SOUTHERN HAIRY-NOSED WOMBAT
(Lasiorhinus latifrons)

HUSBANDRY MANUAL

"Willie"

By

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2005

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1. INTRODUCTION

There are three species of wombat within the Vombatidae: the Common Wombat (*Vombatus ursinus)*, the Southern Hairy-nosed Wombat (*Lasiorhinus latifrons)* and the Northern Hairy-nosed Wombat (*Lasiorhinus krefftii)*. Common wombats and southern hairy-nosed wombats are relatively common, and many are killed by cars and shot under permit each year as they are considered a pest by pastoralists. The northern hairy-nosed wombat is one the most critically endangered animals in the world with only an estimated population of 90 individuals in Epping Forest National Park (Scientific) in the Central Queensland Highlands .

Common wombats have been held in numerous zoos throughout Australia and the world. The first common wombats to be held in a zoo were kept in the zoological gardens attached to the Natural History Museum in Paris in 1803. London Zoo had common and hairy-nosed wombats well before 1863. The southern hairy-nosed wombat is also currently held in zoological institutions overseas and within Australia.

Table 1. List of institutions that are members of the Australasian and Regional Association of Zoological Parks and Aquaria that hold Common and Southern hairy-nosed wombats.

Common wombat	Southern hairy-nosed wombat
Western Plains Zoo	Westerns Plains Zoo
Taronga Zoo	Taronga Zoo
Cleland Wildlife Park	Melbourne Zoo
Australian Reptile Park	Currumbin Wildlife Sanctuary
The ACT National Zoo & Aquarium	Dreamworld
Healsville Sanctuary	Rockhampton Botanical Gardens and Zoo
Melbourne Zoo	Adelaide Zoo
Halls Gap Wildlife Park	Monarto Zoo
Ballarat Wildlife Park	Perth Zoo
Crocodylus Park	Australia Zoo
Australia Zoo	
Dreamworld	
Lone Pine Koala Sanctuary	

The northern hairy-nosed wombat was briefly held in captivity at Western Plains Zoo in Dubbo and also by the Dennis family from Epping Forest Station up until the late 1990's No northern hairy-nosed wombats are currently held in captivity.

2. TAXONOMY:

Wombats belong to the Vombatidae. There are two genera and three extant species of wombats within this family. The first species to be described was the common wombat (Shaw 1800), later the southern hairy - nosed wombat was described by (Owen 1845) and the northern hairy-nosed wombat by (Owen 1872) (Hamilton *et al.* 2000; Strahan 2000).

Southern Hairy - Nosed Wombat Status

ASMP	Management level currently 3, proposed 1b Institutions holding this species are requested to assist the critically endangered northern hairy-nosed wombat, as an analogue species.
IUCN	N/A
OH&S	Hazardous
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Northern Hairy – Nosed Wombat Status

ASMP	None in captivity not managed
IUCN	Critically endangered (B2ab(iii) – single population occupying <10km^2 , declining habitat quality).

2.1 Nomenclature

Class: Mammalia
Supercohort: Marsupialia
Cohort: Australidephia
Order: Diprotodontia
Suborder: Vombatiformes
Superfamily: Vombatoidea
Family: Vombatidae
Genus: *Lasiorhinus*
Species: *Lasiorhinus latifrons* Southern Hairy – Nosed Wombat
Lasiorhinus krefftii Northern Hairy-Nosed Wombat

Etymology

Lasiorhinus	Hairy nose
krefftii	After Gerrard Krefft who was a curator at the Australian Museum
latifrons	Broad forehead. Refers to the wide nose

2.2 Subspecies

The hairy-nosed wombats do not have any subspecies

2.3 Other Common Names

- Southern hairy - nosed wombat; hairy-nosed wombat. (Strahan. 2000).
- Northern hairy-nosed wombat; Queensland wombat, Queensland hairy-nosed wombat or Moonie River wombat. Yaminon – Indigenous name (Strahan. 2000).

3. NATURAL HISTORY

3.1 Morphometrics

Depending on the species wild adult wombats range in body weight from 19-40kg and are approximately 900–1150 mm in body length (Strahan 2000). The southern hairy-nosed wombat maintains a silver coat colour; however white animals are known to occur. The northern hairy-nosed wombat is dark grey almost black in coloration. Both the hairy nosed species have silky fur while the commons have a very wiry coat.

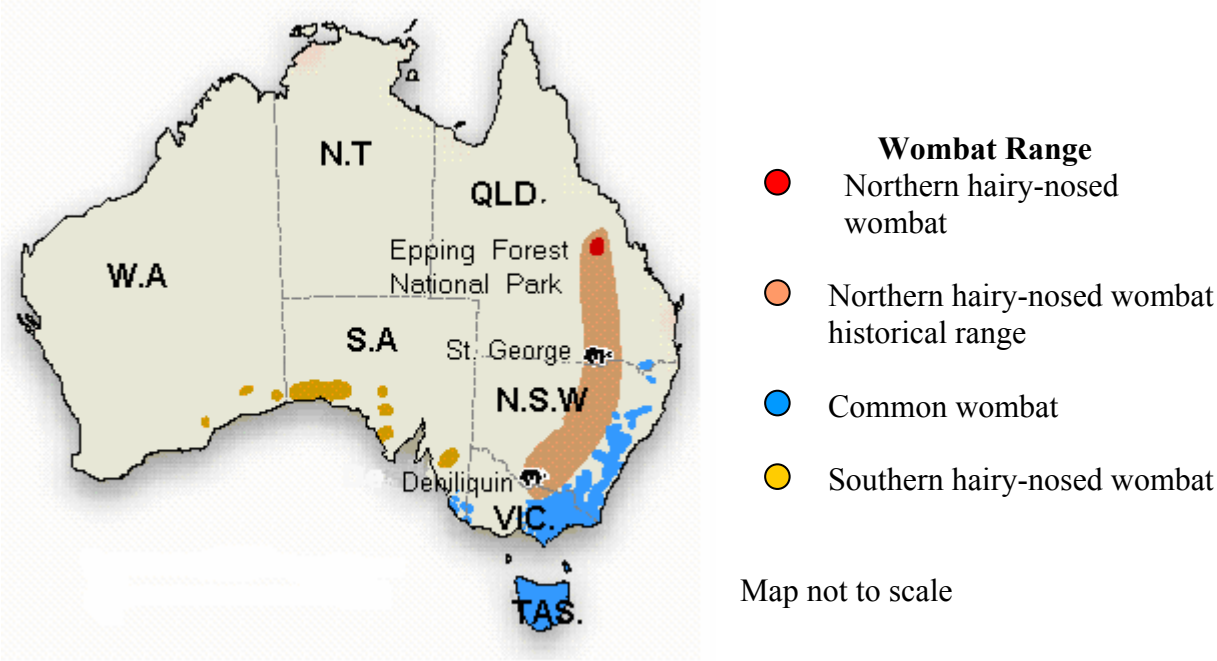
Table 1. Body weight and head-body length for the different species of wombats. CR- critically endangered, LR – lower risk. (Jackson 2003)

Species	Weight (kg)	Head & body length (mm)	Status
Lasiorhinus krefftii	27 - 40	970 - 1110	CR
Lasiorhinus latifrons	19 – 32	772 – 934	LR
Vombatus ursinus	22 – 40	900 – 1150	LR

The female northern hairy-nosed wombat tends to be larger than males, significantly so for body length, head and body length and weight. Despite the slightly smaller size of adult males they tend to have thicker necks than adult females. Body measurements for the southern hairy-nosed wombat reveal no significant differences between the sexes, except in foot length, which is slightly longer in males. Adult female common wombats tend to be larger than males, but the differences are not significant (Johnson & Crossman 1990).

3.2 Distribution and Habitat

The southern hairy - nosed wombat has a patchy distribution in semi-arid shrubland and mallee in southern South Australia and south-eastern Western Australia (Map 1).



Map 1. Map of Australia showing present and historical distribution of the northern hairy-nosed wombat and current distribution of the southern hairy-nosed and common wombats (Geographic 2004).

3.3 Diet in the wild

Wombats are strict herbivores and are hindgut fermenters (Booth 1999). The natural diet of all three wombat species is principally perennial native grasses, often of low nutritive value. When foraging, southern hairy-nosed wombats graze closely in a circular pattern around the burrow complex to produce a 'lawn' or grazing halo of green shoots, and home ranges are small, about 4 ha. The grazed halos expand as plant growth declines. Wombats have a split upper lip which allows them to use their two upper and lower incisors to crop pasture close to the ground. Wombats have continuously growing incisors, premolars and molars, a feature not found in any other marsupial. Consequently, tough grasses are reduced to minute particles. The fact that wombats are able to reduce their food to small particles is an important ability to obtain maximum benefit from its diet. Perennial grasses, especially *Stipa nida,* are the main component of the diet of SHW. However, more forbs and dicots in grassland habitats and more woody shrubs in bluebush shrubland and mallee woodland habitats are eaten during severe drought (Hume 1999).

3.4 Longevity

3.4.1 Wild

In the wild the southern hairy - nosed wombat have been known to live for 14-15 years (Wells 1989).

3.4.2 Captivity

The southern hairy - nosed wombat is expected to live 10 -15 years in captivity. Brookfield Zoo had a wild caught female live to the known age of 27 years and similarly Melbourne Zoo had a wild caught male attain 25 years (Treby 2003).

3.4.3 Techniques to determine the age of adults

Once wombats reach adult size, there is no reliable technique for aging them. Patterns of tooth wear are commonly used to age mammals; however this is not possible in wombats due to teeth growing continuously.

4. HOUSING REQUIREMENTS:

The minimum enclosure sizes for exhibiting wombats as directed by the Exhibited Animals Protection Act (EAPA) (*Standards for exhibiting mammals in New South Wales* 2002) are as follows;

Minimum Surface area for one wombat is $23m^2$
Minimum Surface area for two wombats is $45m^2$
Additional Floor area for each extra animal is $9m^2$

The exhibit structure for wombats needs to be only a basic design as wombats are highly destructive due to their powerful build and digging habits. Most plants will be uprooted; logs and other furnishings will be dug around. A natural dirt/sand substrate floor should be provided to allow the animal to express natural digging behaviour. A mesh underlay approximately 1 -1.5 m below the surface is required to prevent them from escaping under the fence The perimeter fence should be smooth as wombats are quite capable of climbing mesh fences, chewing or digging at fences, which may result in holes in the fence and damage to the teeth, gums and feet of the wombat. Fencing types such as corrugated iron are not suitable because of the reflective heat in summer. Wombats are capable of jumping at least a meter in height (pers.obs); therefore surrounding walls need to be a minimum 1.5m high.

Although wombats can live in environments where the temperature can reach 35-45˚C with relative humidity of 2-5%, the corresponding temperature in the burrow is about 10-27˚C with 60-70% humidity. Wombats do not sweat which is useful for conserving water but makes them more susceptible to heat stress. Southern hairy-nosed wombats begin to show signs of heat stress when temperatures reach 33-35˚C, with deaths being known to occur above 38˚C. Southern hairy-nosed wombats are also known to salivate profusely when they get hot, and may also roll on their back and expose the sparsely furred belly (Wells 1989).

If captive animals are kept outdoors where they cannot construct burrows, appropriate measures must be taken so that they can behaviorally thermoregulate. Provision of a burrow or the means to construct one will make them feel secure. Burrows can be

constructed using mock rock caves, pipes or hollow tree trunks (figure3.). Overstorey planting will provide shade and should be included (Gaughwin *et al.* 1998). The use of old koala browse placed over mounds and tunnels has been employed by many institutions in an attempt to keep the temperature down. Sprinklers and adequate shading during warm weather should always be provided. Water can be provided in a stainless steel, ceramic bowl or an automatic filling device. Water features or wet moats should be avoided as wombats have been known to drown in them.

