Introduction to the Care and Rehabilitation of Microbats

(Focussing on Species of South East Queensland)

This guide is a work in progress……there is much to learn about the particulars of our native microbat species and as we get better each year in our rehabilitation practices we will be continually updating this guide.

Please share your knowledge and learnings as we have, so that we can improve our collective understanding of microbat rehabilitation……

Come join us and keep in touch at the

***'Australian Microbat Rehabilitation Forum'** on Facebook*
https://www.facebook.com/groups/507677942577505/

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Front Cover Image: *Rhinolophus megaphyllus* Credit: Steve Parish

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Introduction

Microbats are perhaps the most mysterious and misunderstood mammals on earth, despite comprising more than 20% of the world's mammal species.

Their unique and specialized anatomy, physiology and behavior make them the most fascinating and often the most challenging of the animals that wildlife rehabilitator's encounter. It is fair to say that collectively little is known in Australia about the best approaches and methods to rehabilitate and care for the diverse number of microbat species we are blessed to have on this continent and islands.

This collection of words is an attempt to pull together the critical biological knowledge, rehabilitation experiences and current best practice methods necessary for rehabilitators to have a basic understanding of microbat captive care and rehabilitation.

This guide is only partially complete and its authors aim to continue populating missing information gaps as information comes to hand and necessary research is undertaken. As we all move forward improving our collective knowledge, please feel welcomed to contribute your learnings and research for future editions, so that as many of our little furry friends can benefit as possible.

Greater Broad-nosed Bats (*Scoteanax rueppelli*), mother and pups. Credit - Steve Parish

What is a Microbat?

All bats belong to the order Chiroptera, which includes two suborders, Yinpterochiroptera and Yangochiroptera.

Bat species are classified within the following divisions:

Suborder **Yinpterochiroptera (Pteropodiformes)**

- Family Megadermatidae (Ghost Bats and False vampires)*
- Family Pteropodidae (Megabats – Flying Foxes, Tube-nosed Bats and Blossom bats)*
- Family Rhinolophidae (Horseshoe, Old world leaf-nosed and ghost bats)*
- Family Rhinopomatidae (Mouse-tailed bats)

Suborder **Yangochiroptera (Vespertilioniformes)**

- Family Antrozoidae (Pallid Bat and Van Gelder's bat)
- Family Craseonycteridae (Kitti's Hog-nosed bat)
- Family Emballonuridae (Sheath-tailed or Sac-winged bats)*
- Family Furipteridae (Smoky bats)
- Family Molossidae (Free-tailed bats)*
- Family Mormoopidae (Ghost-faced bats)
- Family Mystacinidae (New Zealand short-tailed bats)
- Family Myzopodidae (Sucker-footed bats)
- Family Natalidae (Funnel-eared bats)
- Family Noctilionidae (Bulldog bats)
- Family Nycteridae (Hollow-faced bats)
- Family Phyllostomidae (New world Leaf-nosed bats)
- Family Thyropteridae (Disk-winged bats)
- Family Vespertilionidae (Evening or Vesper bats)*

*Denotes Super families found within Australia.

Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) has had a recent taxonomic classification change. Credit - Steve Parish

Microbats are roughly described as those bats with echolocation ability and the characteristics of a clawless second finger that is tightly connected to the third finger and a large humerus in comparison to the larger non-echolocating flying foxes (Neuweiler, 2000).

New scientific understanding of the Rhinolophidae superfamily and their closer molecular links to flying foxes see them described in the Yinpterochiroptera Suborder, despite their very advanced echolocation ability (Churchill, 2008).

The two major orders were believed to have separated about 64 million years ago, with the most recent evolutionary change within the suborders and families occurring 30 million years ago. Consequently, bats are considered ancient, with all families and genera that we know of today in existence 30 million years ago (Churchill, 2008).

In all there are over 1400 species of bats in the world across 19 different families, and in Australia there are 80 different species of bats across 9 families (Australasian Bat Society, 2020).

In South East Queensland from Gladstone to the NSW border and west to the Toowoomba range, there are approximately 40 different bat species (including 5 traditionally known megabats) (Hall, 2010). It is vitally

important to know the difference between each species as they have vastly different diets, behaviors, rehabilitation needs and release considerations.

Appendix 7 is an attempt to document the important characteristics relevant to rehabilitation and care for each of the species of microbat in the broader SEQ region.

The latest and most up to date listing of taxonomic names of Australian bats is maintained by the Australasian Bat Society and can be found at: - http://ausbats.org.au/species-list/4593775065

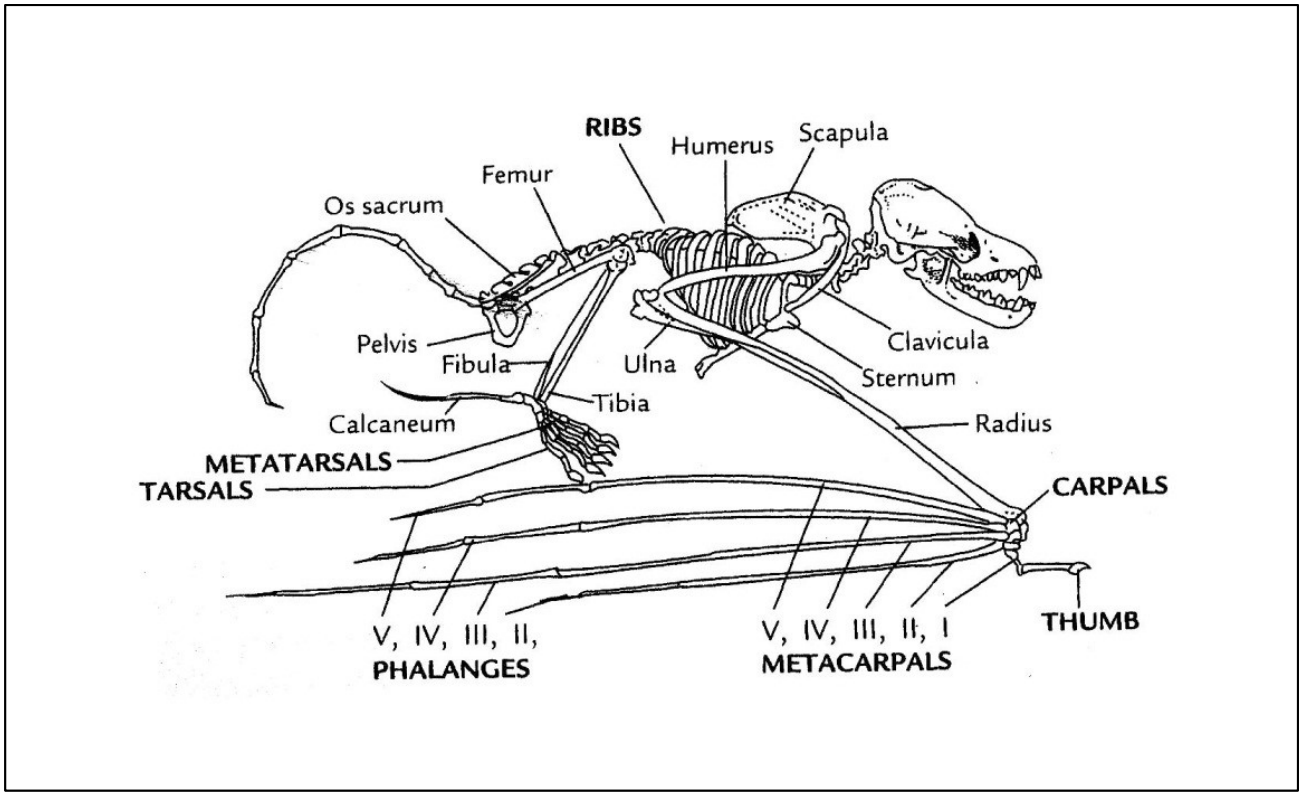
Ride's Free-tailed Bat (*Ozimops ridei*). Credit - Steve Parish.

Microbat Anatomy and Physiology - Critical Rehabilitation Considerations

Skeletal & Muscular Structure

Microbats have a very similar skeletal and muscular structure to megabats with some exceptions.
Microbat anatomy and physiology has evolved to suit the essential functions of flight and foraging style and the delicate energy, fluid and thermoregulatory balances that accompany them.

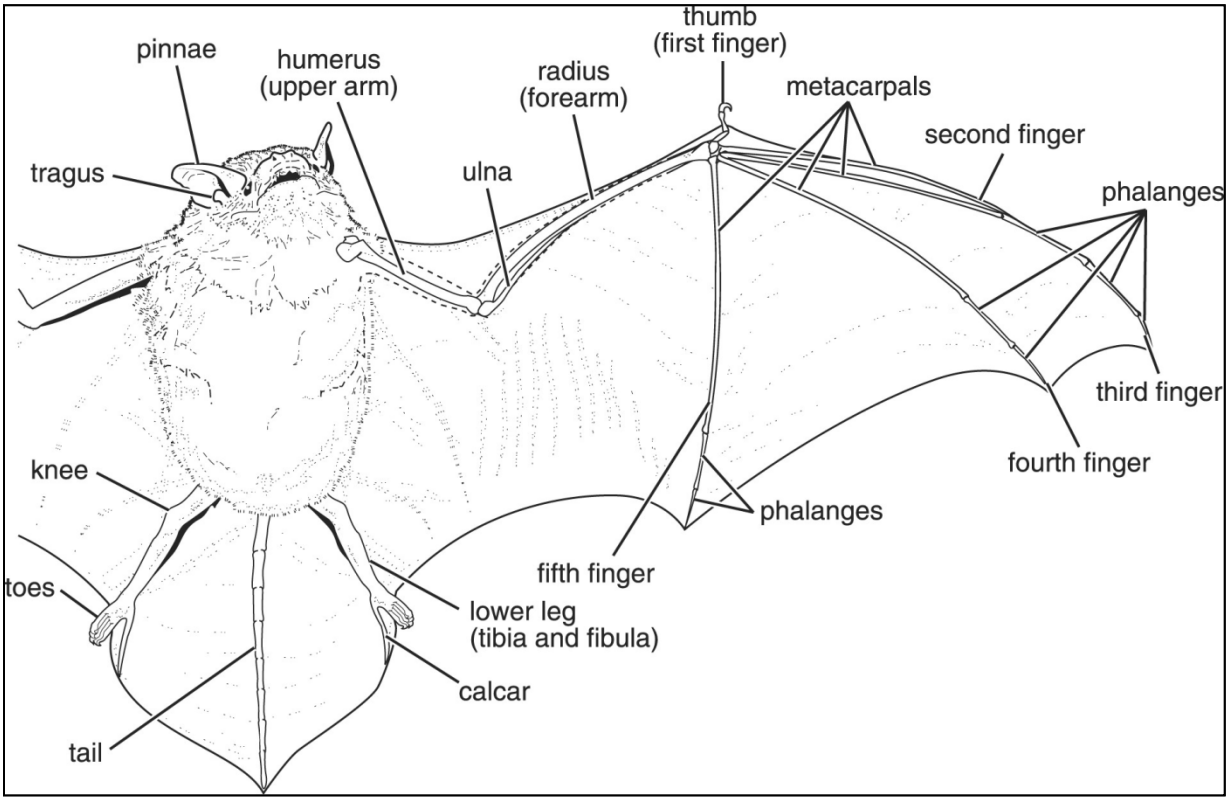
Figure 4 provides a simple diagram identifying the major skeletal components of a microbat.



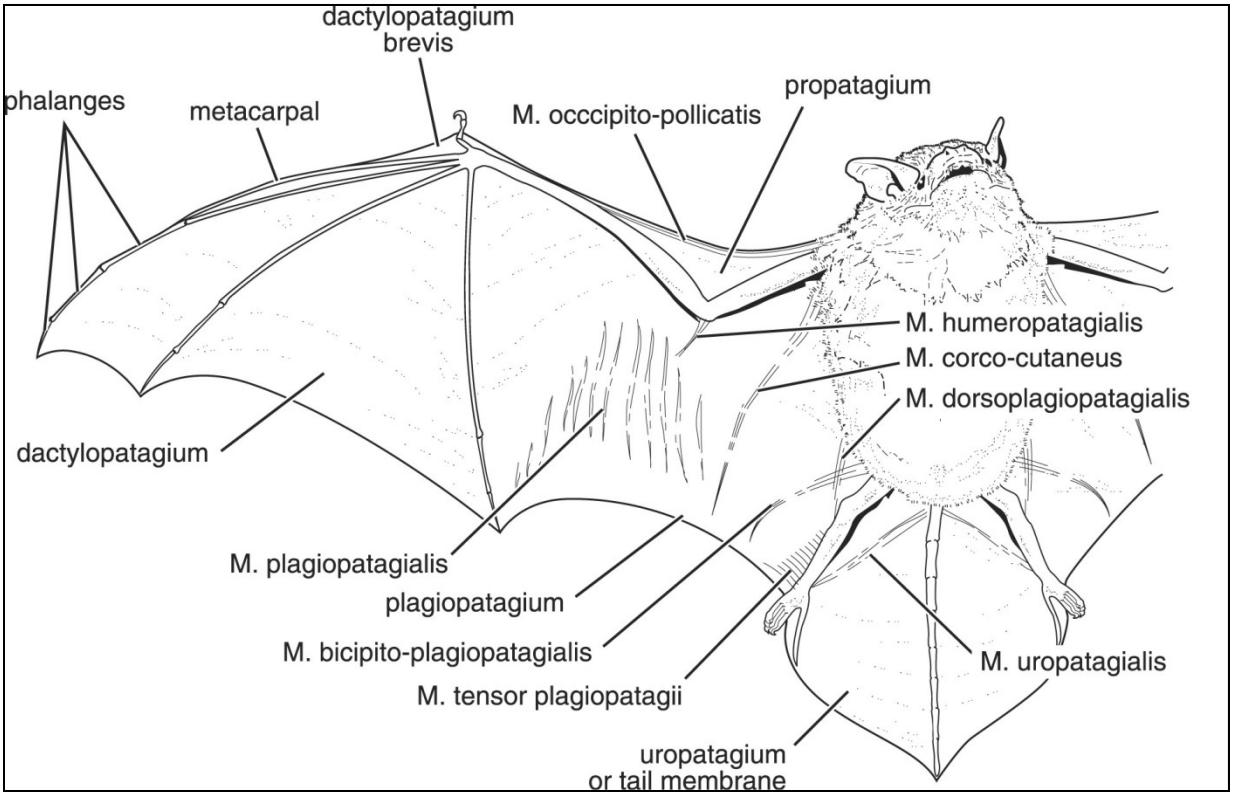
Skeletal diagram of a typical microbat. Source: (Neuweiler, 2000)

The wings and legs are typically the only skeletal aspects of a microbat that most rehabilitators will see without access to x-ray images, and are the most common bones that are damaged due to injury and developmental problems.

