 % Termite	a.m	40 gm
		p.m.	30 gm
96 F	100 % Termite	a.m	40 gm
		p.m.	30 gm
Young		a.m	80 gm A.D add 10 gm termites
		p.m.	80 gm A.D add 10 gm termites
Males fed		am.	30gm +5 gm termites twice a day.

If termite supplies are good we endeavour to give a 100% termite diet where ever possible but we have had considerable success with a 60% termite diet.

Appendix 4:

Laboratory Procedures for Oestrus and Sperm Detection

1. Take all samples as soon as possible to the fridge and store until you are ready to do lab work.

2. Record all samples (urine and faeces) in the Lab book eg. Studbook # and accession # sex and enc #.

3. Use a sterilised pipette and transfer the urine to a labelled (same as Lab Book) sterilised centrifuge tube and stand on the rack beside an identically labelled centrifuge tube.

4. Centrifuge urine samples at 2000 rpm / 10 mins. Make sure to balance the tubes opposite each other. If there is only one sample use water in a tube to counter balance centrifuge.
   While tubes are spinning write on slides with the same information, date, file #, sex.

5. Transfer the superannuate to a clean labelled tube and freeze for additional hormonal analysis.

6. Sediment remaining resuspends in PBS sol at 0.5-1.0 mls and agitate.

7 Pipette up a small amount (2 drops) not removing any sediment and drop onto slide and air dry.

8. Stain according to DIFF QUIK protocol, dry and mount with DePGX.

9. Store in the slide case.

DIFF Quikk

1. **Fixative** 5 * 1 sec dips, drain BLUE
2. **Sol. 1** 5 * 1 sec dips, drain RED
3. **Sol. 2** 5 * 1 sec dips, drain PURPLE

- Gently rinse with deionised water
- Allow drying.

- **Vaginal Smears**

- Moisten swab in normal saline.
- Insert swab gently into urogenital sinus tract and rotate anterior to cloaca.
- Pre- label slides prior to procedure.
- Remove and roll out in one direction onto a clean slide.
- Air dry
- Stain as above methods.

Appendix: 5

IATA

CONTAINER REQUIREMENT 79

The illustrations shown in this Container Requirement are examples only. Containers that conform to the principle of written guidelines for the species but look slightly different will still meet the IATA standards.

Applicable to:

Carnivorous	*Herbivorous*	
Desman	Agouti species	Moonrat
Ermine	Chinchilla species	Muskrat
Ferret species	Gopher	Nutria
Fox (farm)	Guinea pig	Paca
(also see	Gundi	Pacarana
Container Req. 82)	Hamster	Pika
Marten species	Hare	Rabbit species
Mink	Hutia	Squirrel species
Sable	Lemming	Tuco-tuco
Solenodon	Marmot	
Stoat		
Tasmanian devil		

See USG Exceptions in Chapter 2 and Exceptions BA-02, CX-01/02, GF-01, IB-01 and OS-02 in Chapter 3.

Note 1: *Mink are to be housed in individual compartments of the container.*

Note 2: *Normally one animal per compartment unless the animals are used to co-habiting.*

1. CONTAINER CONSTRUCTION

(see Exception QF-01 in Chapter 3)

Materials

Wood lined with wire mesh, sheet metal, fibreglass, rigid plastic, strong welded wire mesh, wire mesh, and nylon mesh.

Principles of Design

The following principles of design must be met in addition to the General Container Requirements outlined at the beginning of this chapter.

Dimension

When constructing travel containers for these species the normal habits and movement must be considered, they must be able to move around freely. The size of the container will vary with the species, refer to the density guidelines in this Container Requirement. Multiple compartmentalised containers must have individual access doors.

Frame

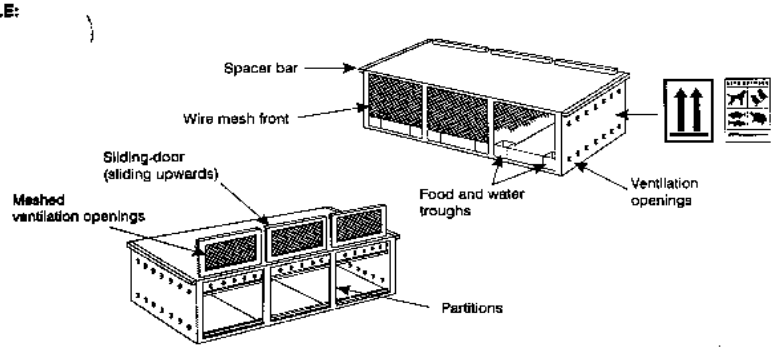
The strong weld mesh lining can form an internal cage round which the outer casing of wood or other suitable material is constructed. When the frame is made from solid wood, it must be screwed together. The frame can also be formed by the wooden base, sides and top of the container being screwed together and then lined with weld mesh, if the weight of the animal permits this type of construction.

Sides

The sides and door must be made of metal sheet, weld mesh lined wood or plastic. One third of the front of the container must be made from weld mesh. Containers made without a wire mesh liner must have wire meshed screening over all ventilation openings.

Wire meshed ventilation openings, with a diameter of 2.5 cm (1 in), must be present on the sides. Curtaining may be required for some species, this can be provided by nylon mesh or other similar material which will reduce the amount of light within the container but allow good ventilation.

EXAMPLE:



REGULATIONS

CONTAINER REQUIREMENT 79 *(cont'd)*

Floor

The floor must be solid and leak-proof, it must be covered with a layer of absorbent material, such as wood shavings, for bedding.

Roof

Must be made of solid sheet metal, wood or plastic.