Wombats have also been successfully housed indoors, which has the advantage of allowing better control of the temperature and humidity. In these enclosures, soil or sand should still be provided over the concrete floor to allow for natural digging behaviour. Indoor enclosures also allow the use of reverse lighting to display them when they are generally most active (normally at night). Brookfield Zoo in Chicago has successfully used this technique to display and breed southern hairy - nosed wombats in the past (Crowcroft & Soderlund 1977).

4.1 Holding area design

The holding area can be similar in principle to the design of the exhibit and only needs to be quite basic.

4.2 Spatial requirements

A pair of wombats requires at least $45m^2$ as well as a shaded nesting area. Larger enclosures are preferable and enclosures up to $400m^2$ have been suggested to reduce the likelihood of pacing, climbing and other attempts to dig out of the enclosure (Booth 1999). Southern hairy - nosed wombat's can be readily held in groups, a further area of at least $9m^2$ should be provided for each additional animal (Jackson 2003).

4.3 Position of enclosure

The enclosure should be situated in an area that has plenty of shade during hot weather and provides sunny areas during cooler weather, so wombats can bask when it is cold.

4.4 Weather protection

The enclosure can be open, semi enclosed or fully enclosed. If open they need to have adequate shade and sprinkler systems for cooling.

4.5 Heating requirements

Heating is not required for the display of wombats. However, Dr. Glenn Shimmin from the Dept. of Environment and Heritage, Adelaide, suggests that the wombats may need to experience seasonally varying den temperature from 14-25˚C (held constant over any given day), as this may stimulate reproductive behaviour in southern hairy-nosed

wombats (Shimmin *pers. comm*. 12.10.2000). Therefore the inclusion of a heating system may be of benefit for reproduction.

4.6 Substrate

The substrate should be soil or sand that is well drained. Care should be taken when using leaf litter as southern hairy-nosed wombats have been known to suffer from fungal infections of the feet when kept on leaf litter that was damp. Apart from allowing activity and other natural behaviours, the provision of substrates to allow digging enables the wombats to wear down their claws. The provision of sand or soil will also allow the wombats the opportunity to dust bath. If kept on a cement floor where there is no provision for digging, nails may grow excessively.

4.7 Nest boxes

To best cater for wombats psychological needs an artificial burrow should be provided to stimulate natural behaviour and a feeling of security. Nest boxes/dens should be approximately 1m x 1m x 1m with a hinged lid, narrow tunnel like entrance/passage, lined with straw or hay, and positioned in the shade where ever possible in outdoor enclosures. Artificial mock rock, concrete and brick sleeping dens have been used at several institutions. Straw or hay can be used as bedding. However, quite often in the summer months it may well be pushed out of the den and discarded by the wombats. Presidente (1982) found that hessian bags filled with straw were accepted. The animals slept between these bags, which provided additional insulation during winter.

4.8 Enclosure Furnishings

The enclosure requires very few furnishings as wombats are destructive by nature. Large hollow logs, branches, large rocks and pipes that are buried in the soil and large enough for them to sleep in are perfect (photograph 1). If large rocks are used in the enclosure they will need to be checked regularly as wombats can destabilize their foundations by constant digging. The risk of rocks falling or rolling onto animals should not be overlooked. If difficulties are encountered in getting plants established inside the enclosure, then plants may need to be planted around the outside of the exhibit to provide shading. Branches and rocks are used by wombats as scratching posts to reach places on their body that they cannot otherwise reach. Large tussocks of *Lomandra logifolia* have been successfully used in the southern hairy - nosed wombat exhibit at Currumbin Wildlife Sanctuary, the wombats there do not seem to be interested in eating it.

Photograph 1: Enclosure furnishings

4.9 Wombat breeding facilities

Western Plains Zoo has a state of the art wombat facility located in the off limits area of the zoo (photograph 2). The design mainly focuses on the thermoregulation requirements of wombats. The complex is a series of interconnecting tunnels packed in soil and surrounded be a retaining wall to prevent digging. Soil acts as a natural insulation. Burrow temperature should range between, 14-24˚C. Access to wombats is by hinged lidded sleeping boxes. Sleeping boxes are lined with hay/straw bedding. The wombats' movements are controlled by a series of sliding doors. This design also makes it easy to restrain and handle wombats (MacCallum 2003).

Photograph 2: Wombat Breeding Facility at Western Plains Zoo – D. Treby

The "Wombat Breeding and Research Facility", is located within the grounds of the Rockhampton Botanical Gardens and Zoo a replica of the Western Plains Zoo enclosure, and is dedicated to the reproductive research of the southern hairy - nosed wombat as an analogue species for the northern hairy-nosed wombat. This facility is air conditioned to provide optimal temperatures for the wombats. Staff feel that the inclusion of humidifiers may also be required to replicate burrow conditions and stimulate natural breeding behaviour.

Melbourne zoo have incorporated a heating system into the tunnels of the wombat exhibit as well as into the floor of one of the boxes in the off limits area. This heating system can be controlled via thermostats.

Taronga zoo's Backyard to Bush exhibit contains a custom made wombat facility which consists of a series of six burrows, of varying sizes on display and two outdoor off exhibit areas. The exhibit has the capability of being opened up for access all areas, or being sectioned off into two indoor/outdoor exhibits or two indoor and two outdoor areas. Thermal stability can be obtained through altering the floor heating in the six burrows.

Perth Zoo's wombat exhibit is split in half to form two enclosures, with an off limits area located between the two exhibits. One half of the exhibit contains an underground tunnel system with viewing area for the public (photograph 3a & 3b).

Photograph 3a: Perth Wombat Exhibit (D Treby)

Photograph 3b: Underground tunnel with public viewing area (D Treby)

4.10 Hygiene and cleaning

Wombats are best maintained with a high standard of care. All enclosures should be cleaned daily to remove faecal matter and uneaten food. Drinking water dishes should be

cleaned and refilled daily. Wet or soiled bedding in dens should be replaced as required. When an individual permanently leaves an enclosure, it should be scrubbed out and thoroughly cleaned prior to the new animal going in.

4.11 Record keeping

Health, condition and reproductive status of captive wombats should be routinely monitored. Animals should be checked daily and the following records kept.

- Identification numbers
- Veterinary examination conducted
- Treatments provided
- Behavioural changes or problems
- Reproductive behaviour or condition
- Weights or measurements
- Changes in diet
- Movements of individuals between enclosures or institutions
- Births & deaths

The collection of information on individual physical and behavioural patterns can contribute greatly to the husbandry of this species.

4.12 Methods of identification

4.12.1 Microchip transponders

Microchips (Trovan, Microchips Australia), implanted subcutaneously between the scapulae of wombats, provide a permanent method of identification. Micropchips do require the animal to be caught to confirm identification with a Microchip scanner.

4.12.2 Tattoos

Tattooing has been successfully used on the inside of the ear. This technique is highly visible though only temporary and may be difficult to see depending on the way the animal is laying, therefore the animal may need to be manually restrained to confirm identification.

4.12.3 Visual identification

As wombats show a degree of anatomical and behavioural variation, visual identification can often be used. This technique requires an intimate knowledge of individual animals.

4.12.4 Ear tags

Ear tags are not recommended, as they are highly likely to be torn out. Ear tags that have been used include self piercing, nylon disc swivel tags similar to that used for cattle, pigs and sheep, however although highly visible, these are sometimes lost, become entangled or are ripped out by other wombats.

4.12.5 Hair bleaching

Rockhampton and Taronga zoos, have experimented with bleaching patterns on different parts of the wombat for identification purposes. This technique is highly visible although only temporary.

4.12.6 Ear notching

Ear notching by cutting U- or wedge-shaped notches out of the ear margins, are permanent, but may be obscured by subsequent injuries. Ear notching may be objectionable on humane grounds (Rice & Kalk 1996).

4.12.7 Freeze marking

Freeze marking or cryobanding, is a relatively new, permanent marking technique that shows promise for use in the zoo industry, but as yet not seen widespread use. Freeze marking has the potential to meeting many of the ideal marking criteria. It is permanent, can be legible at a distance, and is thought to be painless; the rapid freezing of the skin acts as a local anaesthetic. It has been used on mammals ranging in size from neonatal mice to African elephants (Rice & Kalk 1996).

5. FEEDING REQUIREMENTS:

5.1 Captive diet

The Basal Metabolic Rate (BMR) of the southern hairy - nosed wombat is one of the lowest recorded for any marsupial, and the maintenance energy requirements of wombats also the lowest recorded for any marsupial. Low rates of metabolism and low rates of nutrient turnover provide animals with advantages in terms of their ability to survive long periods of food shortage under adverse environmental conditions (Hume 1999).

Given the low BMR and energy requirements wombats have a tendency to become obese in captive situations, therefore a low energy low protein diet primarily based on grass and or palatable but low quality food is essential. Studies rates of microbial fermentation of fruits and vegetables suggest that these forages ferment more rapidly than grasses. The wombat with its low metabolic rate and slow digesta passages rates, does not require and can not economically utilize these more rapidly fermenting foods. Dry dog/cat food which is high in protein low in fiber has a mineral balance designed for carnivores,

should not be fed to wombats. There may be a link between feeding inappropriate diets such as dog/cat foods and systematic calcification in captive wombats (Booth 1999).

In 1995 Ridley Agriproducts produced a "wombat pellet" which offered a high fibre (15%) low crude protein (12.5%) pellet with Vitamin D reduced to 2400 IU/kg. The pellet formulation is intended as a supplement to hay and fresh grass to provide a maintenance diet for captive wombats (Booth 1999). However, due to lack of demand Ridley ceased production of this product. A feed that possessed similar nutritional qualities would by preferred. Such as Ridley's Complete–O and Town and Country Pellets.

A maintenance energy requirement for a southern hairy - nosed wombat of 23.1 kg is 140 kj/kg (Hume 1999).

Therefore the recommended captive diet for an adult southern hairy-nosed wombat is:

- 200 g of a commercially produced feed;
- meadow hay ad libitum;
  and during the breeding season;
- fresh native grass daily.

Below is a list of diets fed by a variety of institutions. Amounts given are daily rations per animal. Rations need to be measured to ensure animals are not overfed.

Currumbin Wildlife Sanctuary

- 200 g macropod pellets
- 10g lucerne hay
- clumps of fresh native grasses 1-2 times per week

*Perth Zoo

- 150 g kangaroo pellets
- 80g Silverbeet
- 150 g pumpkin
- 150 g carrot
- 150 g beetroot
- 150g corn on cob or sweet potato 3 x weekly
- Access to lucerne hay at all times
- Fresh cut grass daily - fed Pm

*Melbourne Zoo
This diet changes on a weekly basis and is offered A.M.

Week 1

- 1 cup of macropod pellets — Daily
- ½ handful of grass — Daily
- 2 chunks of vegetable — Sunday
- ¼ cup of maize — Tuesday
- browse — Monday, Wednesday and Friday
- ad lib meadow hay — Daily

Week 2

- 1 cup of pellets — Daily
- ½ handful of grass — Daily
- browse — Monday, Wednesday and Friday
- meadow hay ad lib — Daily

Weeks 3

- 1 cup of pellets — Daily
- browse — Monday, Wednesday and Friday
- meadow hay ad lib — Daily

During lactation the female wombats are given 2 cups of pellets daily until joey is fully weaned.