Interesting Fact:
As with all mammals, tendons have the function of connecting and holding many bones together and in shape. Of particular interest in bats is the locking mechanism in their feet which enables them to hang whilst sleeping. Tendons attached to the various feet bones disengage only when weight is lifted (Neuweiler, 2000).



Microbat skeletal detail of the wings. legs and tail. Credit - (Lollar, 2010)



Microbat muscular detail of the wings, legs and tail. Credit - (Lollar, 2010)

Fluid Balance (Homeostasis)

Water is vitally important to microbats for maintaining the:

- ionic balance in the blood (homeostasis);
- evaporation of water from the skin surface and lungs as part of the bats cooling and thermoregulation system; and
- removal of wastes and toxins from the body via urine.

The Large-eared Pied Bat (*Chalinolobus dwyeri*) in flight, illustrating their large naked skin surface area common with all microbat species. Credit – Michael Pennay

Microbats have large lungs and over 80% naked body surface, meaning they can lose large amounts of water very quickly.

The daily water turnover rates have been measured for several bats and is extremely variable. Some bats have high water turnover rates (which we describe later as 'high humidity' bats) and some have very low water turnover rates. Several papers indicate that many bats are well adapted to low water requirements and can meet the majority (if not all) of their moisture requirements from food and metabolic processes evolved to conserve water.

The blood urea concentration of insectivorous bats is 4-5 times higher than that of other mammals, and is highest immediately after feeding (Neuweiler, 2000). This appears to be a special adaptation used by bats to maximise water efficiency and to rapidly deal with their high protein diet through concentrated urine waste.

Fluid intake and adequate hydration acts to dilute the blood urea concentration to acceptable levels. Issues MAY arise where fluid intake for SOME species is restricted through either physical means (e.g. injury or entrapment) or through overall fluid shortages in food during extended dry periods.

All animals however, have a point where evolved adaptions is limited and where physical demise occurs. Huge metabolic rates and energy requirements of microbats, particularly when in stressful situations (trapped, injured or in captivity) also influence the situation (Personal Communications – T. Bishop, 2017). While physical limits to fluid conservation is significantly different for different species, it is postulated that some individuals succumb to urea poisoning often without typical dehydration signals exhibited.

Fluid therapy in microbats, particularly in relation to addressing the impact of adverse urea concentration is a largely unstudied science and is based on anecdotal postulation. The inability to extract sufficient volumes of blood to undertake testing is a major limitation to confirming if issues exist at scale.

The potential for urea poisoning in some individuals of certain species has critical implications to emergency first aid and the assessment activities of rehabilitators. The precautionary principle and lowest risk approach to managing this issue is favored. It is advisable that **all microbats, regardless of typical dehydration signals, should be rehydrated via sub-cutaneous injection as a matter of course as soon as possible after admittance into care to offset death or damage of organs by potentially high urea concentrations. The correct process, route, equipment, type and amounts must be followed (Refer Pg 58).**

The amount of fluid required and the speed at which fluid absorption is needed to offset urea poisoning, renders oral rehydration of microbats as generally ineffective. Many species of microbats will not drink sufficient amounts orally even at full health and there is risk of aspiration with a torporing individual. Subcutaneous fluid injections should however only be undertaken by a veterinarian or experienced and vaccinated rehabilitator trained in fluid therapy.

Energy Balance and Thermoregulation

Like all animals, the microbats daily task of survival is to balance the input and output of energy via the metabolism of food they eat and the activities they undertake as part of each day.

The energy needs of microbats, when they are active, are high compared to other mammals. This is due to:

- their smaller size and resultant faster metabolism;
- their need to fly which expends huge amounts of energy; and,
- their large heat loss due to large surface area ratios and existence in often cold climates.

Consequently, microbats have been known to eat relatively large amounts of food (up to 61% of their body weight) at night so to avoid using their valuable but limited fat reserves (Neuweiler, 2000).

Thermoregulation

Microbats have different energy demands based on the activity they are undertaking. When flying and when socially active, they use large amounts of energy. Further, their large lungs and naked flight membranes can result in heat loss six times greater than other mammals of the same size (Neuweiler, 2000).

Microbats **in the wild** do not and cannot create massive fat stores due to their need for agile flight. This consequently makes the heating and energy predicament difficult.

The thermoneutral zone for a microbat, where it consumes the least amount of energy and oxygen, is 30-35°C. Outside of this ambient temperature when active, bat must consume larger amounts of energy to maintain a **constant body temperature of 35-39°C** (Neuweiler, 2000).

In order to maintain a suitable body temperature in times of cool weather, microbats choose particular roosts, often colonial roost and sometimes migrate long distances to warmer locations.

However, microbats have also developed an evolutionary solution to reducing energy requirements, called heterothermy. Heterothermy or heterothermia is a physiological term for animals that vary between self-regulating their body temperature, and allowing the surrounding environment to affect it. In other words, they exhibit characteristics of both poikilothermy and homeothermy.

A heterothermic animal can **consciously and in a regulated way**, reduce their body temperature to save energy and then consciously return to normal temperatures (Neuweiler, 2000).

The Goulds long-eared bat (*Nyctophilus gouldi*) a typically lean bat, cluster roost to aid thermoregulation and energy conservation. Credit - Les Hall

Two different physiological and behavioral mechanisms for heterothermy are evolved energy saving solutions for bats in situations where temperature is below their thermoneutral zone. Some research suggests that these mechanisms are more likely a spectrum:

- Torpor (diurnal lethargy); and,
- Hibernation.

Torpor

Torpor is when bats allow their body temperature to drop close to or equal to ambient temperature, thus entering a state of diurnal lethargy and reducing their metabolic needs (Altringham, 2011). Torpor is controlled and does not fluctuate freely with ambient temperature. A torporing bat feels colder to touch and they often have limited or slow movement. They cannot fly and they typically will not eat of drink food when in torpor. If they are predated upon when in torpor they cannot fly or move away. When in torpor their Basal Metabolic Rate (BMR) is often much lower than mammals of the same size.

Torpor is used regularly in all microbat species, in all areas and at any time of day or night. It is an energy and water conservation mechanism that is the default position when a bat is not actively socializing or flying. Torpor can last for periods of several hours. During torpor, microbats enter into an arrhythmic pattern of ventilation and apnea, thus reducing energy use and moisture loss (Neuweiler, 2000). Different species of microbats drop their temperature during torpor to different levels and for different durations.

When in torpor, both food consumption and water consumption needs are much less than when active and flying. Consequently, in winter when torporing duration is typically longer and more frequent, food consumption is much less.

Hibernation

Hibernation is often described as an extended torpor. Hibernation lasts from several days to several months and much planning occurs prior, including the building up of fat stores, seasonal migration to particular winter roosts and timing arrangement taking reproduction needs into account.

The physiological processes of hibernation are complex and not completely understood. A bat in hibernation concertedly slows down all processes in the body including metabolism activity, breathing/ oxygen consumption, water consumption, heart activity and blood sugar levels.

Microbat species have different abilities regarding temperature for entering and emerging from hibernation. Many species of microbats around the world change their roost sites throughout winter to ensure the most appropriate roost temperature is reached and will go in and out of hibernation.

Around the world, many species of microbat hibernate, however in Australia due to somewhat warmer winters and the ability to find suitable roosts with adequate ambient temperatures, bats enter extended periods of torpor as opposed to hibernation.

Husbandry Considerations

When a microbat is torporing or hibernating, their metabolic rate is significantly slower which has an impact on everything from the amount of food eaten, the amount of water ingested, wound healing rates and the rates of medication metabolization.

Microbats in general care need to be provided with a temperature gradient so that they can choose roosting spots and be the most comfortable. This could entail one end of an enclosure heated by heat pad and the other end not.

However, during medication treatments (and for a few days after), in order for any treatment drugs to have designed effect without organ damage, and to facilitate healing as quickly as possible, microbats require constant peak temperature of 30-35°C (or higher if a pup).

Microbats undergoing medicinal treatment are best housed in full temperature-controlled situations (e.g. humidicribs) and provided <u>ample nutrition and fluids</u> to collectively lessen the incidence of entering torpor and also accommodate the increased energy needs of bats that are not torporing (normothermic).

Shivering

When a microbat emerges from torpor, it does so by a process called 'shivering'. Shivering is when the skeletal muscle fibers contract in a particular way that generates heat without causing body movement. The shivering increases the bats metabolism but at the same time expends a large amount of energy.

Bats will begin to shiver when aroused from torpor for nightly or daily feeding in captivity. Refer to page 67 for instructions on feeding techniques and processes.

Overheating

Microbats are less able to cope with overheating than overcooling, as they cannot sweat. The lethal heat for microbats is between 44-45°C. Their primary but limited physiological means of reducing heat is by evaporative cooling and through air movement around their wings and body. Microbats instead attempt to avoid excessive heat and stay within their thermoneutral zone through roost choice, which may be in different geographic locations or in different structures than those used during winter. Northern Free-tailed bats (*Ozimops lumsdenae)* have often been encountered in roofing structures near hot iron in mid-summer. They appear to have a different heat tolerance than most bats, however no known study has been undertaken to test this assumption.

The Eastern Bent-winged Bat (*Miniopterus orianae*) has the physiological ability to hybernate but does not do so in SEQ. Credit - Les Hall.

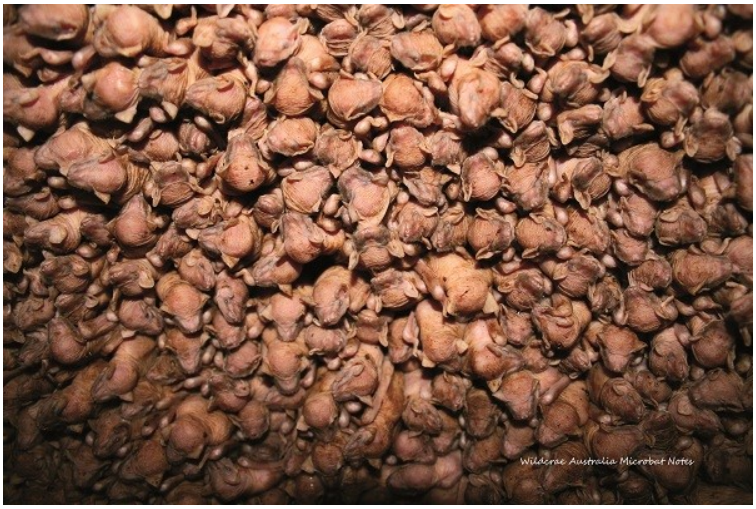
Reproduction and Longevity

The reproductive processes and ability of microbats is amazing and complex.

The mating behavior of microbats is hugely variable, ranging from harem type situations, to defined mating territories, to swarming systems. Usually female range and social behavior indicates the type of system used (Altringham, 2011).

Bats are placental mammals and have similar processes to humans once the egg is implanted in the wall of the uterus. However, microbats have the ability to control the timing of many aspects of reproduction so to coordinate pup birth times, food availability and survival, including:

- Sperm storage by males for a number of months;
- Delayed ovulation and fertilization through the storage and nourishment of sperm by the female bat in the oviducts and uterus;
- Delayed implantation of the fertilized egg by storage in the oviduct;
- Embryonic diapause, where the embryo is made dormant for an amount of time;
- Delayed birthing to accommodate poor weather and insect supply; and,
- Asynchrony or the timing of pup births in colonies to maximize co-development heating opportunities.



Simultaneous pup birthing is typical of the Eastern Bent-winged Bat (*Miniopterus orianae*). Credit - Les Hall.

Gestation timeframes are difficult to determine given the techniques used above and the variability between species and within species in different habitats. Typical timeframes are between 40-50 days for a smaller microbat, to 5-6 months for the larger microbats.

Birthing of microbats is typically performed in a head-up or cradle position where the tail and wing membranes are used to cradle the pup. The weight of pups at birth is on average 22% of the adult weight of the mother (Altringham, 2011).

The size and developmental stage of pups when born varies markedly between species. Some are born with eyes open (several species of the Molossidae family) but most are born with their eyes closed. Typically, microbats are furless when born, but their skin pigments and cuts fur from within several days to up to 4 weeks for some species.

All microbat pups are born with milk teeth and like their flying fox cousins, can climb and cling to their mothers. Several species do not however roost with their mothers, instead roosting in large pup colonies with their mothers nearby. Some species (e.g. *Miniopterus schriebersii*) have been observed to regularly nurse non-related pups.

Prior to being able to fly, bats generally need to grow to 90-95% of their adult skeletal size and 70% of their adult mass (Altringham, 2011).

Temperate and sub-tropical bats typically give birth to single young or twins once a year, however tropical bats, due the availability of heat and insect supply, can breed 2-3 times per year.

Longevity

Bats live on average 10-20 times longer than non-flying mammals of similar size, and provided they survive their difficult first year, usually live to between 7 and 40+ years depending on the species.

Different species longevity is assumed to be related to the number of pups born (fewer pups increases life expectancy), hibernation ability (hibernating bats live approximately 6 years longer than non-hibernating), typical roost type used (cave roosting bats live approximately 5 years longer) and foraging style (ground gleaners are more prone to predation) (Altringham, 2011).

Navigation and Communication

While it is known that many microbats do rely on their visual eyesight for foraging and flight, particularly in relation to flying altitude, little studies have been undertaken into the performance of microbat vision (Neuweiler, 2000).

However, the most defining and outstanding feature for microbat navigation and foraging is echolocation.