Doors

A sliding door must be provided at the rear of the container to give access into the container. Each compartment of a container must have its own sliding door. All doors must be provided with a secure fastening so that they cannot be opened accidentally.

Ventilation

Ventilation is provided by wire mesh at the front fo the container and wire meshed ventilation openings, with a minimum diameter of 2.5 cm (1 in), which must be present on the sides. When non-wire lined containers are used any internal sharp edges from the wire mesh must be covered with smooth material.

Spacer Bars/Handles

Must be made to a depth of 2.5 cm (1 in), must be present on the sides of the container as shown in the illustration.

Feed and Water Containers

Metal food and water containers must be provided, they must fitted into the wood/plywood at the front of the container and be fixed to the uprights of the framework so that they cannot be moved by the animal, there must be a means of outside access for replenishment. Soldered tin must not be used.

Rigid Plastic Pet Containers
(see Container Requirement 1)

Rigid plastic pet containers can be used for the air transport of small numbers or individual animals. The following modifications must be undertaken:

the height and width of the container must allow the animal to stand in a natural position, turn around and lie down comfortably;

the floor of the container must be made non-slip before being covered with absorbent bedding;

the grill door and all ventilation openings must be covered with fine wire mesh, if this is fixed on the inside, all edges must be protected and made smooth. The door must be fixed shut at both the top and the bottom in such a manner that it cannot be opened easily;

food and water containers must be fixed inside the container and have outside access for replenishment;

the container must be correctly labelled.

If a container has wheels, they must be removed or rendered inoperable.

2. PREPARATIONS BEFORE DISPATCH
(see Chapter 5)

Squirrels must be given a piece of sacking from whi
make their own bedding.

3. FEEDING AND WATERING GUI
(for emergency use only)

Animals do not normally require additional feedir
watering during 24 hours following the time of dispat

If feeding is required due to an unforeseen delay, the
vorous species must be provided with pieces of raw
a little fish or dog food and milk. The herbivorous sp
must be provided with carrots, fruit, nuts or grains.
shipper's instructions must always be followed.

Note: *Laboratory and SPF animal containers mus
be opened, therefore, these animals must be fed
scientifically controlled conditions. A viewing panel m
incorporated into the container of SPF animals.*

4. GENERAL CARE AND LOADIN
(see Chapters 5 and 10)

Animals known to be for laboratory use must be sepa
completely from other animals to reduce any risk of
infection or contamination, e.g. specific pathogen free
consignments.

Mink, when disturbed, give off a strong feral odour
will contaminate other loads.

When animals are to be carried in quantity, maintain p
separation of cartons in the aircraft. Care must be
that there is adequate air circulation throughout the s
and the boxes are secured in a manner which will pr
them from toppling during flight.

Warning: *These species bite.*

CONTAINER REQUIREMENT 79 *(cont'd)*

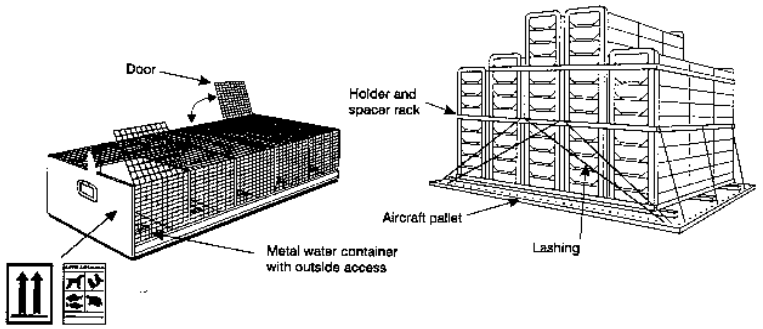
DENSITY GUIDELINES						
Species	Weight of Animal (grams)	Maximum Number per Compartment in Container *	Space per Animal		Height of Box	
			cm^2	in^2	cm	in
Chinchillas	450–550	2 **	260	40	23	9
Hamsters	Young	18	32	5	13	5
Smaller Animals	170–280 281–420 421 or more	12 12 12	90 160 230	14 25 36	15 15 15	6 6 6
Larger Animals	2,000 or less 2,001–5,000 5,001 or more	4 2 1	770 970–1,160 1,400	120 150–180 220	20 25 30	8 10 12

* If ground temperature exceeds 24°C (75°F), reduce maximum number per compartment in the container by 10%.

** If ground temperature exceeds 24°C (75°F), allow 520 cm^2 (80 in^2) per animal. A temperature in the box of more than 27°C (80°F) is liable to be lethal to chinchillas.

EXAMPLE:

CONTAINERS LOADED ON A PALLET



Appendix 6:

An example of:
Body Weight and Seasonal Reproductive Development in the Male Numbat

Appendix 7: Artificial feeding formula & guidelines

Appendix 8: **Products Mentioned**

Digestalact Powder **Supplier Fauldings**
493 Abernethy Rd, Kewdale W.A. Tel: 9353-0190

S.F. 40 **Glen Forrest Stockfeeders**
3150 Gt Eastern Hwy, Glen Forrest W.A. Tel: 9298-8111

Calcium Powder **Brigadoon Produce**

1125 Gt Northern Hwy, Baskerville W.A. Tel: 9296-1575

Feed Bowls **Symonds Seeds**
5 Hutton St, Osborne Park W.A. Tel: 9443-7100

Drums **Van -Leer Australia**
8 Rawlinson St, O'Conner W.A. Tel: 9337-3511

Plastic Bags **Dysons**
5-7 Abrams St, Balcatta W.A. Tel: 9344-5655

Bakers Trays (Termite separating)

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