* Institutions which have successfully bred wombats on this diet.

5.2 Supplements

No specific supplements are required due to wombat's low metabolic rate and energy requirements.

5.3 Presentation of food

It is recommended that food be provided in strong stainless steel bowls (dog bowls) or hoppers 20cm above the ground to prevent the wombats from soiling or walking on their food. One bowl per animal is required.

6. HANDLING AND TRANSPORT

6.1 Timing of capture and restraint

Wombats are best caught during the day when they are less active. Manual handling of mature wombats can be difficult due to their size, weight and sometimes aggression.

6.2 Catching bags

Strong hessian bags or wooden boxes are generally used to transport wombats.

6.3 Capture and restraint techniques

Juvenile wombats less than approximately 18-24 months of age are generally easily picked up under the armpits placed in a hessian bag and carried away. Adult wombats can be highly aggressive. They will readily attack and can cause severe injury. Some animals will retreat into the best box, pipe or log and face their rear towards you. Care needs to be taken as the wombat will attempt to crush your arm against the side or roof.

If manual restraint is required the animal is approached from behind and held in position by placing a foot against the rump so it cannot reverse, and placing a hand on each shoulder so that it cannot turn or go forward. The hands then firmly hold the shoulders in place and move back towards the armpits, where one arm slides under the armpit and slides across the chest. The animal is then picked up one arm now under both armpits (MacCallum 2003). You can place your hand under the rump of the wombat, however, be cautious as this may reduce the affect of your grip on the wombat if they are struggling (photograph.4). Highly aggressive animals may put their head back and try to bite or head butt, so keep your head tilted back and away. Alternatively if the wombat is in a box with a hinged lid, throw a blanket over the animals head; this seems to quieten them considerably, and then proceed with restraint technique as mentioned above.

Figure 4: Manual restraint – D. Treby

Chemical restraint, such as darting or hand injection is another alternative for capturing/restraining highly aggressive wombats and will require veterinary assistance.

6.4 Weighing and examining

Wombats are generally best weighed by holding them, and then weighing yourself with the wombat and then subtracting your weight. At Currumbin Wildlife Sanctuary with a particularly aggressive male wombat, he was crate trained and the same weighing principle as above applied. Wombats can also be conditioned to walk onto a weighing platform.

6.5 Release

When releasing an aggressive wombat, ideally this should be done from over a barrier or wall, as wombats can turn quickly and attack.

6.6 Transport requirements

6.6.1 Box design

The box must be very strongly built, otherwise they are likely to chew or dig their way out of the box during transit. Further specific details of the box can be found in IATA (IATA. 2002). Photograph 5 show transport boxes used at Currumbin Wildlife Sanctuary. Dimensions for these boxes are 900mm L x 600mm H x 300mm W.

Figure 5: Transport Box – D. Treby

6.6.2 Furnishings

When transporting southern hairy-nosed wombat's Currumbin Wildlife Sanctuary packs the box with straw. The wombats burrow into the straw, which acts as support and cushioning, is absorbent and quietens the wombats. Some institutions transport wombats within hessian bags. With this method the wombats are quiet; however, death due to heat stress has been recorded.

6.6.3 Water and food

Due to the low metabolic rate and slow digestion times, wombats do not need to be fed for trips less than several hours (though they probably could manage not feeding for considerably longer than this) (Wells 1989). For longer journeys, food and water should be provided in a deep dish.

6.6.4 Animals per box

One animal per box. Females with pouch young should not be transferred unless the young is still attached to the teat.

6.6.5 Timing of transport

As wombats do not tolerate high temperatures (>35˚), transportations should be overnight or during morning in the cooler months.

6.6.6 Release from the box

Place the box in enclosure open the door and allow the wombat to exit in its own time. Remove the box when the wombat has chosen another site as its den.

7. HEALTH REQUIREMENTS

7.1 Daily health checks

Each wombat should be observed daily for any signs of injury or illness. This is generally done during cleaning of the enclosure ie in the morning or in the afternoon when food is presented. This is when wombats are most likely to be active. Each wombat should be checked for:

- Condition of coat
- Discharge from the nose, eyes or cloaca
- Changes in appetite
- Behaviour changes – depressed, aggressive
- Injuries
- Faecal quality
- Presence and development of pouch young by observation of the bulge in the pouch

7.2 Detailed physical examination

7.2.1 Sedation and anaesthesia

Pre-anaesthesia fasting is not required for adult wombats as they are not prone to regurgitation. If hand-reared they should not be fed for at least one hour before anaesthesia. Sedation can be undertaken using Diazapam, (Valium®) 0.5 – 1.0 mg/kg, by an intramuscular (IM) injection in the thigh muscle. Wombats can be anaesthetized using injectable agents such as tiletamine/zolazepam (Zoletil®) at 3 – 8 mg/kg IM, with lower doses being adequate for minor procedures (Vogelnest 1999).

Evans *et al* (1998) undertook studies on tiletamine and zolazepam on all three species of wombats and found that most animals displayed mechanical chewing and 'paddling' movement of the front limbs, particularly when recovering. Chewing and paddling seemed to be more prevalent in animals which had been stressed before anaesthesia.

Inhalation anaesthetic agents such as isoflurane or halothane in oxygen are frequently used for induction and/or maintenance of anaesthesia, however isoflurane is preferred

since there is a greater relaxation of the muscles. Intubation is difficult and not usually attempted or required (Vogelnest 1999). However, if intubation is necessary, the wombat is intubated by extending the head, retracting the tongue and placing a 7.5 gauge endotracheal tube 'blind'. Once intubated, adult wombats are maintained on 1 – 2 % isofluorane delivered by a circle anaesthetic system (MacCallum 2003).

The vital signs recorded for wombats under Zoletil and isoflurane anaesthesia have been:

o Body temperature	35.4 – 36.7˚C	
o Heart Rate	90 – 120 beats/min	
o Respiratory Rate	20 breaths/min	(Booth 1999)

7.2.2 Physical examination

A thorough physical examination should be conducted once per year with the wombat under anaesthetic. The following should be included and recorded in the health check process, as defined by Jackson (Jackson 2003).

- Body Condition – various body condition indices have been used to examine the condition of wombats. A subjective condition index provides a score of one to five (Horsup 1998):

  1. Ribs visible, backbone and pelvis
  2. Ribs covered but easily felt, backbone still visible, and the rump is sunken
  3. Pelvis, backbone and ribs covered
  4. Pelvis, backbone and ribs well covered
  5. Wombat in excellent/fat condition

- Weight – is recorded and compared to the previous weights recorded. Trends in body weight give a good general indication of the animal's state of health; provided age, sex and geographical location are taken into account. Animals in captivity should be weighed monthly to gain indication of trends in body weight.

- Temperature – Normally 32– 36.7˚C. Body temperature can be measured rectally; by placing a thermometer gently in the rectum of the wombat.

- Pulse rate – Normally 40-45 beats per minute (BPM) at rest and 55-60 when active. Taken over the femoral artery, or by auscultation of the heart.

- Respiration rate – Normally 12-16 BPM in deep sleep and 26-32 BPM whilst dozing.

- Fur – Check for alopecia, ectoparasites, fungal infections or trauma

- Eyes – Should be clear, bright and alert
  Normal bilateral papillary light response

Normal corneal reflex and no discharge should be present

- Nose & nostrils – should be clean. If discharge is present swab for pathogens
- Ears – check pinnae for signs of fighting; use otiscope to check external ear down to external acoustic meatus
- Mouth- check lips and cheek pouches, check for abnormal swellings, mucous membrane color
- Teeth – check for tooth wear and make sure that teeth are wearing properly and not over grown
- Cloaca – should be clean, check for faeces around the cloaca
- Also check for the presence of lumps over body and auscultation of lungs
- Females – condition of the pouch
  Check whether lactating
  If pouch young is present; record sex, stage of development, weight if detached from the teat and measure to determine age from growth curves if necessary
- Males – Check testes – size (length, width, depth) and consistency (firm, not squishy). Extrude penis and assess. Measure accessory gland bulge (length and width) which is an indicator of reproductive status
- Faecal sample – perform a qualitative faecal float to test for parasites
- Urine sample - test using multi sticks and a refractometer for specific gravity
- Blood sampling – Blood can be collected from the cephalic, radial, caudal tibial femoral or jugular veins. As the skin if thick, a tourniquet helps to visualize the peripheral veins on the shaved limb (Booth 1999). See Appendix 1 for Haematology and serum biochemistry.

7.3 Routine treatments/ vaccinations

None required.

7.4 Known health problems

Wombats suffer few problems in captivity, apart from superficial bite wounds to rump and ears from other wombats. However, parasites and diseases that are found to occur in wombats are described below; the following information is taken from Jackson (2003) unless otherwise indicated.

7.4.1 Ectoparasites

7.4.1.1 Mange, ticks & fleas

Cause – The mite *Sarcoptes scabei*, burrows into the deeper parts of the stratum corneum resulting in infestations on the skin. More commonly known as 'mange' it is often seen in wild populations of Common wombats and kills many individuals. Sarcoptic mange was once an uncommon parasite in southern hairy - nosed wombats. In early 2004 a sever outbreak of sarcoptic mange occurred in the drought stricken area of the Murraylands region of South Australia and has the capacity to cause a catastrophic decline in the wombat population of this region. Reports of 80% mortality rates are being recorded.

Most wild wombats will have infestations of ticks and several genera of fleas are known to occur as well.

Signs - Fur loss, the presence of thick scaly crusts on the body, and in severe cases, large open sores with secondary bacterial infection and the presence of maggots. Movement, visions and mastication may be impaired by the severity of the skin changes and death through starvation or misadventure is likely to occur in wild animals.

Ticks occur more commonly on the ventral areas and on the ears. Severe infestation can cause anemia.

Diagnosis – Visual observations or a skin scraping and microscope examination to identify the parasites. Identification of sarcoptic mange is made by taking skin scrapings and confirming the presence of mites or their ova.

Treatment – In mild cases a topical acaricide may be effective such as 3-4 treatments of 1.25% solution of Amitraz at weekly intervals. Other treatments such as Ivermectin pour-on, can be applied to the body or given subcutaneously at a dose of 200-300mg/kg. Treatment should be repeated after 10 days; a total of four treatments are required. Soaking in keratolytic solutions first to remove crusts may be necessary. In advanced cases euthanasia is the most humane approach. Care should also be taken that re-infestation does not occur from infected bedding or boxes.

Ticks and fleas can be treated with an insecticidal was such as Malawash for dogs and given 14 days apart, or treatments such as 'Frontline' (Fiprenil) spray or 'Spot On' as recommended for dogs.

Prevention – Maintaining food hygiene and addressing the first signs of an infestation.

7.4.2 Endoparasitic worms

7.4.2.1 Cestodes

Cause – *Progamotaenia diaphana, Paramoniezia johnstoni* have been recorded in southern hairy - nosed wombats (Smales 1998).

Signs – Signs of cestode infections are not obvious unless metacestodes cause severe damage to internal organs such as the liver.

Diagnosis – Faecal flotation and presence of eggs or segments. Only infection with adult Cestodes can be diagnosed in this way since the metacestode stage of the cestode life cycle occurs within internal organs and does not produce eggs or shed segments.

Treatment – Treatment with anthelmintics such as Droncit (praziquantel) 1 tablet per 10 kg retreat within 14 days is necessary.

Prevention – Generally not required but could be with routine treatment with anthelmintics. It is also important to remove faeces from the enclosure.