Echolocation

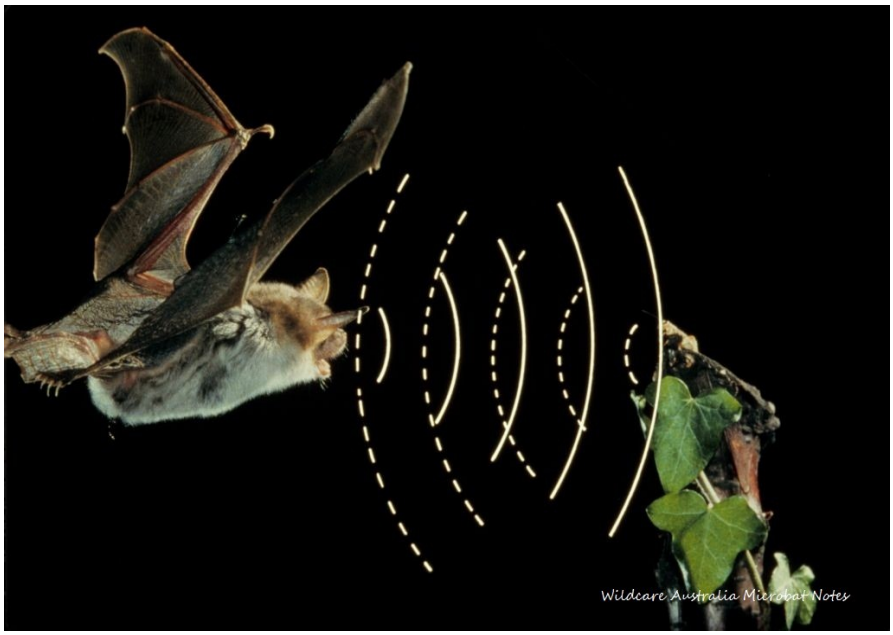
The concept of echolocation is more adequately described as echo imaging, whereby microbats can determine the location, travelling speed and direction, size, form and texture of obstacles, predators and prey (Neuweiler, 2000).

Microbats transmit echolocation sounds from their larynx via their mouth and/or nose depending on the species, and receive sound via their ears and associated neural systems. The evolutionary differenced in the nose leaf, ear tragus structure and ear lobe (pinna) shape and size are all related to refinement of echolocation signals for a microbat species and its associated habitat, flight style, wing shape and prey characteristics.

Echo imaging calls are harmonically complex and contain a number of different frequencies. Further the calls themselves are very short in duration and only last a few milliseconds.

Horseshoe bats over a typical hour-long hunting session will emit over 36,000 separate echolocation calls (Neuweiler, 2000). Echo imaging ranges in the different species can reach distances from 1m to 60m, depending upon the foraging requirements and the consequential flight speed and ability of the microbat. Typically, the species that are fast flyers and forage above the tree canopy have larger echo imaging ranges, whereas the species that forage in dense rainforest by hovering tend to have much shorter echo imaging ranges.

Microbat echolocation calls, which are different to general communication calls, are mostly above 20 kHz, the upper limit of human hearing.



A simple illustrative diagram of Echo imaging. Credit - Les Hall.

Other Communication & Learning

Microbats have complex and poorly understood communication ability and processes.
Often during foraging and echolocation activity, bats make broadcast calls or social calls which differ in structure to echolocation calls and are often multi-syllable. The meaning and purpose of these calls are largely mysteries to us but some have been researched and found to most likely correspond with territorial behavior, others with cooperative hunting (Fenton, 2003).

Within roosts, microbats produce social calls that are common within a social group and very different from colonies of the same species elsewhere, indicating the strong social bonds of colonies and small social groups (Fenton, 2003). Many rehabilitators have experienced excited calls of likely roost mates when releasing microbats back to their original capture location.

Bats also use alarm calls and distress calls which are known through research to attract other bats.

A study of one overseas species in 1985 found that 33 discrete syllables were used in various combinations to form sentences, which suggests considerable capacity for elaborate vocal communication (Fenton, 2003).

Mother and pups have distinct and individual search calls enabling them to find each other, even in roosts containing hundreds of thousands of mothers and pups. Research indicates that elements of such calls are hereditary and linked to family genetics, and as such are not learned as pups can use them within minutes of being born (Altringham, 2011). Scenting and odour depositing is also understood to assist this recognition process (Neuweiler, 2000).

Genetically acquired individual search calls allow mother and pup microbats to locate each other in roosts where there are sometimes more than 100,000 bats. Credit - Les Hall.

Recent evidence from a published study found that communicating and learning with experienced bats plays an integral role in juvenile upbringing and foraging in particular. Two control groups were set up of juvenile and adult bats, one group being housed with adult microbats that had been previously trained to catch mealworms suspended by string from a ceiling, and the other group not. The group that had been temporarily housed with trained adult bats was attracted by the 'buzzing' of hunting bats and many learnt from the trained bats and captured the mealworm themselves. The other group when placed into the same situation showed no interest in the mealworms (Wright, 2011). Other species however have been observed to instinctually hunt for food in care without wild adult bat interactions.

Much more research is needed to understand and describe accurately the well observed communication sounds and learning actions between microbats.

Emotions and Relationships

A study published in early 2011, using data collected over 20 years, confirmed what many microbat rehabilitators around the world had observed for many years - that highly complex social structures exist within local populations and colonies of bats. These high-level socio-cognitive skills, on par with the likes of elephants, dolphins and primates, enable bats to maintain lifelong personal social relationships and wider friendship networks with friends and relatives (Kerth, 2011). The two closely located bat colonies observed in the 20-year study interestingly showed that no interaction occurred between them which also provide further interesting interpretation into the strong colony bonds.

The outcomes of the Kerth (2011) study has recently been supported by a study by Godinho et al. (2015) identifying strong and often exclusive social structures in Australian Gould's Wattle Bats.

Microbats have exceptionally advanced socio-cognitive skills and form very close bonds with roost mates. Every attempt possible to reunited roost mates should be taken. Credit - Steve Parish.

Microbats when removed from their home roost and taken various distances away have been observed to return even from several hundred kilometers away (Barbour, 1979). No doubt due to the strong social and personal bonds they have with other individuals in their roost groups.

In line with other animals with high level socio-cognitive skills, emotions indicative of depression and grieving have been observed by many rehabilitators.

The consequence of the above points has significant impact on the way rehabilitators raise and release orphans and how adult bats are rehabilitated and released.

Adult bats upon rehabilitation should always be released as close as possible to where they were found. Most rehabilitated bats at release are not at their peak health, fitness and muscle tone due to being injured or ill. To require them to fly several or tens of kilometers to their original point of capture is counterproductive to the purpose of rehabilitation.

Microbats typically have several roosts within their defined territories or home ranges. In the event that a single roost is destroyed, they usually have several others in the same vicinity that they can occupy. As such they should still be released as close as possible to point of capture.

Juvenile bats have strong ties to their original colonies and should be released at their original point of capture also.

In 2017, SEQ carers started chipping bats coming through our Noosa flight aviary so that the identity of each bat was certain and they could be returned to their point of capture.

Due to chipping of a pup in early 2018 we were able to prove that even when pups come in very young that they re-integrate back into their original family colony. The pup came in at 4 weeks old, was processed through the pup milk and blended food stages and put in the flight aviary for around two months learning to fly and hunt before being released back at his point of origin. Approximately a month later a house wall was demolished one house away during renovations and a single bat was non-fatally injured which was found to be chipped and the hand-reared pup. To be alive 1 month after release, meant he could hunt and fly well and most interestingly he reintegrated back into his maternity group.

Microbats like all other animals feel pain and fear. Fear in microbats is displayed by ear flattening, narrowing of the distance between wrists when wings not extended, exposing teeth, biting, elevated heart and breathing rates and trying to evade handling. Pain expression in microbats is harder to observe, although typically presents as lethargy, eye dullness, irritability and reluctance to feed.

Habitat Preferences and Roosting Behavior

The roost selection and habitat preference of microbats are almost as varied as microbat diversity.

Roosts are important for bats as they are used for:

- Climatic protection from wind and rain;
- Predator protection;
- Thermoregulation protection;
- Close commuting to foraging sites;
- Mating;
- Maternal care;
- Social cohesion; and,
- Competitor avoidance (Altringham, 2011).

Microbats are the most common species to use tree hollows as roosts. Credit - Les Hall.

Bat roosts can be nightly opportunistic or deeply traditional and can include:

- Caves and cave like structures;
- Rock crevices;
- Within tree bark;
- Tree crevices and hollows;
- Within tree foliage;
- Bird nests;
- Arboreal ants and termite nests; and,
- Man-made structures such as mines, tunnels (for cave dwelling species), roof and building cavities (for tree hollow and crevice dwelling species), cracks in rock and steel structures (for crevice dwelling species) and umbrellas, hanging jackets and hanging material (for foliage and bark dwelling species).

Drain holes and crevices beneath bridges are common roosting sites for the Large Footed Myotis Bat (*Myotis macropus*). Credit - Les Hall

Bats roost in wide ranging numbers from singularly right up to 100,000's. The largest colonies of bats are found in caves during summer maternity periods, however they typically fragment and disperse during winter. The Large (Eastern) Bent-winged Bat (*Miniopterus orianae oceanensis*) and the Little Bent-winged Bat (*Miniopterus australis*) in SEQ form such colonies.

The majority of bat species in SEQ form groups ranging from several to several hundred individuals at different times of the year. Female and males of the species also have different roosting behaviors.

Some research has been undertaken into the preference of both cave and tree hollow types as roosting structures for bats. Different species prefer different types of caves and different sections of caves for different purposes, including but not limited to temperature, accessibility, humidity.

Disused mine shafts are often inhabited by cave roosting microbat species. Credit - Les Hall.

Studies into tree hollow roost selection show many microbats have strong association to tree types and locations, despite moving roosts regularly. Preferred trees include those that are large in diameter, taller than the surrounding trees (allowing increased solar access), are uncluttered with adjoining vegetation and are live (live trees have higher moisture content and insulating properties). These roost preferences enable greater navigational ability, reduced predation and optimal internal micro-climate conditions (Lumsden, 2003).

At a landscape scale, roost selection is generally favored closer to water and closer to forest edges, which provide the greatest opportunities for foraging diversity and solar access (Lumsden, 2003). Most species of microbat move roosts regularly within their local area.

Appendix 7 identifies the known preferences for roosting sites and structure for microbats of South East Queensland.

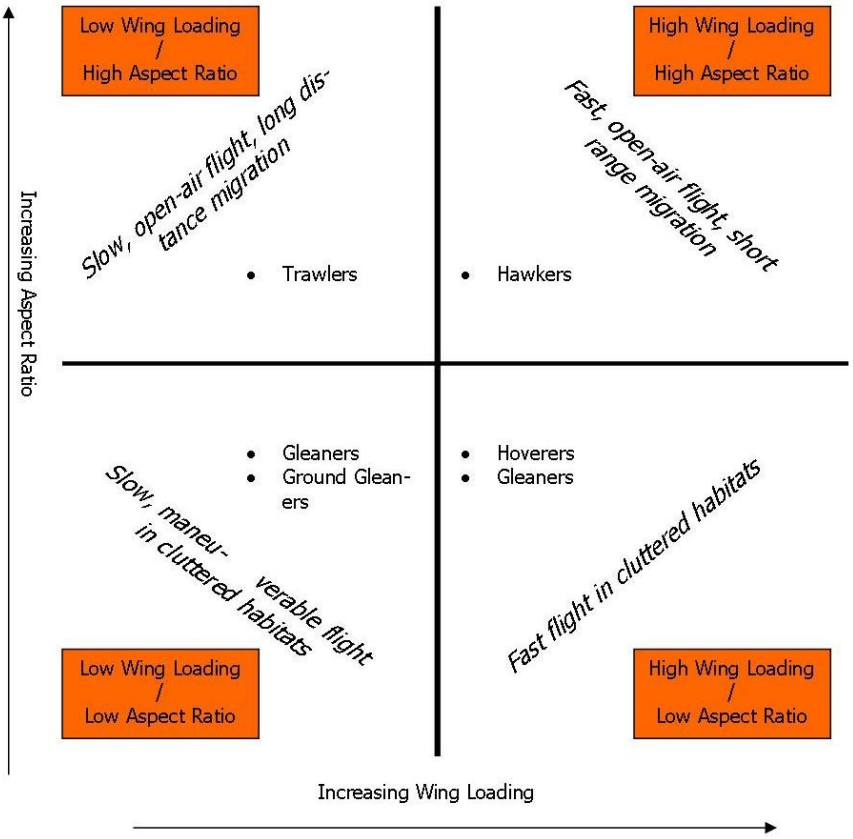
Flight Characteristics

Every single microbat has different flight characteristics. Flight speed, maneuverability and agility is related to wing shape, bat weights, feeding styles, roost types and forage habitat types. The flight characteristics and corresponding diets of many species is still unknown.

Generally speaking, wing shape and sizes are a reflection of the foraging strategy of the bats, including where, how and what they feed on. The wing shape and size has evolved over millions of years to best suit each bats requirements.

Wings can be large or small relative to the size of the bat, otherwise described as 'wing loading'. Secondly, wings can also be short and broad or long and narrow which is described as 'aspect ratio' (represented as AR = span^2 / area). These characteristics tell us a lot about the bats flight style and the foraging strategies it undertakes (Altringham, 2011).

Echolocation projection/ length is strongly related to flight speed and foraging characteristics.
Flight characteristics dictate the rehabilitation needs of each species. Some species, typically the slow highly maneuverable flyers, will undertake sustained (15 min +) flight in small spaces (e.g. 3 x 3m). Other high speed but less maneuverable flyers need large areas (16 x 16m) to undertake sustained flight. All bats need a minimum of 3 weeks (often longer) of sustained flight practice to build needed flight muscles prior to release.



Flight speed and manoeuvrability diagram. Credit - Adapted from (Altringham, 2011)

The ability to undertake sustained flight prior to release is critical. Many bats will attempt to fly significant distances once released to rejoin roost mates that may have migrated, or that have traditional forage areas a significant distance from their roost area. Some species of microbats have been known to fly 300km in a single night. If they don't have sufficient flight muscle strength and fitness they will not survive.