7.4.2.2 Nematodes

Cause – *Macropstrongyloides lasiorhini* and *Oesophagostomoides stirtoni* in the southern hairy - nosed wombat (Smales 1998).

Signs – Infection with *Strongyloides* and roundworm spp. Results in a mild enteritis while others appear to show no or few problems.

Diagnosis – Faecal float.

Treatment – Where thought to be a concern, nematodes are treated with an appropriate anthelmintic such as benzimadozole or ivermectin 0.2 mg/kg sub- cutaneous (S/C) twice at 10 day intervals.

Prevention – Good hygiene and surveillance by faecal float.

7.4.3 Protozoans

7.4.3.1 Coccidia

Cause – Due to the parasites *Eimeria spp.* and is often associated with enteritis in sub-adult and hand-reared wombats.

Signs – Often associated with the onset of grazing in juvenile wombats. It occurs at approximately 10 months of age or sometimes earlier in hand-raided animals. In sever cases the wombat may develop mucoid to liquid green diarrhoea, progressively loose

weight and become bloated. Although generally not considered to be pathogenic, deaths are known to occur.

Diagnosis – Standard faecal float.

Treatment – Once clinical signs of enteritis have developed, treatment becomes very difficult, as fluid therapy is hard to deliver and anti-coccidial therapies that are used in other species are often ineffective.

Prevention - Frequent feacal examination for the presence of coccidial oocytes.

7.4.3.2 Toxoplasmosis

Cause – It is often associated with hand reared animals, and occurs when wombats have access to cat's faeces, with the protozoan *Toxoplasmo gondii*, in the house or yard.

Signs – Neurological signs including ataxia, circling and blindness, respiratory symptoms or poor growth and death often associated with interstitial pneumonia and or focal encephalitis.

Diagnosis – Visual signs and serological tests.

Treatment – If treatment begins as soon as clinical signs are apparent, it is possible to successfully treat, so do not wait until diagnosis is confirmed as this may take several days. Nonetheless this disease is usually fatal in wombats.

Prevention - Avoiding all access to cats and cat faeces and hay that may have been contaminated with cat faeces should be avoided.

7.4.4 Fungus

Cause – Fungal lesions of *Chrysosporium* sp. are common in wild southern hairy - nosed wombats and have been found in captive animals.

Signs – Appears to be subclinical.

Diagnosis – As incidental findings on autopsy.

Treatment – Not required.

Prevention – Not required.

7.5 Quarantine requirements

As part of a preventative health program all new arrivals must be quarantined, despite being considered free of transmissible diseases by the previous holding facility, the

wombat could have been exposed to disease during transport. Wombats should be housed in a separate facility for 30 days and cared for by keepers who are ideally not in contact with other animals outside of the quarantine facility, or at least the resident wombats.

On arrival new wombats must undergo;

- Physical examination
- Dental examination
- Record body weight
- Record or apply ID
- Collection of blood sample
- Faecal float – to check for parasites.

Three consecutive negative faecal and blood tests are required before wombats are released from quarantine.

8. BEHAVIOUR

8.1 Activity

Wombats are generally nocturnal and display little activity during daylight hours. They may spend up to 16 hours each day asleep in their burrows in order to conserve energy; this is a behaviour adapted to their low energy diet. Southern hairy-nosed wombats are known to bask and feed during the day in autumn, winter and spring (Jackson 2003).

Wombats have adapted their behaviour to their semi fossorial lifestyles due to their inability to regulate their body temperature when temperatures rise above 25˚C, whereas they can easily withstand long exposures to air temperatures approaching 5˚C. Burrows also enable wombats to conserve water by avoiding high and low ambient temperatures (which may vary from -5˚C to 50˚C) and low humidities (typically 2-5%) outside the burrows, compared with lower temperatures (10-27˚C all year) and higher humidities (60-70%) in the tunnels (Shimmin 2001).

In summer wombats are more active from, midnight to early morning before the temperature gets too hot, while in winter they are more active in late afternoon to early evening before temperatures have dropped. The only time in which wombats appear to be diurnal is when they sometimes bask in the sun during the cooler months especially after cold nights.

Wombats spend time digging new or extending existing burrows which have tunnel lengths that range from 1.5 m to more than 60m. Southern hairy - nosed wombats are known to occasionally construct earth plugs to block the tunnel they occupy which may be a defensive behaviour. At Currumbin Wildlife Sanctuary this behaviour was noted with a wild caught female when she first arrived, and was seen as a stress mechanism.

8.2 Social behaviour

Wombats are territorial with respect to feeding areas and may have disputes over the use of a burrow, which is focus of wombat activity.

As social and reproductive strategies are not well understood in the southern hairy - nosed wombat in the field, there is little information upon which to base husbandry techniques and group sex ratios in captivity (Finlayson 2004). However, the focus of social organization of the southern hairy - nosed wombat is the warren, which can have from one to thirty burrows. There can be ten or more wombats using them though not necessarily at the same time. Typically a wombat colony uses 10-20 warrens in a cluster, which can be spread over an area up to 1 km^2. Females show greater preference for burrows than males, but there appears to be no evidence of burrow ownership among warren occupants (Wells 1989). Although in the wild adult male southern hairy - nosed wombats are dominant to adult females, there appears to be no set rule to dominance in captivity as in some cases the female as alpha (Gaughwin 1982).

Fighting in wombats consists of bites to the face, ears, rump and flanks. Fights that do occur can result in head to head attacks or with one defending itself by pushing its rump toward the attacker.

8.3 Reproductive behaviour

In many mammals the function of the selected pheromones that pass with the urine is to signal the reproductive status of the females. Flehman has been observed in southern hairy-nosed wombats, it is typically made by the wombat standing with its head stretching up and its mouth open while it retracts the lip, thus baring the gum and wrinkling the nose. Sometimes the wombats make rapid licking and mouthing movements during or after showing flehman (Gaughwin 1979).

Activity levels are noticed to increase during the breeding season. The male's aggression levels increase towards the females by chasing and exhibiting dominance over them. Both males and females display an increase in vocalization during this time.

8.4 Bathing

Although wombats can swim, they usually do not bathe in water. However, wombats will dust bath in sand or dusty soil.

8.5 Behavioural problems

Individual adult wombats in captivity can show a high degree of aggression towards keepers, husbandry practices need to be adjusted to deal with these animals.

8.6 Signs of stress

Stress in wombats can be associated with very loud vocalizations and teeth gnashing. When being caught they may show very aggressive defense, biting scratching or attacking. Chronic stress may result in alopecia that is usually symmetrical and immunosuppressed, excessive drinking and eating or anorexia.

8.7 Behavioural enrichment

Although wombats may not require an intensive behavioural enrichment program, several activities can be provided for them as wombats tend to display quite inquisitive personalities when presented with unusual items (photograph 6 and 7). Even though wombats sleep for most of the day, in captivity they can be active in the morning and evening due to husbandry requirements, with most activity occurring at night. It is at these times that enrichment can be offered.

Table 2 below is a list of behavioural enrichment devices utilized at Currumbin Wildlife Sanctuary. Interest is scaled 1 – 5.

1. ignored item
2. approached item and interest lasted less than10 seconds.
3. interacted with item for greater than 60 seconds
4. interacted with item for up to 5 minutes
5. interacted with item for over 5 minutes

Enrichment device	Scale 1-5
Cardboard box food dispenser	5
Grass tussocks	5
Soil substrate that allows for digging	5
Wheel barrow	5
Scatter feed	5
Scatter seed and leave to sprout in enclosure after rain=green pick	5
Scratching brush on tree	4
Garbage bin to climb in and on	4
Placing logs or large rocks in the path or entrance to sleeping dens	3
Tractor tire; wombats like to hide in the tire rim.	3
Mulch piles	2
Large logs to climb in or on	2
Browse	1

Table 2: Environmental Enrichment Devices at Currumbin Wildlife Sanctuary

Photograph 6: Scratching brush on tree

Photograph 7: Cardboard box food dispenser

Staff at Taronga Zoo have designed a maze for the wombats which can be used for either enrichment or breeding. The box is made from ply, has a hinged roof for each section and is placed directly on the ground to encourage digging (figure 1 & photograph 8). Dimensions are 2.4m x 1.2m.

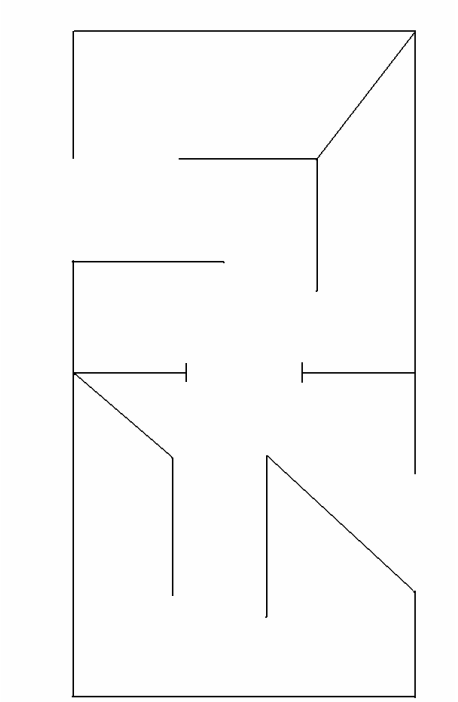


Figure 1 & Photograph 8: Wombat Enrichment/Breeding Maze: V. Hudnall

8.8 Introductions and removals

Generally if introducing animals as a pair, the male should be released first to the enclosure so that he can establish territory before the female is introduced. If the male is introduced into an enclosure with an established female, the female may be dominant

over the male and they may not breed. Animals are usually removed from each other with few social problems when they return (Jackson 2003).

8.9 Intraspecific compatibility

Southern hairy-nosed wombat's can be held as solitary animals but preferably should be held as pairs or in small groups as long as each wombat is supplied with it's own burrow within the exhibit aggression levels should be low. Wombats tend to bite each other and patches of hair loss are common. Daily observations will establish is aggression levels have become to severe and if separation of animals is required.

8.10 Interspecific compatibility

Because of their aggressive nature, wombats are not recommended to be housed with other species.

8.11 Suitability to captivity

Most wombats are brought into captivity as hand reared orphans and readily settle into captivity. However, the southern hairy - nosed wombat, when wild caught as adults, have been known not eat for up to 4 weeks when brought into captivity. They can however, generally be encouraged to eat after 2 -3 weeks if initially provided with fresh grass and left undisturbed (Gaughwin 1982). See Appendix 2

9. BREEDING

With the growing body of knowledge on marsupial reproduction it is clear that marsupials have physiological complexities that control reproduction. Seasonal factors, such as photoperiod, weather patterns that, in turn, affect pasture growth influence the annual cycle of reproduction (Renfree 1988; Taggart *et al.* 2004).

Therefore in a species such as the southern hairy - nosed wombat where females breed seasonally but in response to variable environmental conditions, such as rainfall, the exact timing of reproduction may vary from year to year (Taggart *et al.* 2004)

9.1 Mating system

It has been proposed that in the three species of wombat, the males are polygnous, whereas the females may be monogamous (Taggart *et al.* 1998). It has also been suggested that inter oestrous separation of animals may be necessary for the normal enactment of reproductive behavioural cues (Bryant 2000).

The present data indicates that reproduction season for the southern hairy - nosed wombat is restricted to winter and spring. Furthermore, it appears that breeding only occurs in years in which rainfall is plentiful and, by implication pasture growth is abundant. Reproduction of the southern hairy - nosed wombat seems to be both seasonal and

opportunistic (Gaughwin *et al.* 1998). Captivity does not appear to suppress progesterone secretion and excretion during the oestrus cycle whether the animal is held by itself or with another animal. It is suggested that failure to mate might instead be due to a lack of behavioural stimulation (MacCallum 2003).

9.2 Ease of breeding

Wombats have not bred routinely in captivity. One reason for this may be to the ease of acquiring young from the wild. Orphans are routinely brought into captivity for handraising which may have lead to complacency in the past for the establishment of a captive breeding program. Zoos in Australia and overseas have bred wombats with some success. With Perth and Melbourne Zoo, recording the most births of southern hairy-nosed wombats (Treby 2003).

Southern hairy-nosed wombats do not show mating behaviour within the first three years or until they reach sexual maturity (Gaughwin 1982) and even after a successful mating the female may not produce young (Crowcroft & Soderlund 1977; Gaughwin 1982). This event has been witnessed many times at Currumbin Wildlife Sanctuary.

9.3 Fertility assessment

9.3.1 Females

To determine the reproductive status of the common wombat Western Plains Zoo the oestrous cycle was monitored by changes in urogenital cytology, plasma (blood) progesterone concentrations, and faecal progesterone metabolic measurements. Wombats were manually caught three times per week, weighed and placed under gaseous sevoflurane anaesthesia via a modified mask ('witches hat') and maintained by mask on sevoflurane, in oxygen. After the completion of the health check, blood was taken for FBC/Biochemistry, serum and plasma; animals were weighed, pouch checked, a urogenital swab taken for cytology, and faecal samples collected (MacCallum 2003).

Faecal steroid analysis has also proven to be a valuable tool in assessing the reproductive status of southern hairy-nosed wombats (Hamilton *et al.* 2000; Paris *et al.* 2002)

9.3.2 Males

Eelectroejaculations (EJ) carried out on male southern hairy-nosed wombats showed that collection carried out from September to March, encompassing the breeding season 94% contained sperm. During March and May the penis was very difficult to evert from its pre-pubertal sac in almost every male examined and 92% of ejaculate did not contain sperm (Taggart *et al.* 1998). Recent research has found that males with a peri-cloacal measure (accessory gland measurement) $\geq$ 5.2 cm were generally considered reproductively active and those with a measure of $\leq$ 4.0 cm were considered to be inactive. Semen analysis data support this conclusion with ejaculated of small volume (<1ml) collected from males with small peri-cloacal gland widths. Therefore accessory

gland size can be used as an indicator of hormone levels may be high enough for successful breeding to occur (Taggart *et al.* 2004).

9.4 Breeding management

Wombats do not breed well in captivity; this does not appear to be a problem associated with sperm production in captive males as captive male wombats produced spermatozoa during the breeding season. This suggests that the problem is either one of a behavioural nature, associated with the manner in which the animals are housed in captivity, or else, that captivity is affecting reproduction through some other mechanism in the females. If the problem is one of a behavioural nature this may be overcome using semen collection, cryopreservation and AI techniques. If it involves the female reproductive cycle then methods will need to be developed to artificially induce oestrous and ovulation (Taggart *et al.* 1998).

Staff at Perth, Melbourne and Taronga zoos are using nest boxes with small entrances as an aide for reproductive behaviour. The female can retreat into the box and block the opening to inhibit entrance by the male. When she is receptive she can then allow him in the nest box (figure 2 & photograph 9).

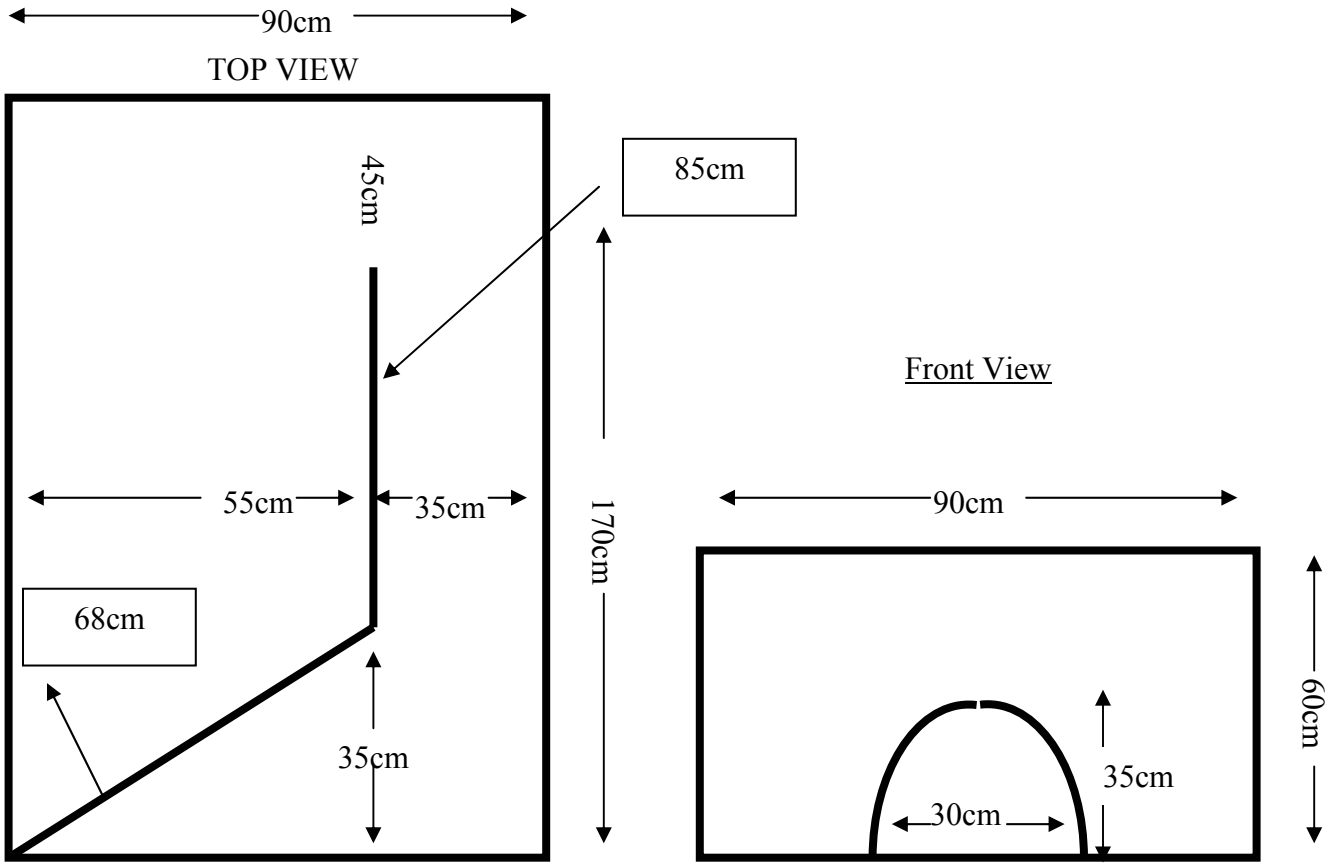


Figure 2: Southern Hairy-Nosed Wombat Breeding Box (Perth Zoo)

Photograph 9: Perth zoo wombat breeding box

There is no established or tested optimal ratio for the housing of wombats for reproduction. The housing ratios employed by different institutions outside of breeding season is given below in Table 3.

Table 3: Housing sex ratios of wombats outside of breeding season.

INSTITUTION	**Exhibit #1**	**Exhibit #2**	**Exhibit #3**	Exhibit #4
PERTH	1:0	0:1		
TARONGA	1:0	0:4	0:1	
CURRUMBIN	1:3	1:0		
MELBOURNE	1:0	2:1	2:0	**1:2**
ROCKHAMPTON	2:5	0:3	1:2	**1:2**
ADELAIDE	1:1			

At Melbourne Zoo prior to the breeding season, (approximately in March), all wombats are separated so that bonds were broken and new territories established, with the females occupying 2 enclosures and the males housed separately with no visual contact. Males were then re-introduced to the females one–two months later for breeding, with the ideal

time for introductions in late July/August. If no mating behaviours were noted in this time, the males would then be rotated.
Once the animals have been introduced there should be minimal disturbance to the wombats, therefore all conditioning ceases and cleaning is kept to a minimum.

Melbourne Zoos recent success with breeding occurred in an on display enclosure with off limits area attached. The female with pouch young was separated from the group due to aggression from other wombats.

Perth Zoo's wombats are housed separately and are only introduced prior to the breeding season.

Perth and Melbourne Zoo are also the only ARAZPA institutions to have second generation captive bred stock.

A problem observed with the captive breeding of southern hairy - nosed wombats is the failure of the male to copulate with the female. Gaughwin et al. (1998) found that the concentrations of androgens in the plasma of breeding wild southern hairy - nosed wombats (3-15 ng/mL) were higher than those of some captive animals (0.5-4.0 ng/mL). Androgen or gonadtrophin therapy may possibly stimulate sexual behaviour in apparently inhibited male southern hairy - nosed wombats (Gaughwin *et al.* 1998).

Below is a check list of recommendations for the successful captive breeding of southern hairy-nosed wombats. Not all of the steps in the list are being used by all institutions. However, each institution that has been successful has included most of these recommendations into their captive breeding management.

- House males and females separately, but allow visual contact.
- Rotate wombats in July to break old territories and to stimulate breeding activity.
- Introduce fresh green grass daily at this time.
- Pair animals from August. Male is introduced into female's enclosure.
- Provide tunnels and access to digging. Each wombat should have a separate box/burrow.
- Have more than one male in the collection so they can stimulate each other to a state of reproductive readiness via competition.
- Female is checked for seminal plug if mating is suspected.
- Remove male from females exhibit no later than 20 days after first seminal plug is observed

9.5 Courtship/mating behaviour

Below (figure 3) is a diagram taken from Marks (1998) displaying the courtship and mating behaviour of common wombats. However, the behaviours exhibited by the southern hairy - nosed wombat are the same.