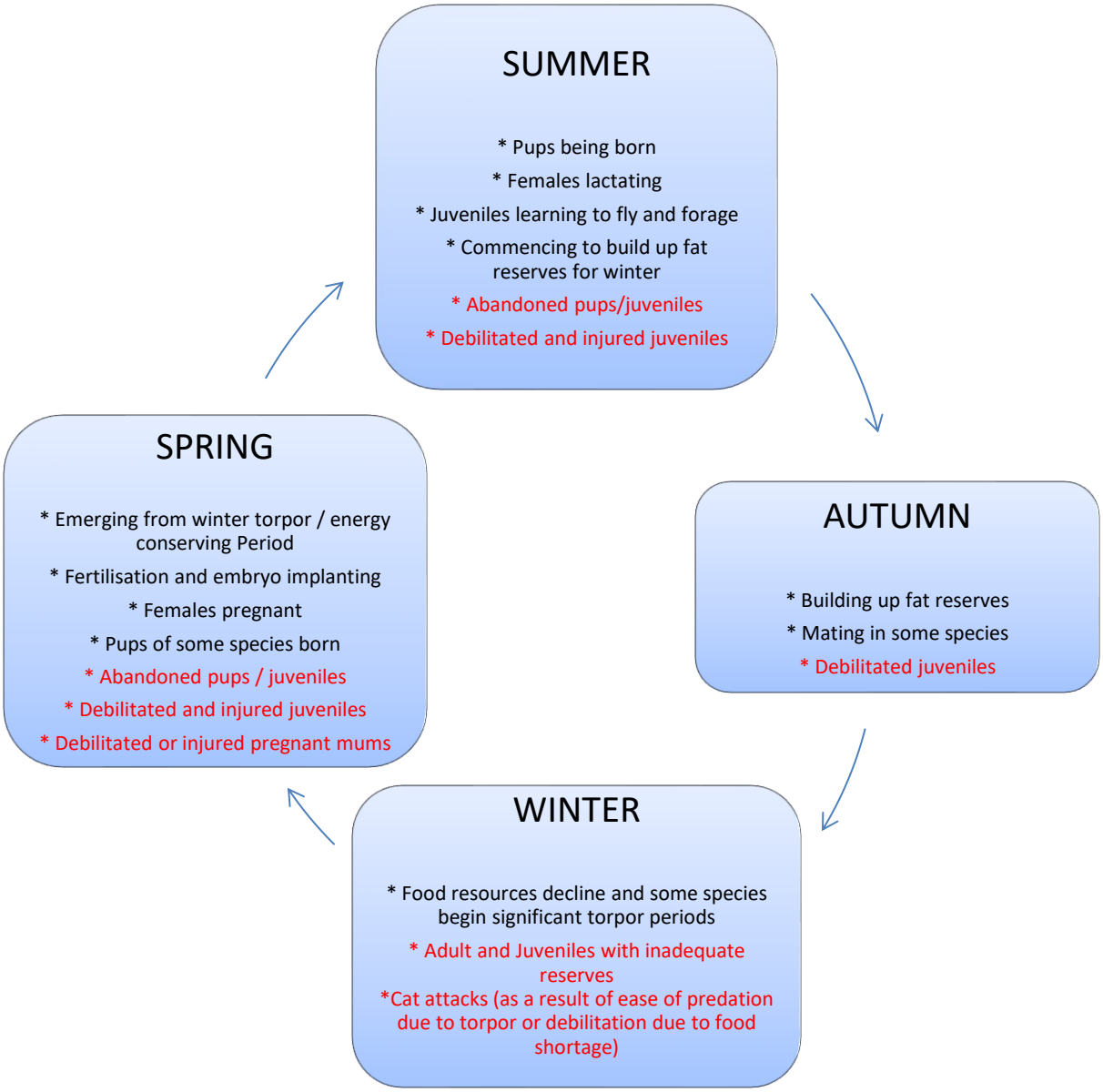
Appendix 7 identifies the known flight characteristics of SEQ microbat species and the corresponding flight aviary minimum dimensions where known.

Natural Diets

Microbat diets are hugely varied and are species and location specific.
Appendix 7 attempts to capture the known diets of the microbats of South East Queensland.

The Microbat Calendar

Understanding the seasonal patterns and activities of microbats is essential in microbat rehabilitation. Many significant decisions in rehabilitation relate to the time of year.



Human Safety

Like all species of animal, bats carry known and likely unknown zoonosis. Similarly, humans carry pathogens that could be transmitted to bats.

Appropriate steps to minimize cross species transmissions should be taken at all times. This includes using appropriate personal protective equipment such as gloves and masks.

Lyssavirus

Microbats, like their megabat cousins have the potential to injure and transmit diseases to humans.

In 1994 an outbreak of Hendra virus occurred in Queensland. As part of an attempt to identify a possible source of the virus, native fauna was tested. In May 1996 a black flying fox showing nervous signs was found at Ballina NSW. The animal was sent to Veterinary Laboratories in Brisbane and to the CSIRO in Geelong for testing under the Hendra virus program. Tests for Hendra virus were negative, as the animal showed signs of viral encephalitis; it was tested for rabies, as rabies is common in bats overseas. The result was positive. A virus was then isolated and gene sequenced showing that it was not in fact rabies, but another lyssavirus and a close relative of common rabies. There are 7 lyssavirus strains worldwide, which infect bats.

Microbats when feeling threatened will often bite. They have an impressive set of razor sharp teeth. Credit - Steve Parish

In Australia virus antigens has been found in megabats and one species of microbat. Other than the Yellow-Bellied Sheath-tailed Bat (*Saccolaimus flaviventris)*, no other microbat has tested positive to active Lyssavirus in Australia (S.H. Newman, 2011). However, several species of microbats and megabats have tested positive to the existence of lyssavirus antibodies throughout Australia, suggesting that exposure to Lyssavirus antigens has occurred previously (Hume, 2004). **The potential does exist for all species to be infected by Lyssavirus** and standard procedures for bat bite and scratches as stipulated below must be followed.

In 1996, 1998 and 2013 three people died from confirmed lyssavirus infection. One was from the bite of a Yellow-Bellied Sheath-tailed Bat and the other two were reported to be from flying foxes, one case having exposure two years previously. To date, there have been no other human cases of infection. In 2013 a horse contracted lyssavirus from an interaction with a Yellow-bellied Sheath-tailed Bat.

Rabies virus is usually transmitted to humans and other animals via bites or scratches, which provide direct access for the virus in saliva to exposed tissue and nerve-endings. Lyssavirus appears to spread the same way. Exposure to urine, faeces and blood are not considered a risk of exposure. Animal studies have suggested that disease caused by the lyssavirus could be prevented by rabies vaccine. It is assumed that the same protection applies to humans. Further research is continuing.

A C3 bat is the terminology given by Queensland Heath for a bat that has bitten or scratched someone in Queensland. If you are involved in a C3 bat rescue, the following procedures apply.

IF THE PERSON IS UNVACCINATED DO THE FOLLOWING: -

1) Advise the victim to wash the wound well with warm soapy water (approx. 5 minutes) and apply Betadine™® or alcohol.
2) Advise your Bat Coordinator immediately. The coordinator will from this point liaise with the Health Department who in turn will liaise with the victim and will coordinate the GP visits if considered necessary.

3) Pick up the bat and deliver it to the coordinator or to a wildlife hospital conversant with C3 protocols (e.g. Australia Zoo Wildlife Hospital, Currumbin Wildlife Sanctuary, and RSPCA).

IF THE PERSON IS VACCINATED (i.e. You) and you have been BITTEN DO THE FOLLOWING: -

1) Washing the wound well with warm soapy water (approx. 5 minutes) and apply Betadine™® or alcohol.
4) Contact your coordinator and arrange the hand-over of the bat for euthanasia and subsequent testing. This may be undertaken by the coordinator or a wildlife hospital conversant with C3 bat protocols (e.g. Australia Zoo Wildlife Hospital, Currumbin Wildlife Sanctuary, RSPCA).
2) The coordinator will advise Qld Health who will in turn contact you to coordinate attendance at a GP if necessary.
3) Contact either the President or Vice President of Wildcare and advise.

Bats involved in C3 incidents are euthanased and sent to Queensland Health for testing.

People at occupational risk that work with microbats should receive a pre-exposure course of rabies vaccine and have their serum antibody titres checked annually.

Hendra Virus

Microbats like their cousins the flying foxes, may also be potential reservoirs of Hendra virus, although no studies have been undertaken to confirm this to date in Australia. The possibility of microbats to be reservoirs for Hendra Virus is supported by microbats in other parts of the world testing positive for viruses closely related to Hendra Virus, within the Henipavirus family.

Histoplasmosis

Histoplasmosis is an infectious disease caused by inhalation of spores of the fungus *Histoplasma capsulatum* which is found worldwide. The fungus is found in soils, particularly those with high levels of bat excrement in densely populated caves. The disease is rare in Australia due to the low numbers of caves with the fungus in existence. The risk of the disease in captivity is even lower due to routine cleaning and absence of fungus buildup (Jackson, 2007).

The largest and possibly most distinctive microbat in SEQ, the sloth-like Yellow-bellied Sheath-tailed Bat *(Saccolaimus flaviventris*). Credit - Rachel Lyons

Microbat Identifying Features

Four main obvious features of microbats in SEQ help us identify the family group of a bat, these are:

- The existence of a ‘freetail’; or
- The existence of an ‘sheath’ tail; or
- The existence of a ‘enclosed’ tail; and,
- The existence of a horseshoe-shaped nose structure.

Free-tailed - membrane ends halfway along tail bone. Credit - Rachel Lyons

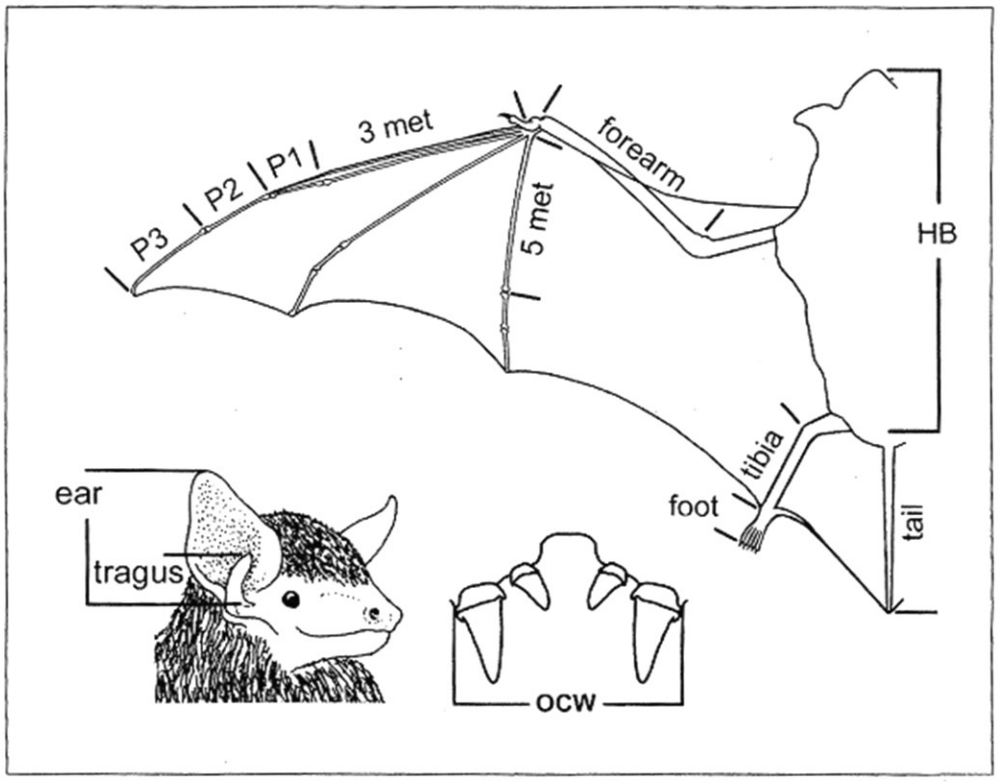
Enclosed Tail - the membrane completely enclosed the tail bone. Credit - Rachel Lyons

Sheath-tail - the tail bone protrudes from within the membrane. Credit - Rachel Lyons

Horseshoe shaped nose leaf. Credit - Steve Parish

However, in order to identify microbats past the broad family classes accurately, there are several other key identification features that are necessary to recognize and understand. These basic features include:

- Weight
- Forearm Length
- Ear (length – notch to tip)
- Tragus (length)
- Skull (greatest length of skull)
- Outer Canine Width
- Tibia length (lower leg length)
- The nose shape and features
- Tail and tail membrane shape and length



Wt—weight in grams (g)
All measurements below are in **millimetres**.
Fa—forearm length
Ear—length of ear from notch to tip
Trag—length of tragus in ear
Foot—hind foot length; from heel to toe tips, excluding claws
Tibia—tibia or lower leg length
5 met—length of metacarpal of fifth digit of wing
3 met—length of metacarpal in third digit of wing
P1—length of first phalanx of the third digit in the wing
P2—length of second phalanx of the third digit in the wing
P3—length of third phalanx of the third digit in the wing
Tail—tail length; from tail tip to anus
HB—head and body length; from nose tip to anus
WS—wingspan; from wingtip to wingtip
Head—head length; from junction with neck to nose tip
Skull—greatest length of the skull
OCW—outer canine width; the distance between the outer edge of the upper canines at the gum line
HS—horseshoe width
Sella—sella width

Measurements Used for Bat Identification and ID Key use. Credit - (Churchill, 2008)

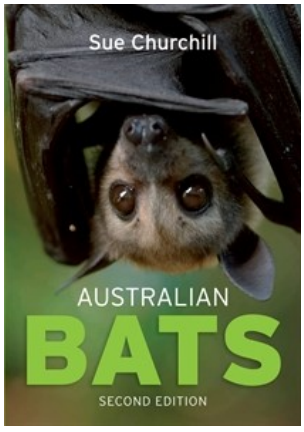
Equipment for Identification

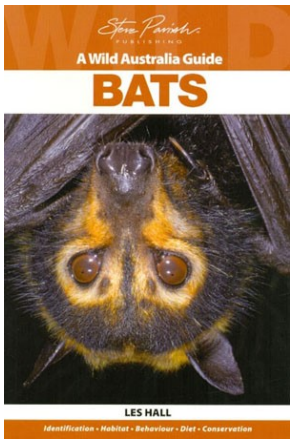
- **Jewelry Scales** – As microbats are small animals, small increment digital scales are required. Jewelry scales can be purchased relatively cheaply and usually measure to 0.01g. Make sure that the scales still measure to at least 100g however which will be useful for other purposes.

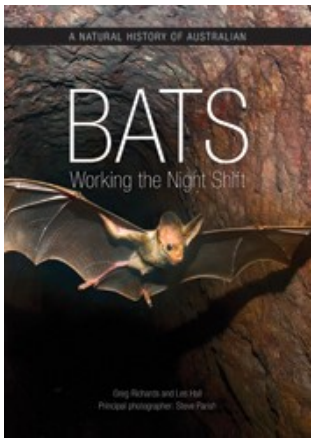
- **Vernier Calipers** – Calipers enable the more accurate measurement of body and body feature lengths. They are available in large or small size, small sizes being easier to use for microbats. Vernier calipers are also available with digital readings.