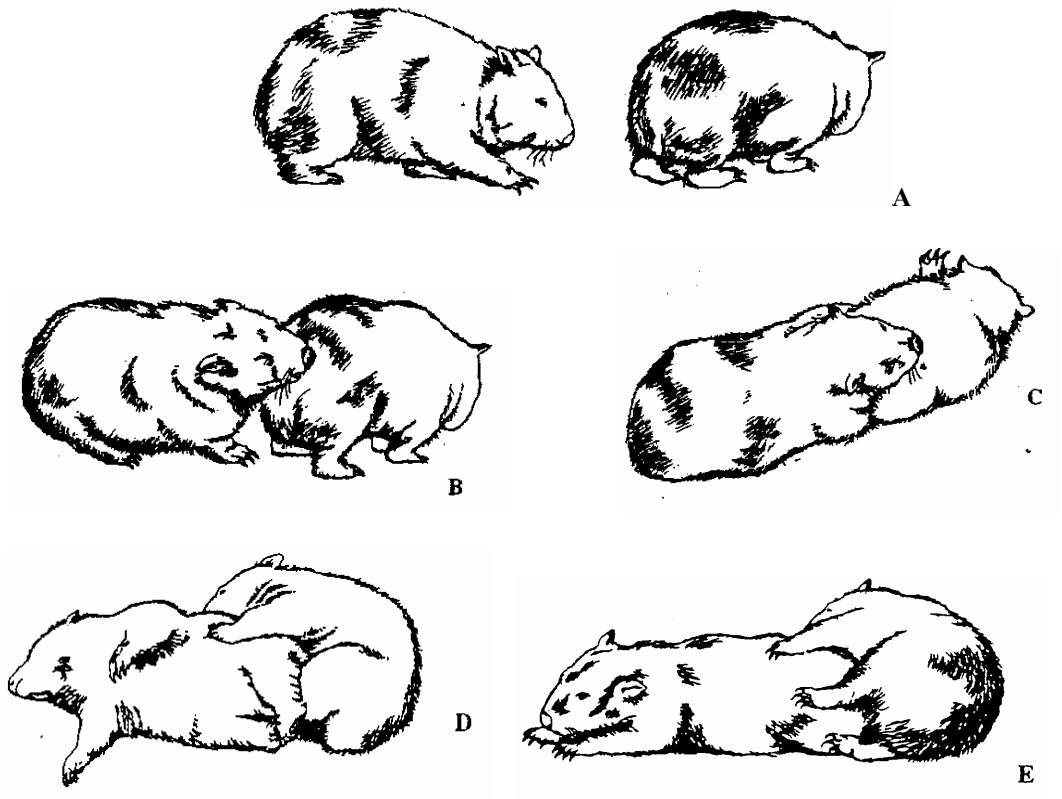
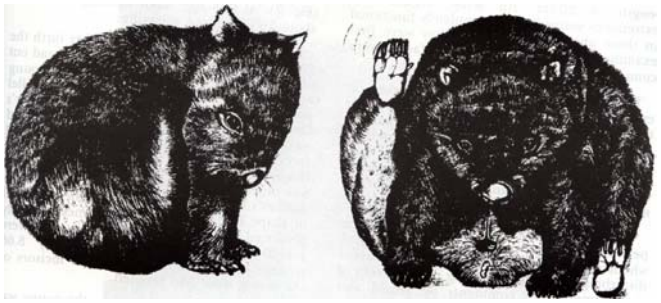


Figure 3: Courtship and Mating behaviour in Common Wombats (Marks 1998)

The position assumed by the female wombat during birth greatly resembles that used by the female Koala. Böer (1998), describes an account given by a keeper at Hanover Zoo. "A female wombat was observed squatting on her hindquarters with her body partly borne by her forelimbs (figure 4). During periods of tremor of her entire body, lasting between 5 and 10 seconds, the female extend and flexed hindlimbs. In between these phases the female once rolled on to her side and grasped with one forelimb the area between her urogenital and pouch openings. The female wombat was positioned with her body bent in such a way that the neonate had to ascend an inclination of 45%." Böer (1998) concluded that the method of progression used by neonate common wombats in moving from urogenital opening to the pouch was similar to that of other species of marsupial.

Historically captive reproduction of the southern hairy - nosed wombat has been poor. Many of the successful copulations occurred in enclosure simulating the natural burrow environment. In the wild copulation probably occurs in the burrow. Consequently, to copulate effectively the male may have to prevent the female escaping by forcing her to the blind end of a tunnel or burrow. The implications of this observation for the design of enclosures for the southern hairy - nosed wombat are obvious (Gaughwin 1982).



A B

Figure 4: A: Lateral View B: Antero-ventral view (Boer 1998)

9.6 Reproductive condition

Wombats are generally placed in several categories depending on their reproductive status. For females these include:

1. Juvenile non-breeding (non-parous) – pouch clean and dry teats very small.
2. Adult non-breeding (parous) – pouch dry and dirty (photograph 10)
3. Pregnant – pouch pink in colour and glandular in appearance.
4. Pouch young present- pouch deep, very moist and young attached to teat. (photograph 11)
5. Lactating (young absent from pouch but still suckling) – pouch area large, teats enlarged.
6. Post lactations – teats are still enlarged, expressing only clear liquid and regressing in size.

Photograph 10: Adult non breeding pouch (DTreby)

Photograph 11: Reproductive pouch with young (K.Payne)

9.7 Pouch checks and birth of pouch young

After mating is observed on several occasions, pouches of the females should be checked for the presence of a joey, a month or two after the last mating. On confirmation of

pouch young males should be separated immediately from females so as not impose any extra stress on the female's (Jackson 2003).

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Developmental stages of the pouch young that need to be recorded:

- Sex distinguishable
- Tips of ears free
- Papillae of facial vibrissae evident
- Eyelashes visible
- Eyes open
- Fur visible
- Eyes open
- Fur visible – slight tinge, medium or well developed
- Tips of first incisors through the gums
- At foot
- Eating solids
- Self feeding
- Independent

Measurements of the pouch young that need to be recorded (Jackson 2003).

- Crown rump length (mm) – primarily for very small neonates where measurements are difficult
- Weight (g) – if detached from the teat
- Head length (mm) from the occiput to snout tip
- Head width (mm) maximum width across the zygomatic arches
- Snout next to length (mm)
- Tail length (mm) – from the cloaca to the end of the last vertebrate of the tail tip
- Length of right tibia (mm) – from the stifle to the heel
- Pes length (mm) – from the heel to the base of the longest toe, not including the claw

9.8 Techniques to control breeding

The potential of breeding in excess to requirements has not yet become an issue. Separation of the animals would be all that is required if breeding was not desired.

9.9 Occurrence of hybrids

None are known to occur.

9.10 Timing of breeding

Wild southern hairy - nosed wombats has a defined breeding season, with most births from late July to September and some in October and November, which correlates with the growth and germination of native pastures. Weaning occurs in spring or early summer, as these growth periods are associated with the winter rainfall patterns of the

arid and semi-arid zones of South Australia. When there is little rain, body weight and reproduction activity are decreased in both males and females (Gaughwin *et al.* 1998). In captivity births have been recorded in all months of the year with 18% of births occurring in July and April followed by 14% in February and 11% in June (Treby 2003).

9.11 Age at first and last breeding

Data recorded in the southern hairy-nosed wombat stud book show that the youngest female to have produced pouch young was 3.5 years and the oldest female to have bred was almost 18 years of age. The average age of females at first reproduction was 7.5 years, with the average age of females to reproduce being 10 years. The youngest male recorded to have successfully inseminated a female that subsequently produced pouch young was 4 years, with the oldest being 18 years of age. The average age of males at first reproduction was 6.11 years, with the average age of males to successfully inseminate females was 9.9 years (Treby 2003).

9.12 Ability to breed every year

The shortest interbirth interval recorded for the southern hairy-nosed wombat in captivity was 36 days, which shows that once a female looses her pouch young she can return to oestrous and breed again. However, the shortest interval between births of young which gained independence was 219 days (Treby 2003).

9.13 Ability to breed more than once per year

Wombats can breed more than once per year. However, this is unlikely to occur in the wild due to the length of time required to raise their young.

9.14 Nesting requirements

A burrow or nest box should be supplied for each animal. Female wombats should be provided with a well built nest box, a large hollow log, an artificial burrow or ideally an area of earth in which they can dig their own burrow. Nesting material such as straw or hay should be provided.

9.15 Breeding diet

Births in hairy-nosed wombats appear to be correlated with rains and associated grass growth after rain when forage is maximal, so the provision of large amounts of fresh grass at the beginning of the breeding season is recommended for these species.

Staff at Perth, Melbourne and Taronga Zoo change the wombats to a "dry diet" of pellets and hay, then prior to introductions other food types are offered ie. grass, browse and root vegetables.

The Western Plains Zoos diet for female common wombats carrying pouch young was modified to provide them with as much nutrition to assist them while feeding pouch young. They are fed twice a day morning and afternoon, grasses, kangaroo pellets, corn and sweet potato (MacCallum 2003). Melbourne Zoo also increased the amount of pellets and root vegetables fed to their lactating female.

9.16 Oestrous cycle and gestation period

The southern hairy - nosed wombat is also monovular and polyoestrous and has an oestrous cycle of approximately 35 days and a gestation period of 20-22 days (Moritz *et al.* 1998).

9.17 Artificial breeding techniques

Assisted reproductive technology is well established in wildlife conservation programs in eutherian mammals. The development and application of this technology in marsupials, however, is a relatively new field and until recently had not been applied in a direct effort to help conserve any threatened marsupial species (Taggart 2002).

- **Artificial Insemination (AI) –** can increase the breeding potential of genetically superior animals, expand gene pools without risk and expense of maintaining/transporting sires, is more efficient, disease free, allows movement/distribution of genetic material, and the utilization of males unable to breed naturally due to physical or behavioural problems.

- **Embryo Transfer** – is an efficient method of introducing superior genetics into population.

- **Embryo splitting** – is the ability to predict the embryo's sex which is an important demographic management tool. For example, reduction in the number of males allows more space for a breeding program.

- **IVF –** this approach has many advantages including; making use of animals with certain types of infertility, reduction in the numbers of viable sperm needed as compared with AI or natural breeding. Has the potential for salvaging genetic material from animals after death for oocytes maturation and IVF. Increases the use of potential males being crossed to one female.

- **Semen collection, cryopreservation & storage**

- **Hormone analysis**

Genome Resource Banks – Allow interactive movement of biological material between living animal populations, thereby maximizing genetic vigor/heterozygosity. Genome Resource Banks offer opportunities for improving the efficiency of captive breeding programs, especially when linked to techniques such as AI, IVF and ET. Genetic

resource banks provide a high level of insurance against the loss of diversity of an entire species (Johnston 1997).

9.18 Litter size

Usually only one young is produced for the three species, however Western Plains Zoo recently produced twin common wombats. It is unlikely that twins born in the wild would survive due to the nutritional demands placed on the mother.

9.19 Weaning

The young begin leaving the pouch and eating solid foods at about nine months of age and more than double their weight in the next three to eight months. They reach adult body weight at two years of age at which time they generally disperse. The time in the pouch is 9-10 months in the southern hairy - nosed wombat with weaning occurring at approximately 12-16 months MacCallum (2003).

9.20 Age at removal from parents

Removal of the young is very much dependant on when the female comes into her next oestrous. Generally young should be removed several months before, when approximately 20-28 months old as females can become increasingly aggressive towards their young. Chasing by the mother and severe biting of the young are often observed at this stage resulting in the young hiding and cowering in the corner of the enclosure (Boer 1998).

10. ARTIFICIAL REARING

10.1 Housing

As with all native animals that are taken into care, minimizing stress is a major consideration. Choosing suitable housing can help create a stress-free environment. To achieve this, several factors should be considered including:

- Securing the area from children and animals
- Maintaining the area in a hygienic manner
- Escape-proofing the area
- Clearing the area of obstacles and hazards
- Ensuring the area offers shelter from the weather and noise

The southern hairy-nosed wombat is frequently hand-reared. Unfurred or finely furred young that weigh less than two kilograms should be placed in a soft cotton pouch. Place pouche, plus joey, inside a bag made from sheep skin with the fleece attached, or some other thick woolen surround. A locked cat carry cage or laundry basket lined with clothing, blankets and an inner cotton-lined bag can be used (figure 5). Do not use synthetic fiber as these are either too hot or too cold and rub on the joey's ski2n, producing pressure areas. Never house young wombats so that they have direct contact

with fur or fleece or artificial fibers , as the joeys suck these fibers and they form large balls (like fur balls) which may block the gut (George *et al.* 1995). Joeys should never share a pouch with others. Enforced sharing may cause significant stress (McCracken 1990).