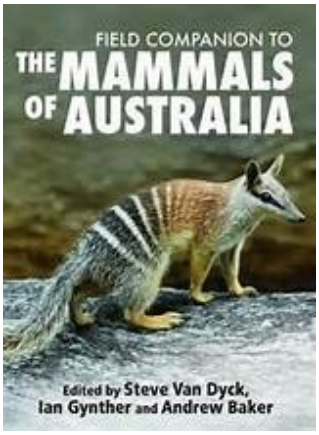
- **Microscope Head Lamp** – Some features require microscopic visual assistance, particularly if a rehabilitators vision is somewhat impaired.

- **Field Identification Guides** – Several good field identification guides are available. These have been listed in Appendix 1 of this workbook. Please be mindful that scientific names for microbats change regularly and consequently there are inconsistencies between all guides. The authors of this workshop guide have attempted to scientifically describe the species in SEQ as accurately as possible in the Species Information Charts in Appendix 7.





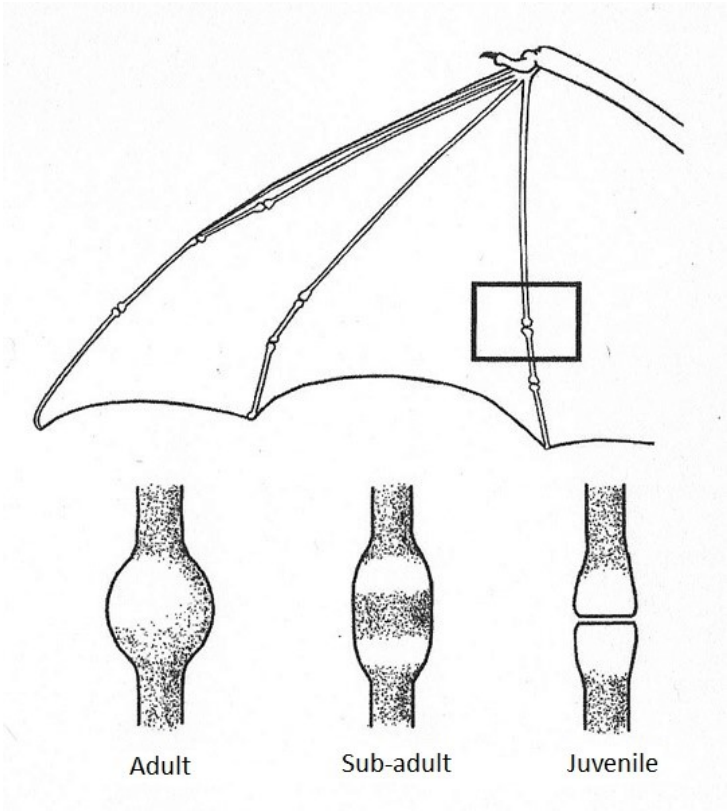




Juvenile Identification

Juvenile bats achieve near adult size and weight relatively quickly and are often difficult to identify using any of the above features. Many juveniles are still unable to fly and may still require milk feeds. The only way to identify a juvenile is to ascertain the existence of cartilaginous bands on the joints between the metacarpals and phalanges.

Very young microbats will have large bands/ gaps that appear white in colour when a light source is shone from behind the wing. Juveniles will have two white bands until several months old in most species, and adults do not have the bands as the cartilaginous gap is not obvious to the naked eye.



Visibility of cartilaginous joints, when held against a light source, provides indication of microbat age. Credit - Adapted from - (Churchill, 2008)

A juvenile Large Footed Myotis (*Myotis macropus)* in care - fully furred pups can often only be distinguished from adults by the existence of obvious cartilaginous joints. Credit - Steve Parish.

ABOVE – The cartilaginous metacarpal / phalange joint of a juvenile microbat – note the opaque colour differentiation compared to the bones above and below it in addition to the joint being thickened (photo over-exposed to illustrate). BELOW – the same joint in an adult microbat - note no colour differentiation at the joint and a much thinner joint. Holding a bats wing up against a light easily helps to determine if a bat is a juvenile or adult. Credit: Rachel Lyons.

Rescue Guidelines

Preserve Life - Prevent injury, this includes the rescuers, bystanders and LASTLY the microbat.

Safety First –Under no circumstances is an un-vaccinated rehabilitator or member of the public asked to assist in the rescue or handling of bats.

Maintain Life – Diagnosis and assessment of the animal must be carried out quickly.

BEFORE ATTENDING A RESCUE
Contact the member of the public who reported the microbat and explain why they must not touch the bat.

HOW BIG IS THE BAT?
Many callers mistakenly misidentify baby flying foxes and microbats, ask them if it is around the size of a matchbox.

WHERE IS THE ANIMAL?

- If it is on the ground ask the caller to place a container over the bat remembering to caution the caller about touching the bat.
- Where exactly is the animal?
- How long has it been there?
- Will you need a ladder?
- Will someone be home?

Reasons for Rescue

Microbats come into care for various reasons: -

- Flight injuries e.g. fractures, torn wing membrane, head trauma
- Cat/dog attack
- Ceiling fan collisions
- Trapped in buildings
- Dehydration
- Malnutrition
- Trapped in swimming pools, sinks and buckets/containers filled with water
- Habitat/roost disturbance and destruction – tree lopping, house renovations, shade umbrellas, coats/boots etc.
- Caught in netting or barbed wire
- Caught in sticky fly paper traps and spider webs
- Road trauma
- Burns e.g. hot road, b.b.q. plates, electrical boxes, lights
- Old age

NB – Each year we receive numerous calls for assistance from building owners wishing to remove bats from structures. Relocations are not the duty of a wildlife rehabilitator as we typically do not have the necessary permits to undertake such work. Relocation requests should be referred to your coordinator who will in turn refer the matter to the relevant State Government Agency or to appropriately trained and permitted experts. The relocation of microbats is an extremely complex task as different species require different treatments (i.e. nestbox relocations typically do not work) and relocations can prove disastrous if undertaken at certain times of the year.

Rescue Equipment

- PPE e.g. gloves (e.g. Lynn River Showa 370's), long sleeved shirt.
- Cotton pillow case, small pouches with ties or elastic bands to secure.
- Cardboard box or small container with lid and air holes.
- Butterfly net with extension handle to reach up high.
- Ladder.
- Torch / Headlamp.
- Scissors.
- Bolt cutters / wire cutters and pliers.
- Cotton square cloth or washer.
- Heat source.
- Basic first aid kit - animal and human.

Common Rescue Techniques

When you first arrive, take time to assess the situation. The information gleaned during this time will assist you in making a speedy and efficient rescue and will make a big difference to the bats welfare, survival and ultimate release.

A grounded bat unable to fly. A pouch or material piece can be gently placed over the bat to pick it up. Credit - Trish Wimberley.

GROUNDED BAT

Microbats may be grounded for a variety of reasons, including but not limited to: being disturbed in its roost while in a state of torpor; domestic animal attack; flight injuries/ collisions; and emaciation from malnutrition. The safest way to pick up a microbat in this state is to place an inside-out pouch over your hand, pick up the bat, then careful pull the pouch back over your hand and tie the pouch closed, ensuring that the bat is well clear. If they are still semi-mobile, a towel or small sheet may be needed to throw over the bat to contain it.

TRAPPED IN A BUILDING

If the bat is not within arm's reach, a butterfly net with padded edges can be used if the microbat is sitting quietly on a wall or ceiling. Carefully place the net over the bat and you can either then slip a piece of paper between the surface and the net and encourage the bat further into the net or directly contain the bat from behind with your hand through the net. If the bat is flying and there are no windows or doors to the outside that can be left open to encourage it to fly out (provided it is not injured), then the bat will have to be caught. The best and safest approach is to wait for it to land and use the above procedure. Microbats can be injured when attempting to catch them using a net, so caution is warranted.

TRAPPED IN SWIMMING POOL/SINK/CONTAINER

Microbats, like flying foxes, usually drink on the wing but occasionally will crawl into a sink if trapped in a building to get to water. Sometimes they may collide with an object and fall into a pool or container and although they are good swimmers, they are unable to climb out if the sides are steep and slippery. They soon tire and either drown or if lucky take respite on a floating object. A pool scoop can be used to capture the bat in this instance.

Place bat face down in box with head lower than the feet in a draining position. Also make sure you identify hypothermia, fluid in lungs or injury and seek immediate veterinary attention.

TRAPPED IN SPIDER WEB

From time to time bats will try to catch moths or other insects caught in a spider web and in turn get trapped themselves. The larger microbats don't seem to have a problem but the smaller microbats can easily get caught. Hold the bat firmly and gently pull away the spider web. If the bat has been entrapped for a length of time it may be dehydrated. The bat should not be released until the dehydration is corrected.

BARB WIRE

Barb wire rescues are not common with microbats but can occur when a bat is caught chasing its prey through the wire or when it is being pursued by a predator. Removing these tiny animals takes patience. Carefully wrap the bat in a cloth to stop it from further injuring itself. You will need a pair of pliers to carefully unwind the barb and remove the membrane, a small spray bottle of very weak Betadine® solution will help to hydrate and loosen the membrane and start the disinfecting process. It is far better to use this method as opposed to cutting the wire as one would do with a flying fox rescue as one has a greater leverage with the wire taunt.

Step 1
Wrap the bat in a cotton cloth to prevent further injury to itself. Cover all adjacent barbwire with folded towels to prevent further snagging of the bat and the rescuer, or nip the ends off the barbs.

Step 2
Begin with the least wrapped (caught) section of the wings. Spray the affected part with weak Betadine® solution which helps to re-hydrate the wind membrane and makes it soft and easier to slip off the barbs. Nip the points off all the barbs.

Step 3
Use pliers to open the winding of the barbs. You may have to nip through spirals to rotate and free the membrane.

Step 4
Ease the membrane off the barb, cover that section of wire and proceed to the next entanglement. Repeat Steps 1-3 on other parts of the wing, until the microbat is free.

Do not rush and do NOT cut the membrane or any other part of the animal, no matter how badly entangled.

If it is not possible to complete the disentangling on-site, the wire will have to be cut. Get permission where possible from the owner of the property before cutting the fence. **NOTE: A bridging wire and extreme caution must be taken if cutting a high tensile fence.**

If you are rescuing alone, cutting the fence is often the only option. You can then take the animal to a veterinarian, the coordinator or another vaccinated rehabilitator for assistance.

Do NOT release the animal as barbwire causes serious injuries and blood loss, not only to the wing membrane (due to constriction of blood supply), but also potentially to the mouth and gums. It can take up to two weeks for the full extent of the injury to become apparent.

TRAPPED IN STICKY FLY PAPER

A bat caught in sticky fly paper is a serious situation. If the bat is still alive the prognosis is not very good as most sticky papers have toxins which the bat would have ingested while trying to extricate itself. Further, the bat is likely to be suffering myopathy, friction burns and hypoglycaemia from being stuck and attempting to free itself. Being caught in sticky paper causes extreme stress for microbats, and often structural injuries caused from thrashing.

The microbat will need to be anaesthetized as soon as possible in order to be properly cleaned and further ingestion of adhesive prohibited. DISOLVIT® is a product commonly used to remove adhesive and residue. Thorough rinsing of the product from the bat is essential to avoid further complications. Fluid therapy, inclusive of intensive glucose provision is necessary. The survival rate of microbats caught in sticky fly paper is poor.

BURNS / ELECTROCUTION

This occurs when bats take up residence in power/meter boxes, light fittings etc. In this scenario a qualified electrician will be needed to turn off all power supply to the site before any bats can be rescued.

If the bat has survived and if more than one bat, each will have to be carefully assessed for any burn injuries and possible dehydration.

Large Scale Events

Regularly we see large numbers of bats from the same roost enter care at the same time due to both human induced and natural roost disturbance or destruction. Unfavorable environmental conditions such as heat events have also resulted in large numbers of bats simultaneously entering into care. Particularly concerning is where maternity colonies are involved.

Inspecting and sealing roosting logs during a roost destruction event in Hervey Bay 2016. Credit - Angela Bell.

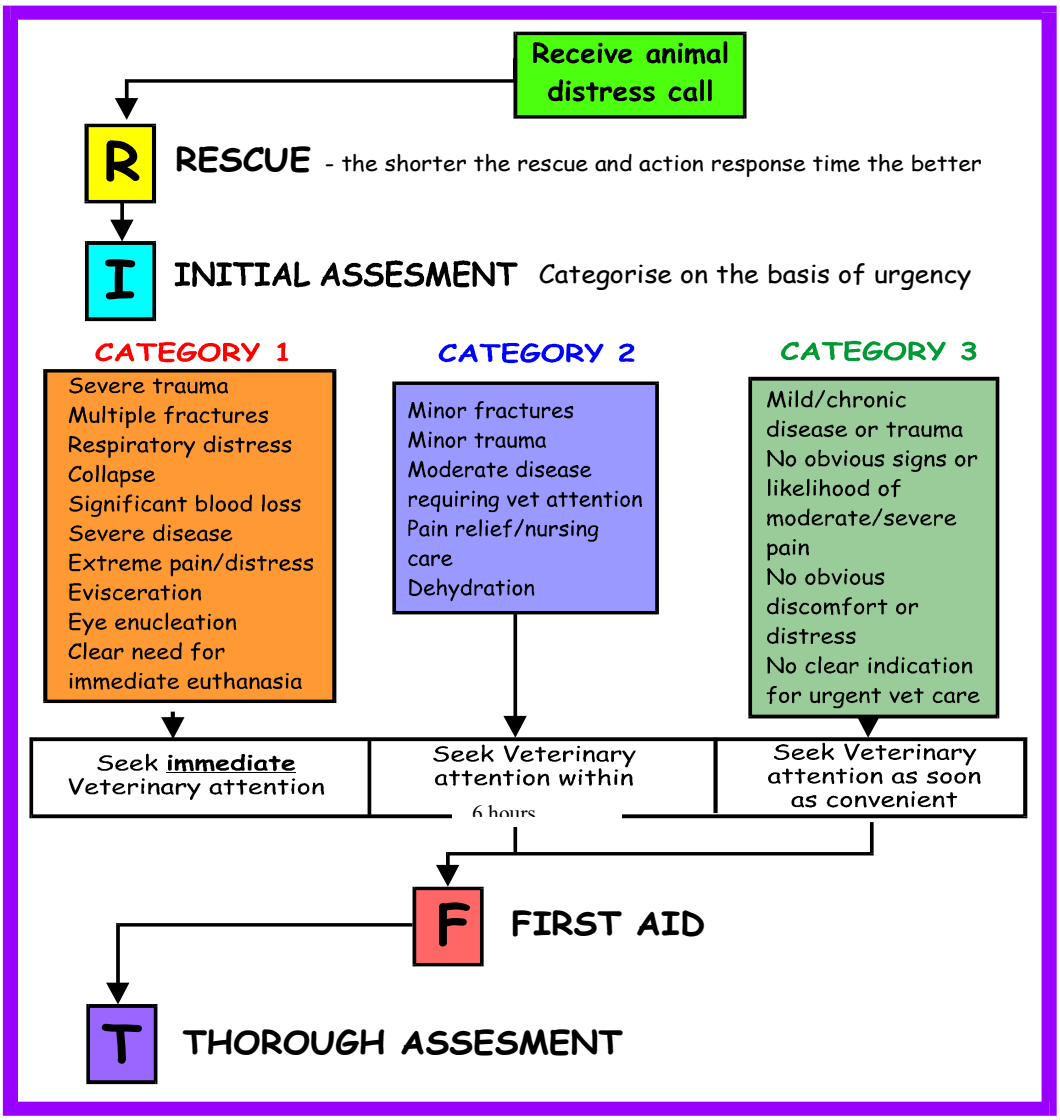
To follow is a series of steps recommended to be taken in such events:

1) Enlist the help of other bat carers to assist at the rescue site
2) Endeavour to keep bats together in a group during caging and transport to reduce stress
3) Triage and assess all bats for injuries, preferably with veterinary assistance
4) House all bats during rehabilitation together to ensure mothers and pups have access to each other and to reduce social stress.
5) Monitor the condition, health and feeding of pups in the group in particular – even if you know which mother and which pup belong to each other, the stress of captivity can be enough to diminish milk supplies in lactating mother bats. Supplementation may be required.
6) Where pups exist and are not able to fly themselves, the roost needs to be kept in care until pups are able to fly and are somewhat independent. Pup abandonments are common where attempts have been made to release a colony with flightless pups even when they are released at the original site.
7) Attempt where possible to retro-fit fallen roost logs and reinstall them with the bats back on the site they originated from, or to replicate as best as possible the roost structure in the event where the roost is completely destroyed.
8) Monitor all reinstatement of roosts daily for several days.

Initial On-site Examination

An examination on site is needed to determine if there are any obvious serious injuries that require immediate veterinary attention as per Category 1 on the R.I.F.T Flow Chart.

These animals will be in extreme pain and distress and should be treated as a veterinary emergency. Assistance should be sought ideally within the hour.



Many veterinarians are reluctant to handle any bats, as many veterinarians and their staff are not vaccinated, and with work place health and safety considerations, the refusal is understandable.

If you are unable to obtain veterinary assistance for badly injured animals, call your Bat Coordinator. Wildcare have experienced and vaccinated rehabilitators who are licensed and trained to administer veterinary anesthetic and euthanasia drugs.

Initial Stabilisation

Initial stabilisation needs to commence ON SITE or shortly thereafter. This needs to be done on all bats, even those that will be euthanased.

1. Commence temperature stabilization - If the bat is cold, commence warming it. If the bat is overheated, commence cooling it.
2. Immobilise fractures by gently wrapping bat.
3. Cover simple wounds and stop any bleeding.
4. Fluid replacement – Administer subcutaneous fluid injection including glucose fluids (once temperature has stabilized – refer to page 58 for method) or offer syringe of water/glucose, however most microbats will not accept sufficient oral fluids or they may be too dehydrated for oral fluids to be effective. Note - **If a bat is going to need immediate veterinary treatment and anesthesia, don't give oral fluids.**
5. Keep animal warm, quiet and feeling secure by placing in a pouch tied off at the end and then placed in a padded container.

Bats due to their high metabolic rate when alert and stressed can very quickly and easily become hypoglycemic, and if left untreated can become hyperglycemic due to the Somogyi effect (Personal Communications – T. Bishop, 2017). Blood glucose levels can continue to fluctuate without intervention, eventually leading to death.

All incoming bats should receive glucose as a component of initial fluid rehydration procedures (Per Coms Bishop 2017). Glucose should be provided over a number of days, particularly for bats that were admitted with moderate to severe dehydration, emaciation or those that have infection (Personal Communications – T. Bishop 2017). Stressy species of bat, including but not limited to Large Footed Myotis, Little Forest, Little Bent-wing and Long-eared Bats should also be provided with additional glucose through at least the first 72 hours. Please refer to the fluid therapy section of this manual (pg 58) as extreme care needs to be had when providing glucose.

Thorough Assessment

A thorough examination is an essential step that should occur shortly after rescue. Most diagnoses are missed by *not looking* rather than *not knowing*.

NOTE: Undertaking a thorough examination on an un-sedated bat should never be taken lightly. If you are bitten then the bat becomes a C3 and the battle to save the animal is lost in the first round. If you choose not to undertake the thorough examination, or are unable to obtain veterinary assistance, contact your coordinator as soon as possible.

The ideal way to carry out a thorough assessment is to sedate the bat. If you have a good working relationship with your local veterinarian, they may be willing to assist with the bat provided you handle and control it.

For sedation, masking down with Isoflurane anesthetic gas is the most desirable method. Alternately Pamlin® (Diazepam) at a dose rate as per Appendix 5 can also be successful.

Many microbats can be quite tolerant when it comes to being handled. To keep bat calm, make slow deliberate movements as fast movements can be interpreted as a threat. Keeping the microbats feet secure as well as a holding it in a half enclosed hand will usually assist handling.

PROCEDURE

Lay the bat on a flat padded surface or in the palm of your gloved hand making sure the feet have something to hold onto then place a cloth over the bat.

Where assessments cannot be undertaken under anaesthesia, gloves and a thick cloth must be used to prevent the handler from being bitten and the bat becoming a C3 animal. Credit - Rachel Lyons.

A thorough examination consists of the following procedure: -

HEAD

- Uncover the head, gently feel over the head from the base of the skull to the snout, look for wounds, possible fractures, tender spots, swelling, note position of head carriage.
- Check facial symmetry, check around eyes and jaw look for wounds, fractures, tender spots and swelling.
- Check outside and inside ears for wounds and bleeding, check for fluid in ears, check for maggots.
- Check for fluids coming from eyes or nose, check eyes for injuries it is a little hard to check pupil dilation and contraction on a microbats tiny eyes. Does the bat look dazed or bright and alert?
- Check mouth for injuries, check for jaw fractures, check colour of mucous membrane using a cotton bud to lift up the lips of the bat.
- Check for infection of the facial gland located between the snout and the eyes on both sides of the face.

WINGS

- Unwrap one wing and extend. Check for broken bones, bruising, burns, (dry areas) holes, tears, swelling, fungal infections and other injuries. (Burns and bruising can take 48 hours to show up.) Holding the wing up to a strong light can make it easier to spot burns, bruises and breaks. Check the thumb.
- Check for maggots if open wounds are present.
- Check that the bat retracts the fully extended wing to a normal position.
- Replace cloth and examine other wing.

Bruising seen clearly on the membrane of a bat. Credit : Amanda Lollar.

LEGS

- Examine legs and toes front and back, look for breaks, burns, swelling and other injuries. Check tail membranes. Check knee and hip for movement.

BACK & FRONT OF BODY

- Examine the whole back of the animal. Look for injuries, missing fur, swelling. Gently palpate ribs, watch for signs of pain. Check movement of shoulders.

- Check the front torso, again looking for injuries, broken ribs, swelling. Note the breathing. Is it normal, laboured, hesitant, is it noisy? Use stethoscope to check lungs, if available. Examine genitals/ear /wing pits.
- Check for maggots / eggs in the bats fur.

If the animal appears to be paralysed or has poor control of limbs check for ticks. These are usually found around the head and neck or in the ears.

If you find something wrong, continue with the complete examination. You may miss something else if you do not.

Measure the right forearm, check for cartilaginous joints and weigh the bat. (This is you can determine if the animal is an adult or juvenile in addition to recording statistics)

If there are no obvious injuries, or disease, return the bat to a cage and leave it to settle for a while, then check the following. This will probably be done over a period of time. Try and observe the bat without being seen.

1. Position of the wings. Do they sit normally? Is it reluctant to use one wing or thumb?
2. Position of the head. Is it held at an angle?
3. Offer the animal some mealworm viscera. Is it reluctant to lick or chew?

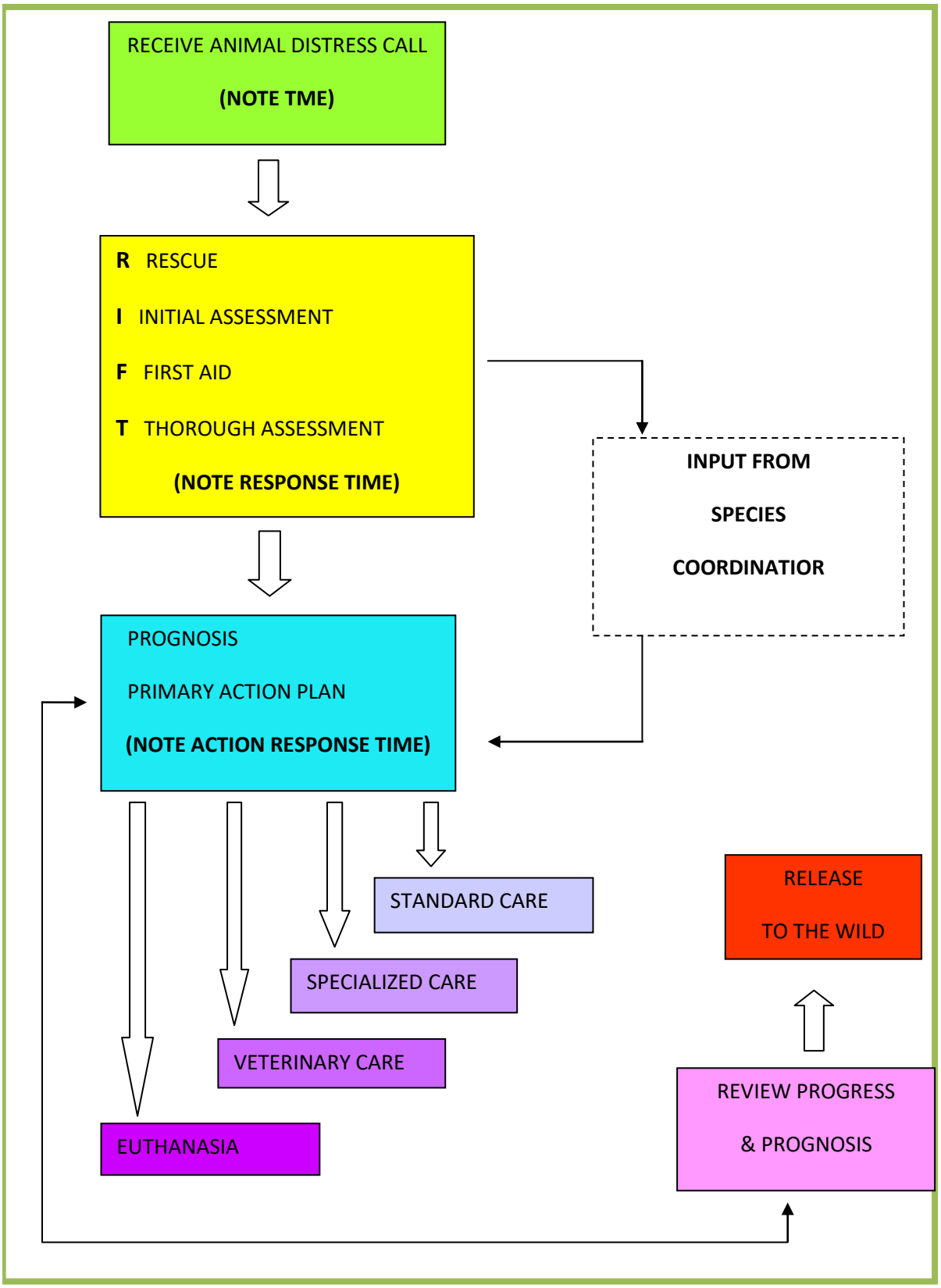
It is important to continue to monitor the bat. Some injuries may not be apparent immediately and sometimes other conditions change and only become apparent after a period of time in care. E.g. burns to the mouth may only show when the bat is reluctant to eat. Die back from compromised blood flow in the membranes develops over several days.

In order to assist rehabilitators conduct a thorough examination, a bat examination form has been designed. Fill out the form and take it with you when you visit the veterinarian. (see Appendix 6).

The following flowchart covers from the rescue through R.I.F.T to P & P (Prognosis and Primary Action Plan - which will be covered in the following pages) to an outcome. Following this plan will ensure the best possible outcome for all bats.

The correct way to handle microbats so to minimise the risk of bites - using gloves and a cloth. Credit - Rachel Lyons.

WILDLIFE RESCUE & OUTCOME FLOW CHART



Contacting the Coordinator

If you are inexperienced in the assessment and identification of injuries outlined in this manual, contact your bat Coordinator as soon as possible. Provided you have the first aid equipment, your Coordinator will be able to "walk-you-through" some of the procedures. When you phone, your Coordinator is going to want to know the following: -

- Species;
- Weight and Fore Arm Measurement;
- Reason the animal was rescued and the situation it was in; and,
- The result of your assessment.

Your coordinator will be able to advise further action required with this information, including pain management, assistance with veterinary consultations and animal placement.

Rehabilitators are reminded that all bats are to be reported to your Coordinator.

HANDY HINT: If you have a digital camera you can email pictures to your coordinator to help with identification and assessment.

Veterinary Consultation

The relationship that you establish with your veterinarian is vital in rehabilitating bats. Contact them and establish in advance if they are willing to treat bats. Do not wait until you have a sick or injured animal before trying to find a veterinarian. Very few veterinarians have experience and knowledge in treating microbats. Contact your coordinator to be advised of known veterinarians that will treat microbats in your area.