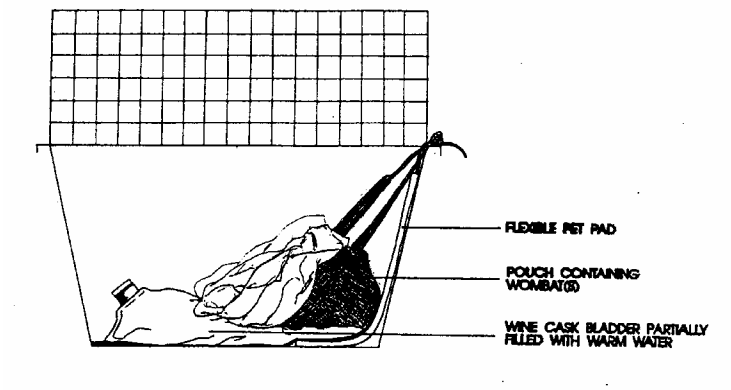

Figure 5: housing for orphaned joeys (George *et al.* 1995)

10.2 Temperature requirements

Unfurred wombats will require extra warmth. A constant pouch temperature is important and should be monitored carefully. Digital thermometer (figure 6) with a probe is recommended for monitoring pouch temperatures. The temperature should be taken inside the pouch and it is the temperature of the air surrounding the joey, not the joey's temperature that is required (George *et al.* 1995).

- **Unfurred** <600gms 28-30˚C no higher. If the wombat's feet are bright pink it is probably too hot.
- **Furred** >600gms 28˚C no higher

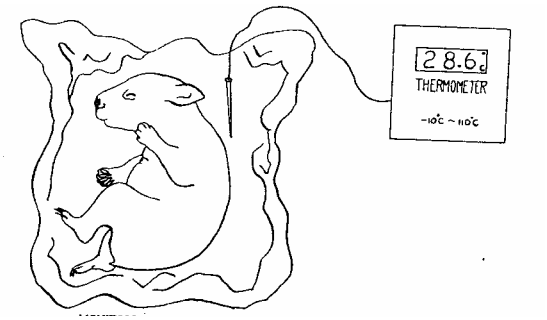

Figure 6: Temperature probe (George *et al.* 1995)

An electric blanket, hot water bed, wheat bag or hot water bottle (that is reheated every four hours) can be used for heating. Hot water bottles should be well wrapped up inside towels or other fabric and not be placed too close to the wombat so that over heating or dehydration occurs (MacCallum 2003).

10.3 Diet and feeding routine

10.3.1 Natural Milk

Common wombat milk increases in total solids during lactation from 22% in early lactation to 55% in late lactation, while lipids increase from 6% to 28% and proteins from 4% to 9%. In contrast, the concentration of carbohydrates decreases from 12% in early lactation to only 4% in late lactation (Jackson 2003).

10.3.2 Milk Formulas

The three main low-lactose formulas used for hand-rearing wombats are:

1. Wombaroo Wombat Milk Replacer (see Appendix 3). The three formulas range from <4 for joeys with less than 40% of their pouch life completer; a 0.4 formula for joeys with 40% of their pouch life completed that have fine fur, eyes open and erect ears; and a>0.6 formula for joeys with greater than 60% of their pouch life completed, that have short dense fur and spend a lot of time out of the pouch. Evidence suggests that Wombaroo wombat formula gives the best growth rate and hair quality than other milk formulas (Booth 1999).

2. Di-Vetalact: Is a widely used, low lactose milk formula. Due to its low energy concentration when prepared as directed, some groups advise the addition of mono and polyunsaturated fats such as canola oil with Wombaroo diets. Adding saturated fats in the form of cream has been suggested but it is too highly saturated and can lead to the malabsorption of calcium. Di-Vetalact should be fed at approximately 20% body weight, except in the case of very small joeys (less than 100g) (Jackson 2003).

3. Biolac: has three formulations – M100 with 2-5ml of canola oil per 100ml for furless joeys; M150, a transitional milk to use when dense fur has developed; and M200, which is used when the animal produces solid dark pellet droppings, as it contains elevated lipid in the form of canola oil. When the joey is nearing weaning, 2-5 ml of canola oil is added per 100ml of formula. Mixing the formulas is the way to make the transition from one formula to another. The young animal should be fed 10-15% of its body weight per day.

Wombats need to establish normal gut flora to break down the vegetable matter in the diet. This can be achieved by several methods including offering dry dirt (pica), which they may eat. It can also be assisted by adding half a teaspoon of natural yoghurt to the formula daily. An alternative method to inoculate with bacteria is by choosing several fresh droppings from a healthy adult wombat, preferably of the same species, grinding them up, adding warm water, straining and adding 5ml or one teaspoon to the joeys bottle containing milk and mixing it up or giving it directly into the mouth by squirting it in (Austin 1979).

When six months of age, Farex or Heinz Rice Cereal can be added to the Di-Vetalact formula by adding half to one teaspoon to every 200 ml and letting is stand for a few minutes before feeding (Austin 1979).

10.3.3 Feeding apparatus

Very small joeys can be fed using a syringe fitted with a bicycle tyre valve rubber or short length (1cm) of infant gastric feeding tube as a teat or plastic intravenous catheter. Most wombat joeys will, however, be large enough to be fed with a plastic feeder bottle (50 or 100 ml) and a special wombat type teat (figure 7) the teat can be punctured with a hot needle (Jackson 2003).

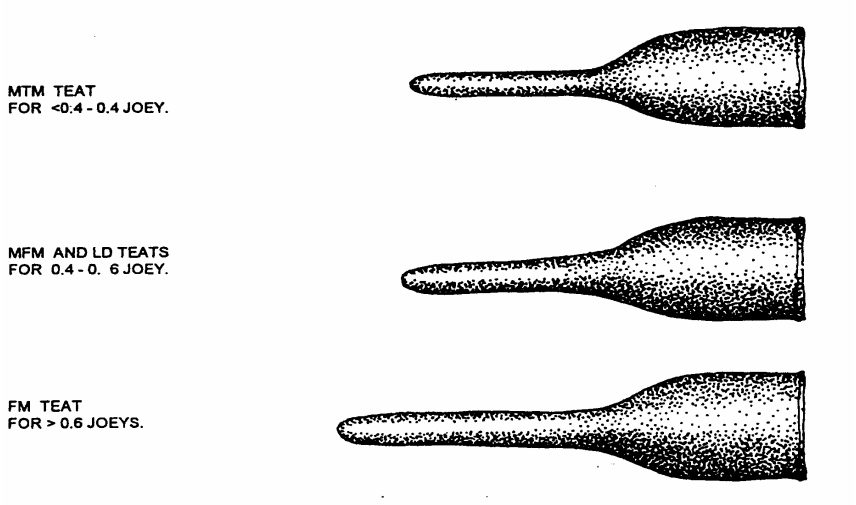

Figure 7: Wombat teats (George *et al.* 1995)

10.3.4 Feeding routine

When first brought in for hand rearing, the joey may be dehydrated, if so it can be given 100 ml of plain boiled water, with 5g (1 teaspoon) of glucose or 1g of electrolyte replacer such as Vytrate. (McCracken 1990; George *et al.* 1995; MacCallum 2003). Some formulas require the joey to be weaned onto them over a few days. The joey should be wrapped up in a towel and a hand placed over its eyes for at least the first few feeds (figure 8) to prevent the joey from being distracted and reduce stress (Austin 1979).

The temperature of the milk should be fed at approximately 36˚C. Young wombats should be fed approximately 15% to 20% of their body weight daily, depending on the formula given. The demand will decrease with the introduction of solid food (Booth 1999). When feeding it is important not to feed the milk formula too quickly, as it can accumulate in the pharynx and be passed into the lungs where it can result in pneumonia and death (Presidente 1982).

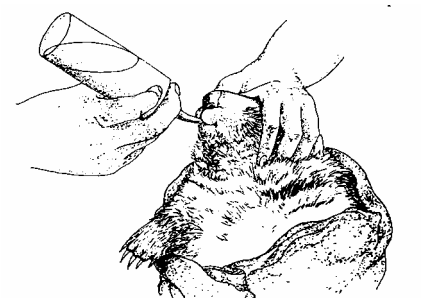

Figure 8: Feeding position (George *et al.* 1995)

It is also important to feed a joey in an upright position or lying on its side. Never feed a young wombat lying on its back as milk may be inhaled. Joeys tend to lie on their sides to feed from 600 grams onwards (George *et al.* 1995). It should be noted that in beginning it may be particularly hard to get some wombat joeys to accept the artificial teat. It may be a month before an individual will accept it without a struggle. Most wombats like to push with their front paws against the abdominal wall (like a kitten), so if they push at your hands while feeding them, they are not attempting to push the teat away (George *et al.* 1995).

The number of daily feeds decreases as the joey develops. Very young, unfurred joeys should be fed every 2 -3 hours night and day. When furred the number of feeds can be reduced to five and the volume increased per feed. At full emergence the number of feeds is reduced to two or three per day and the young wombat should be given access to grass, cereals such as rolled oats, toasted wheat, crushed maize, grated carrot and apple (Presidente 1982).

Joeys should be offered fresh water in a sturdy container as they can dehydrate, especially during warm weather. Water is especially important once the joey begins to vacate the pouch and eat solids (George *et al.* 1995).

10.4 Specific requirements

In the mother's pouch, the unfurred joey is naturally lubricated so that it does not dehydrate. Humidity is also high in the pouch. In an artificial pouch, it is not feasible to keep the humidity high, nor is it desirable, as bacterial infections increase with humidity. The joey will need to be lubricated several times a day with Sorbelene cream (not with added glycerine) so that its skin does not become dry and cracked. Baby oil is not recommended as it is not absorbed, tending to stay on the skin surface where it rubs off. Sometimes, unfurred joeys develop flaky skin, but this usually disappears as the fur comes through (George *et al.* 1995).

10.5 Data recording

When an animal is first brought in for hand-rearing its sex and approximate age, using growth charts, should be recorded. During the hand the information listed below should be recorded. This information serves several purposes including providing important

background information such as food consumption which will assist a veterinarian reach a diagnosis if the animal becomes sick of fails to grow or gain weight. It also allows a comparison with growth curves to assess progress.

The following information should be recorded on a daily basis:

- Date
- Time when the information is recorded
- Body weight to the nearest 1g if possible
- General activity and demeanor
- Characteristics and frequency of defecation and urination
- Amount in grams of different food types offered and eaten
- Food consumption at each feed
- Veterinary examinations and outcomes

The developmental stages and measurements outlined in Appendix 4 should also be recorded on a weekly basis where possible

10.6 Identification methods

Generally not required but a microchip can be implanted once furred.

10.7 Hygiene

Maintaining a high standard of hygiene is critical to the survival of a wombat joey. Emphasis should be placed on the following:

- Maintain a clean pouch lining at all times. Older joeys can be trained to urinate on newspaper by keeping a piece of newspaper with urine on it.
- Maintain personal hygiene by washing and disinfecting hands before and after handling the joey. Use antibacterial solution for washing hands with furless joeys, as their immune system is not well developed.
- Wash hands between feeding different joeys.
- Use boiled water when making up formulas for very young joeys.
- Clean spilt milk formula, faeces and urine from the joey's skin as soon as possible, and then dry the animal.
- Wash all feeding equipment in warm soapy water and sterilize in a suitable antibacterial solution such as Halasept or Milton, or boil it for ten minutes. Once sterilized, the equipment should be rinsed in cold water.
- Store feeding equipment in the fridge when not in use.
- Only heat up milk once and discard leftovers.
- Avoid contact with other animals unless you are sure they pose no health risk. Once fully emerged from the pouch joeys should be allowed to socialize with other joeys to avoid human imprinting and encourage normal social behaviour.
- Stimulate to toilet before or after feeding. As with other marsupials, toileting can be done by the application of warm water to the cloaca using cotton wool to

stimulate urination and defecation, which allows the animal to keep drier and warmer in its pouch.
- If furless cover the joey's body with Sorbelene cream after each feed until fur appears.