It should be remembered that in general veterinarians receive little training in the treatment of wildlife. In addition, handling of bats, particularly by unvaccinated persons is a Work Place Health and Safety Issue. Several hospital facilities have additional work-place health and safety requirements that do not permit vaccinated rehabilitators to handle bats within the facility, only trained and vaccinated staff. Rehabilitators should abide by any WPHS procedure set down by the facility.

Some recommendations for facilitating a successful veterinary consultation:

- Make an appointment, advise that it is a bat and explain what you think is wrong.
- Be patient, understanding and respectful especially on busy days.
- Take the assessment form with you. The veterinarian wants a clear and concise history and description of the problem.
- Have accurate weight so that correct drug rates can be calculated.
- Take this manual with you or offer to contact the Coordinator by phone if the veterinarian is uncertain if treatment is possible or which drug is best.
- Take any samples that may be required. Put in clean labelled containers.
- Take any previous records. E.g. x-rays, previous drug history.
- DO NOT give oral fluids to an animal that is going to undergo a general anaesthetic.
- Give feedback on how the treatment is going and on the final outcome.
- Showering your veterinarian with cake and Chrissie presents will accrue "brownie points"

Remember your veterinarian is running a business; this is how he or she earns a living, pays the mortgage and puts food on the table for their family, so try not to stretch a friendship. Always offer to pay, even if no fee is charged.

Prognosis

After following the steps in the flow charts, a thorough assessment, veterinary attention and consultation with your Bat Coordinator, a prognosis as to the likelihood of the animal making a full recovery for return to the wild can be made.

The failure to make a thorough assessment means that a prognosis cannot be established.

REMEMBER*: - without a prognosis there can be no outcome.*

The Role of Euthanasia

Euthanasia is one of the most common veterinary procedures performed on wildlife. This is particularly true when dealing with trauma. Bat rehabilitators have a great love of these animals and all too often their focus is on saving lives, sometimes at any cost, and they overlook due consideration of pain and suffering. It is important to remember that euthanasia is not a sign of failure as it is an act based on ethics and compassion.

We need to recognize the following facts:
1. We cannot cure every illness in bats;
2. We cannot save every injured animal's life;
3. We cannot provide all the resources and facilities to care for sick and injured animals; and
4. We do not have the resources nor permission to house every non-releasable animal to a standard that ensures good quality of life.

Some questions one needs to ask one's self when confronted with an animal that may need to be euthanased are:

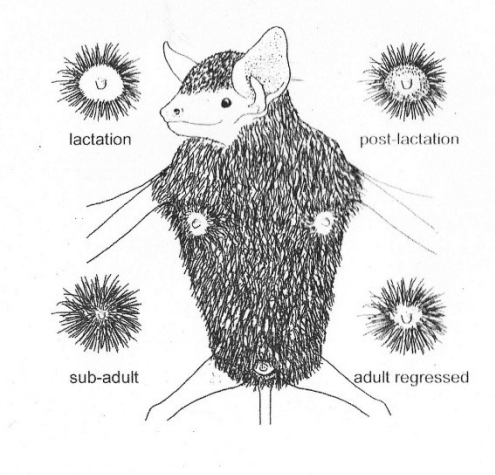
- What level of pain and suffering is this animal likely to continue to experience during its recovery?
- Is there a quality of life in the future for this animal?
- Is treatment of this animal humane? What is ethically and morally right?
- Will the microbat be able to perform all of its necessary hunting and socializing skills to ensure it will survive in the wild?

Notes on Lactating and Pregnant Females

During breeding season, any female coming into care needs to be checked to see if she is lactating. If she is, this can bring on a very painful dilemma.

If the female is in care any length of time, the pup left in the roost, will die. On the other hand, if the female is released prematurely, there is a chance that both may die. This can be a hard choice.

The life of the adult breeding female (your patient), in such cases, is placed above the life of an infant. If euthanasia is required there is nothing you can do about the situation as heartbreaking as it is. However, if the disease or injury is treatable, with proper care and rehabilitation the female bat should be able to be returned to the wild to breed again.



Microbat teat presentations to aid in lactation analysis. Credit - (Churchill, 2008)

Rehabilitators need to be aware that most female micro bats coming into care from August onward are likely to be pregnant.

During the mid to late stage of pregnancy, the developing young can be felt in the lower abdomen. Depending on the severity of trauma/disease, consideration may be given to retaining the animal in care, until they have given birth - but only after discussion with your coordinator and consulting veterinarian.

Housing of pregnant females and those with young is considered specialised care due to the social and dietary needs of pregnant and lactating mothers. If you believe you have a pregnant female or have a female with young, contact your coordinator for further assistance.

Newborn Goulds Long-eared pup. Microbat pups born to mothers in care must be checked at least twice daily to ensure that they are receiving milk (viewable through abdomen) and that the mother has not rejected or attacked them. The 'Long eared' bats usually give birth to twins but often reject and /or injure one pup. Credit – Rachel Lyons

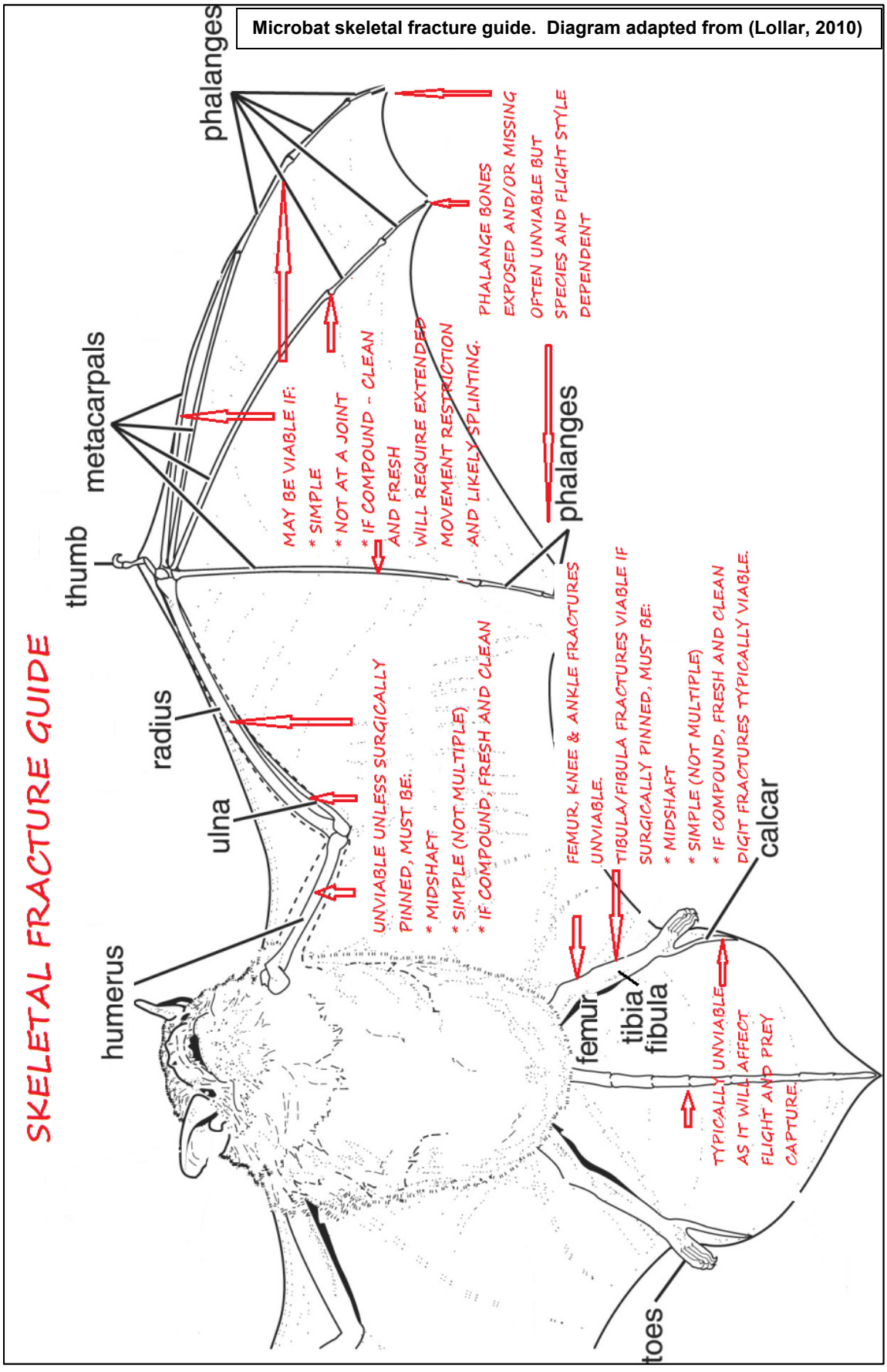
A full-term pregnant Hoary Wattle Bat (*Chalinolobus nigrogriseus*) on the LEFT and the same bat with day old twins on the RIGHT. Credit: Rachel Lyons

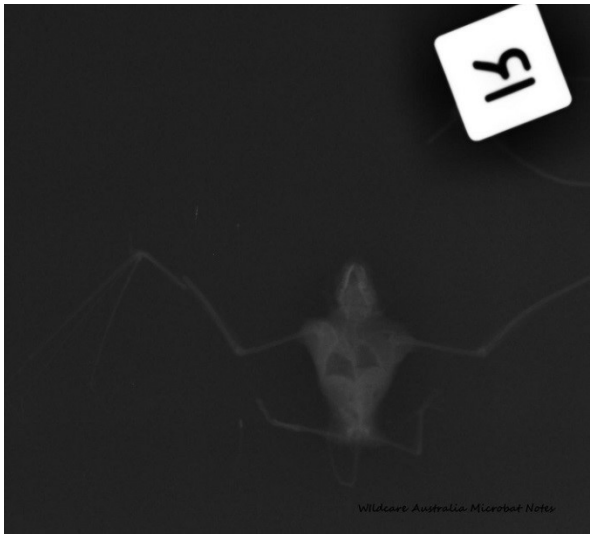
Primary Clinical Reasons for Microbat Admittance into Care

Ailment	**Hypoglycemia & Hyperglycemia**
Causes	Stress, shock, emaciation, all injuries
Clinical Signs	All incoming bats should be assumed to have blood glucose regulation problems
Treatment Plan	Bats due to their high metabolic rate can very quickly and easily become hypoglycemic and if left untreated can become hyperglycemic due to the Somogyi effect. Blood glucose levels can continue to fluctuate without intervention, eventually leading to death. All incoming bats should receive glucose as a component of initial fluid rehydration procedures (Refer Fluid Hydration section pg 58). Glucose should be provided over a number of days, particularly for bats that were admitted with moderate to severe dehydration, emaciation or those that have infection. Stressy species of bat, including but not limited to Large Footed Myotis, Little Forest, Little Bentwing and Long-eared Bats should also be provided with additional glucose through at least the first 72 hours. Extreme care needs to be taken when administering glucose therapy. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Guarded for compromised cases.

Ailment	**Poisoning**
Causes	Fly paper entrapment, organophosphate poisoning, emersion in chemicals
Clinical Signs	Sticky/oil substance on fur, convulsions, vomiting.
Treatment Plan	Veterinary treatment required urgently. Liquid charcoal can be given orally for ingestion but in such a tiny animal with a very fast metabolism, the damage is often done before the bat has been admitted for treatment. Refer to *Coverage in liquid and adhesive fluids* / oils Section on page 57.
Prognosis	Prognosis is very guarded as the damage from the poisoning can often occur before the treatment can be started.

Ailment	**Fractured Humerus, Radius/ Fused Ulna, Metacarpals, Phalanges, Femur, Fibula and Tibia.**
Causes	Ceiling fan strike, cat attack, entrapment, road trauma, human impact etc.
Clinical Signs	Exposed bone, drooping wing, dragging feet.
Treatment Plan	All fractures need to be assessed by a veterinarian or specialized bat trauma carer for prognosis. Each case will have to be assessed on an individual basis as each will have a unique set of circumstances. However s general ***Skeletal Fractures Guide*** is provided on the following page. The wound must be clean and less than 24hours old to have any reasonable chance of repair. Surgical Pinning is necessary for any fractures involving the humerus, radius or tibia. For metacarpal or phalange fractures tissue glue can be used to stabilize a fracture. Under anesthesia a veterinarian can glue the fracture to the adjacent humerus or radius bone as a splint. The glue will need to be replaced as it breaks down which can be anywhere between 2 days and 2 weeks. The fracture site must be stabilized for at least two weeks but requires a further eight weeks rest to completely heal. An appropriate analgesic would be required as prescribed by veterinarian, in addition to an antibiotic where infection risk exists. Appendix 5 provides appropriate medications and dose rates. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Experienced diagnosis is needed for a good outcome. Fractures close to a joint (shoulder, elbow, wrist and knee) or at the joint, and often those that are open (unless fresh and clean) will usually require euthanasia. Fractures to the femur, fibula and tibia typically require euthanasia as fracture stabilisation is often not achievable. Each bone in a microbats wing and their tail and leg is important for different flight manoeuvres and actions which correspond to particular foraging and flight styles. An understanding of the flight requirements for the particular species is necessary for an accurate prognosis.





Radiograph of compound fracture of left radius in a Little Broad-nosed Bat (*Scotorepens orion*) Credit: Dr Tania Bishop

Radius pinning procedure under anesthetic of a Little Broad-nosed Bat (*Scotorepens orion*) Credit: Trish Wimberley.