Good hygiene is important, so all excess milk or waste products should be cleaned away whenever possible.

10.8 Behavioural considerations

Once a wombat reaches approximately 18 months of age, it naturally becomes increasingly independent of its carer and generally becomes quite aggressive. Aggression is a normal behaviour, even in joeys, soon after emergence from the pouch. Mother wombats are quiet tolerant of this behaviour but a joey bite can be very painful. Prior to release or inclusion into a colony they should be gradually weaned from human affection, fed a diet of natural grasses or a captive diet and held with other wombats so they can develop their social skills.

10.9 Use of foster species

Fostering within wombat species has been conducted successfully, with 100% success rates being observed in southern hairy-nosed wombats, provided the pouch young is transferred to another female with a young of equivalent or greater size. Young as small as 1.5g have been transferred successfully to foster mothers using this process and the growth rates are unaffected (Jackson 2003). There may be advantages in having the ability to cross-foster from northern hairy-nosed wombats, which may reduce reproductive stress on the mother, especially in times of environmental stress. This could enable female northern hairy-nosed wombats to breed every year, rather than missing some years. It may also be of use when a captive population is established (Backhouse 2001).

No interspecies fostering is known to have been used to date and the poor breeding success of wombats in captivity means that fostering between wombat species is presently unable to be used.

10.10 Weaning

The wombat can be introduced to solid foods by providing pellets and freshly cut grass with roots and dirt attached. Weaning usually occurs by 14-15 months of age and sometimes as early as 12 months (Booth 1999). Fresh clover, cabbage leaves or leaves from members of the cabbage family should not be fed as these can cause gut problems and are known to kill young wombats (George *et al.* 1995). The number of bottle feeds can be slowly reduced as the wombat develops and its solid food intake increases. Often wombats wean themselves and refuse to drink any formula, it is important that this does not occur at less than 12 months of age (Austin 1979).

10.11 Rehabilitation and release procedures

Preparation for release should begin once the wombat begins to leave the pouch. It should gradually be weaned from the foster carer into an enclosure with adequate soil depth that allows it to burrow, and be fed on increasing amounts of grass. By 18 months of age, the young wombat is usually driven away by the mother. Ideally the wombat should be soft released where it can come and go from the carer's home to the wild and then disperse permanently when it is ready. Wombats released as pairs appear to do better than those released on their own, though this bond quickly breaks down after release (George *et al.* 1995).

Dr. Peter Mawson, senior zoologist for the Department of Conservation and Land Management in Western Australia (*pers. comm*. 01.05.04), stated, "that there is only one small area of the state that contains a population of southern hairy-nosed wombats; this area is approximately 120 km west of the South Australian border. Southern hairy-nosed wombats are allowed to be released at this site under regulation 28A in consultation with the Department of Conservation and Land Management."

The National Parks and Wildlife Act 1972, Department of Environment and Heritage, South Australia, states, in section 3.7 of the Standard Operating Procedures, Native Species-Rescue and Release specific guidelines to cover the release of native wildlife. All animals must be self sustainable and released within 48 hours of rescue, after 48 hours special criteria must be met. If the animal is hand raised or habituated to humans it is not to be released unless it is in accordance with a threatened species recovery program.

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"Willie": - the southern hairy-nosed wombat for showing me how tough wombats can be.

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14. APPENDIX.

APPENDIX 1:Haematology and serum biochemistry of southern hairy - nosed wombats (Booth 1999).

Component	Units	*Lasiorhinus latifrons* n=22**
RBC	x 10^{12}/L	4.68 ± 0.51
Hb	gm/L	128 ± 15
PCV	%	39.7 ± 4.5
MCH	µµg	
MCHC	gm/L	324 ± 14
MCV	fl	85 ± 3
Platelets	x 10^9/L	
WBC	x 10^9/L	10.0 ± 4.0
Segmented Neutrophils	x 10^9/L	5.43 ± 2.38
Lymphocytes	x 10^9/L	4.96 ± 2.65
Monocytes	x 10^9/L	0.01 ± 0.03
Eosinophils	x 10^9/L	0.55 ± 0.68
Basophils	x 10^9/L	0.0
Sodium	mmol/L	143 ± 10
Potassium	mmol/L	5.7 ± 1.2
Chloride	mmol/L	101 ± 6
Bicarbonate	mmol/L	24 ± 6
Glucose	mmol/L	6.4 ± 1.4
BUN	mmol/L	13.± 1.8
Creatine	mmol/L	0.15 ± 0.03
Calcium	mmol/L	2.65 ± 0.30
Phosphorous	mmol/L	1.55 ± 0.45
Cholesterol	mmol/L	3.1 ± 0.6
Total Protein	gm/L	70 ± 9
Albumin	gm/L	
Globulin	gm/L	
Total Bilirubin	µmol/L	2.2 ± 1.1
Alanine Aminotransferase	U/L	
Alkaline Phosphatase	U/L	101 ± 46
Lactat Dehydrogenase	U/L	355 ± 137
Aspartate Aminotransferase	U/L	65 ± 35
Creatine Phosphokinase	U/L	376 ± 240

*From captive and free ranging wombats at Healsville Sanctuary and Melbourne Zoo. Obvious outliers removed.
** From Gaughwin and Judson 1980, data from free ranging wombats

APPENDIX 2:Hairy-Nosed Wombats Growth and Feed Estimates (Wombaroo 1996)

Milk	Age Days	Arm mm	Leg mm	Weight g	Feed ml/day
	20	33	22	2	2
	40	36	37	14	6
<0.4	60	39	32	42	14
	80	42	37	93	25
	90	44	40	129	30
	100	46	43	173	40
Transition	101 to 103		30ml <0.4 + 10ml 0.4		40
From	104 to 106		20ml <0.4 + 20ml 0.4		40
<0.4 to 0.4	107 to 109		10ml <0.4 + 30ml 0.4		40
	110	48	46	225	40
	120	50	49	287	45
	130	52	53	358	50
0.4	140	54	56	439	55
	150	56	59	532	60
	160	58	63	636	65
Transition	161 to 163		40ml 0.4 + 20ml > 0.6		60
From	164 to 166		30ml 0.4 + 30ml > 0.6		60
0.4 to > 0.6	167 to 169		20ml 0.4 + 40ml > 0.6		60
	170	60	67	753	60
	180	62	71	882	65
	190	64	74	1024	70
	200	66	78	1181	75
Emerging from	210	68	83	1352	80
pouch	220	70	87	1592	85
	230	73	91	1882	105
	240	75	96	2212	120
>0.6	250	77	100	2562	135
	260	80	105	2912	145
Fully out of pouch	270	82	110	3262[A]	160[B]

A. Average growth rate from now is about 35g per day

B. Milk volume now depends on other food consumed. If uncertain about what to feed or when to commence weaning consult your Wombaroo supplier.

APPENDIX 3: Young weights and development notes (Boer 1998; Walker 1998; Saunders.A 2003; Hakof.D 2005).

Age Months	Mean Weight (g)	Total body length (mm)	Characteristic ontogenetic events(s)
birth	0.5	20	Unfurred; frontlimbs with nails; hindlimbs: tissue buds.
1.0	6-10	60	Nails on hindlimbs; sex determinable
2.5			
3.0	53-83	130	Vibrissae developed, body hair develops
3.5	224	163	
4.0	306	176	2 incisors erupted
4.5	424	201	Both eyes opened, pushing up onto front legs, ears starting to stand up and soft vocalizations.
5.0	750	200	
5.5	1015	277	All incisors erupted,able to walk
6.0	1056	300	Fine fur over entire body
6.5	1362	430	First emergence from pouch
7.0	1719	440	Completely furred, staring to eat grass
7.5	2290	482	
8.0	2749	330	Descensus testiculorum; molars erupted
8.5	3740	560	
9.0	4440		Permanently out of pouch Ingestion of plants
9.5	5000		
10	5..5-7.5kg	480-550	Weaned
18	15-20kg	600-800	Independent

APPENDIX 4: Quarantine of Southern Hairy-Nosed Wombats (*Lasiorhinus latifrons)* at Taronga Zoo's Veterinary and Quarantine Centre.

M. Wilson, Veterinary Nurse Zookeeper Taronga Zoo (Wilson 2004)

Six wild caught southern hairy - nosed wombats were brought into captivity in November 2002. On arrival, the animals were underweight, in poor body condition, with dull and poor coat condition.

The wombats were paired up in large dens, as there was inadequate space to house them individually. They were then shuffled around until compatible pairs were found. During this time the smallest wombat kept dropping in weight and was separated for close observation, to assess her appetite and feacal output. Two weeks into quarantine, one of the male wombats died of severe pneumonia. Erna Walraven, Senior Curator of Taronga Zoo, noted that this particular wombat was constantly found with his face in his water bowl (pers.comm 25.05.04), suggesting a highly stressed individual.

Dens consisted of a simple layout for ease of cleaning, to minimize disturbance and reduce stress on the wombats. Wooden boxes (length 106cm x depth 60cm x width 54 cm) with one entrance and a lift up lid were provided for each animal. The concrete floors were covered with oaten hay which provided food and bedding and provided an opportunity for wombats to become habituated to a captive diet, as food was every where. This also allowed for easy spot cleaning. Water containers were attached to the walls to prevent the animals from tipping them over.

Each morning the animals were checked and cleaned at the same time to minimise disturbance. This was the only time the lights were on, other wise they were kept with subdued lighting provided through skylights. For the first two weeks of quarantine fresh feaces were left in the enclosures and only a few day old feaces and left over food were removed with spot cleaning and water replaced. After the wombats had settled in more intensive cleaning was carried out. They were then checked again in the afternoon but not disturbed. At this time weekly weighing and body condition scoring started to monitor their adaptation to captivity and new diet.

The diet was observed closely, due to the fact that they were wild caught and in poor condition. Oaten hay and native grass clumps were offered during the first 10 days. The wombats did not adapt well to the new diet and continued to loose weight. Feed consumption was measured by monitoring feacal output.

After 10 days, high concentrate feed such as kangaroo pellets and stud mix were introduced for 7 days in an attempt to reduce further weight loss. Carrots, maize sweet potato and sweet corn were slowly introduced. During the 32 day quarantine period, the wombats displayed a preference for oaten hay, the introduction of pellets, stud mix and vegetables took approximately six weeks.

APPENDIX 5: List of Suppliers

Biolac
Geoff and Christine Smith
P.O. Box 93
Bonnyrigg Plaza
New South Wales 2177
Ph: 02 98239874
Fax: 02 98239874

Central Animal Records
22 Fiveways Boulevard
Keysborough
Victoria 3173
Ph: 03 97063100
Fax: 03 97063198
Email: info@car.com.au
* PIT tags and scanners

Sharpe Laboratories Pty Ltd
12 Hope Street
Ermington
New South Wales 2115
Ph: 02 98585622
Fax: 02 98585957
Email: sharpe@myoffice.net.au
* Di-Vetelact

Ridley Agriproducts Pty Ltd.
P.O. Box 18
Pakenham, Victoria 3810
Ph: 03 59411633
Fax: 03 59413938
Email: enquiries@agriproducts.com.au
* Wombat pellets

Wombaroo Food Products
P.O. Box 151 Glen Osmond
South Australia 5064
Ph: 08 83791339
Fax: 08 83791339
Email: Wombaroo@adelaide.on.net
* Wombat Hand Raising Formula and Equipment