Radiograph of pinned left radius in a Little Broad-nosed Bat (*Scotorepens orion*) Credit: Dr Tania Bishop

Multiple (left and right) compound radius fractures in a deceased Gould's Wattled Bat (*Chalinolobus gouldi*) Credit: Sarah Elizabeth Curran

Ailment	Joint Swelling
Causes	Fracture, dislocation, bacterial infection, insect bite, burn, entanglement injuries, MBD (metabolic bone disorder)
Clinical Signs	Swollen joints, pain when joint is manipulated, heat, redness
Treatment Plan	Hospital cage rest and very regular observation after diagnosis made. Many bats can self-mutilate due to pain, particularly in the joints. Under veterinary prescription an Anti-inflammatory ie Metacam® or Traumeel® for swelling and Antirobe® (Clindamycin) or Clavulox® antibiotics for infection should be prescribed. Additionally, an appropriate analgesic is also recommended as joint swelling has resulted in self-mutilation in some species where anti-inflammatory medication provided was insufficient. Appendix 5 provides appropriate medications and dose rates. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Where not a fracture or MBD, good prognosis if medication regime followed. MBD has a poor long-term release prognosis and is an exceptionally painful condition

Ailment	Bruising
Causes	Fracture, dislocation, impact, entanglement/ entrapment injuries
Clinical Signs	Bleeding into tissue when light source placed behind membrane or dark purple/black skin tone on torso.
Treatment Plan	Bruising should be expected in all impact and entrapment cases. It is important that bruising is treated within the first 24 hours, regardless of whether it is visually obvious. Where bruising is occurring in a membrane, treatment is necessary to prevent further breakdown of the membrane. Analgesic and Anti-inflammatories should be administered via Veterinary prescription, in particular Metacam®. Traumeel® cream can be used sparingly on the bruise as a topical treatment provided there is no skin rupture. Aspirin is not recommended for use in bruising (or in microbats at all) due to risk of blood loss (including internal) from blood thinning in addition to the implications it may have on internal organs. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Guarded prognosis if bruising is left untreated, as it may result in breakdown of membrane requiring extending time in care or possible euthanasia due to loss of critical flight function.

Ailment	Body punctures
Causes	Cat attack, bird attack, fighting, barbed wire entrapment
Clinical Signs	Careful examination will find punctures, obvious wounds and tears
Treatment Plan	Any internal injuries created as a result of the puncture need to be identified by x-ray and thorough veterinary assessment under anaesthesia. All puncture wounds must be treated with an appropriate antibiotic. An appropriate analgesic would be required as prescribed by veterinarian, in addition to an antibiotic. Clyndamycin (Antirobe®) is sensitive to the bacteria found in a cats mouth and can be used in such cases. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Puncture wounds on such a small mammal will typically give a guarded prognosis.

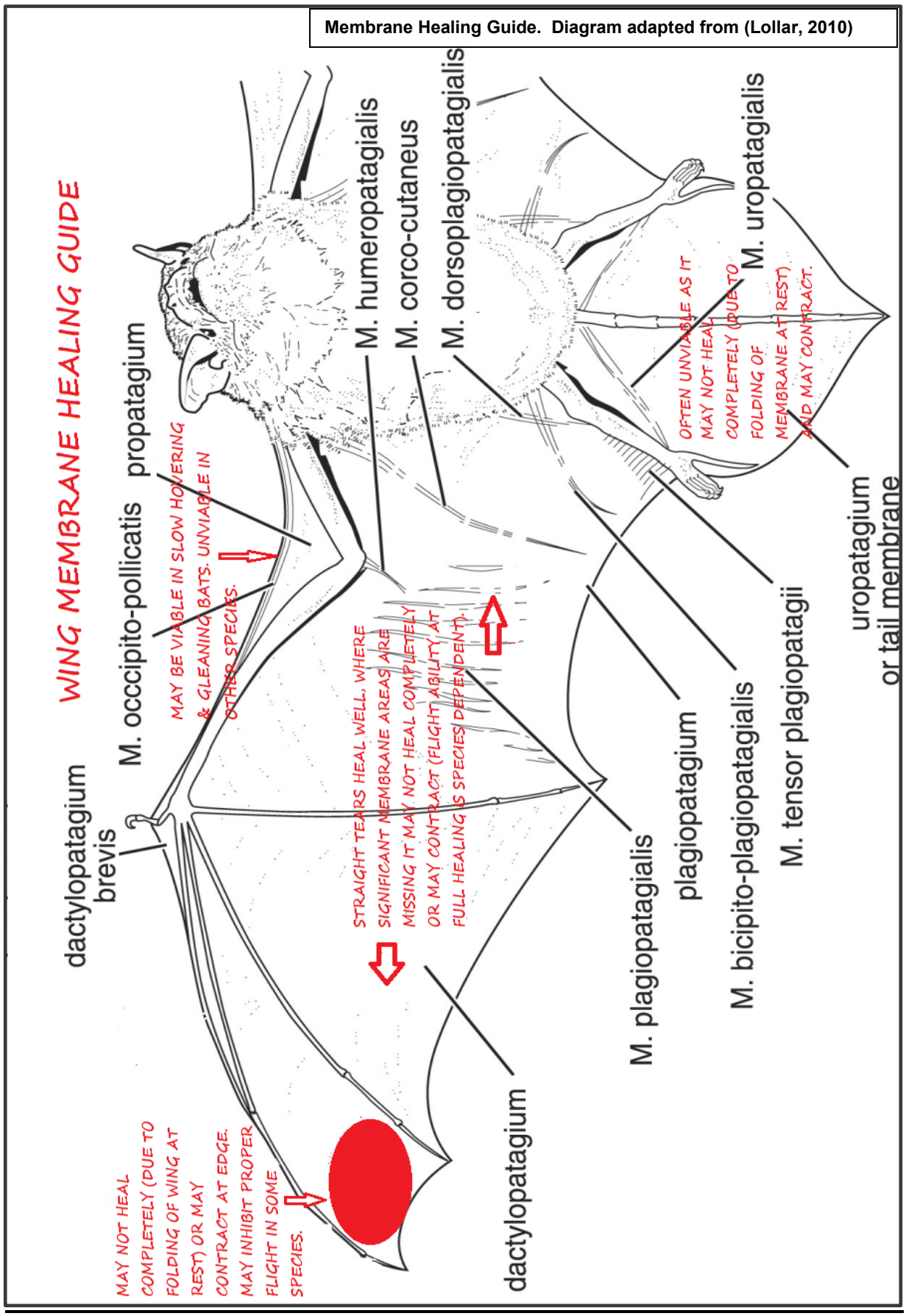
Ailment	Eye Injury
Causes	Dust Particles, bacterial infection, chemical irritants, general trauma
Clinical Signs	Discharge, eye glued shut, cloudy eyes
Treatment Plan	Irrigate the eye with sterile water initially. Then, under veterinary prescription, apply a triple antibiotic ophthalmic ointment which may need to be applied three times per day for up to 10 days. As eye injuries are painful, an analgesic should be provided under veterinary prescription. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Good prognosis if treatment followed as per veterinary advice. The loss of an eye or significant loss of function of an eye has a guarded prognosis. An assessment of the individual bats ability to fly and capture food in a flight aviary environment must be made prior to release.

Ailment	Membrane punctures/tears
Causes	Cat attack, bird attack, fighting, barbed wire entrapment
Clinical Signs	Holes and tears in wing membrane
Treatment Plan	The membrane of a micro bat should not be sutured as it can create further bruising and dieback. Swab wound with a weak solution of Betadine®, Chlorhexadine or saline solution. Tears from the leading or trailing edge often heal remarkably well. Refer to the following ‘Membrane Healing Guide’ Diagram for additional notes related to specific sections of the wing.

	Larger areas of membrane missing or torn may need additional management through the provision of regular massaging in of Emu Oil or Macadamia Oil (ensuring minimal residue left for bat consumption). Severe membrane damage may be addressed by the application of Flaminal Hydro Gel® with dressing under the direction of a veterinarian or coordinator. Dressing of wounds is more often than not unsuccessful. Attention to hydration, heating and the housing of a bat with membrane damage in a high humidity enclosure will aid in recovery. Bruising of the membrane may not be evident for the first 24 to 48 hrs – refer to the 'Bruising' section above. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Small tears and holes will heal without any intervention. Larger tears and holes do often repair remarkably well. Flight requirements of species will need to be considered for an accurate prognosis.

Plagiopatagium healing over 6 weeks on an Eastern Long-eared Bat (*Nyctophilus bifax*). The bat was housed for this duration within its thermonuetral zone and was not permitted to fly. The bat flew perfectly after full repair and was released after time in a flight aviary. Credit: Rachel Lyons

Membrane Healing Guide. Diagram adapted from (Lollar, 2010)



Repairing wing membrane of a Northern Broad-nosed Bat (*Scotorepens sanborni*) held up against a light, despite the considerable tear evident at rescue (to the point of the yellow star) 5 weeks earlier, the bat flew perfectly at this stage and was subsequently released. Credit: Rachel Lyons

A Gould's Long-eared Bat (*Nyctophilus gouldi*) with a severed Occipito-pollicatis muscle (contained within the membrane). This injury may be viable for clutter foragers but is not viable in fast or above-canopy flying microbats due to the reliance of this part of the wing membrane for stability in strong wind conditions. Credit: Rachel Lyons

Ailment	Dehydration
Causes	Loss of blood, loss of bodily fluids (including from skin), entrapment, shock, heat exhaustion, orphaning.
Clinical Signs	Dull sunken eyes, dry papery wing membranes, skin tenting, sunken abdomen
Treatment Plan	Refer Page 58 for information regarding Fluid Therapy. The microbat rehabilitator must be proficient in giving and calculating the volume of subcutaneous fluids to administer. Urine output would need to be monitored to ensure that there is no lasting damage caused to the kidneys, particularly given that microbats have naturally high urea levels. The bat will need to be warmed up or cooled if suffering shock and/or heat exhaustion prior to fluid administration. Emaciated and/or dehydrated bats will need initial bolus rehydration and ongoing hydration at 2 x maintenance volumes for at least 3 days and possibly beyond. This will assist to minimize the potential damage to the renal system. During this time, food should be offered several times per day after the initial hydration. Emaciated and dehydrated microbats will require extended care (> 3 weeks) to rebuild flight muscle, condition and fitness. Dehydrated bats can be prone to eye ulceration and as such, all dehydrated bats should have eyes lubricated regularly with a non-medicated eye lubrication gel formulation such as False Tears®. It is more than likely that emaciated bats are also suffering blood glucose issues – Refer Hypoglycemia & Hyperglycemia table above.
Prognosis	Prognosis determined by extent of dehydration and level of kidney damage. Needs to be placed with an experienced rehabilitator for moderate to severe cases.

Ailment	Emaciation
Causes	Entrapment, injury, disease, orphaning, torpor disturbance and poor season
Clinical Signs	Dull sunken eyes, skin tenting, papery dry wing membranes, sunken abdomen
Treatment Plan	Initially provide fluid therapy. Fluid balance needs to be stable before starting on small amount of blended food mix given several times per day. The feeds can gradually be increased in size and decreased in frequency over several days. Monitoring of fluid balance is critical. Emaciated and/or dehydrated bats will need initial bolus rehydration and ongoing hydration at 2 x maintenance volumes for at least 3 days and possibly beyond. This will assist to minimize the potential damage to the renal system. During this time, small amounts of food should be offered several times per day after the initial hydration. Emaciated and dehydrated microbats will require extended care (> 3 weeks) to rebuild flight muscle, condition and fitness. It is more than likely that emaciated bats are also suffering blood glucose issues – Refer Hypoglycemia & Hyperglycemia table above.

Prognosis	If corrected the bat may still lose its battle down the track due to internal organ damage caused by initial dehydration/malnutrition. Needs to be placed with an experienced rehabilitator.

Ailment	**Burns**
Causes	Chemical burns, Friction (abrasive cage materials), bushfire, house fires, BBQ's, electrocution (e.g. electrical box)
Clinical Signs	Blisters on wing membrane, painful inflamed skin, deep white lesions
Treatment Plan	Dehydration correction is of utmost concern. It must be corrected two-three times daily if not hourly initially for several days. Fluid balance must be carefully monitored for the duration of the burn injury recovery. Irrigate the burn with a weak Chlorhexadine or Betadine® solution and apply Flamazine® with a clean non-stick dressing on day 1 then Flaminal Hydro Gel® from day 2 onwards. Dressings must be changed daily (soak to ease pain of dressing removal). Pain is reduced markedly if the wound is kept covered at all times. Kitchen plastic food wrap can also be considered as a dressing material. Pain relief must be provided. For moderate to severe cases, Temgesic® can be prescribed and given by a veterinarian. Painstop® can be used for less severe cases and as directed by a veterinarian. Antibiotics may also be prescribed by a Veterinarian as the chance of infection is far greater than with other injuries. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage. Food provision must be increased and place microbat on the Blended Food Diet to ensure sufficient protein is ingested to aid healing.
Prognosis	All burns injuries are serious. Pneumonia is a high risk with burn injury so a guarded prognosis is given. The bat needs to be placed with a rehabilitator experienced in burns and wound management for a good prognosis.

Ailment	**Heat Stress / Heat Stroke (progression)**
Causes	High temperatures in the environment, incorrect temperature in care.
Clinical Signs	*Early signs* - Panting, hyper salivation, tachycardia, hyper-anaemic mucous membranes (dark red), hyperactivity. fanning (to cool), seeking cooler / lower conditions (in wild), high body temperature *Progression signs* - lethargy, myopathy, tachypnea, altered mentation (depression, seizures), dehydration, hypovolaemic and cardiogenic shock, direct thermal injury, cell damage due to rhabdomyolysis and the release of myoglobin from muscle cells into the blood stream, renal failure (acute and up to 3 weeks post event), blood in faeces (melena) and in vomit (haematemesis), complete or partial loss of consciousness.
Treatment Plan	Gradual cooling and continued temperature monitoring for several hours. Administration of sub-cutaneous or IV fluid rehydration at rates of 20% body weight for Day 1, 15% Day 2 and 10% Day 3 to avoid kidney failure.

	Administration of Ilium Selvite E® to address myopathy, Carafate® to protect gut lining and Zantac® to protect renal system. Delay feeding for 24-36 hours, fluid therapy and monitoring priority.
Prognosis	Guarded prognosis.

Ailment	**Smoke / Dust Inhalation**
Causes	Bush fire, house fires, house renovations
Clinical Signs	Shallow/difficulty breathing Wings outstretched
Treatment Plan	Urgent veterinary diagnosis and treatment is required. Oxygen administration may be required.
Prognosis	Prognoses good if there is no or limited inhalation damage. Requires ongoing observation by an experienced rehabilitator.

Ailment	**Head Injury**
Causes	Blunt trauma (ceiling fan, car hit, human impact)
Clinical Signs	Bleeding from ears and nose, ataxia (uncoordinated movements), dazed, neurological signs
Treatment Plan	A Cortisone injection administered under veterinary prescription is typically required in addition to an analgesic. Quick acting cortisones such as Redipred® or Solu-delta® are to be provided as opposed to long-acting corticosteroids such as Dexapent®. As with all potential neurological injuries, careful administration of fluid level intake and hydration levels is necessary as too much fluid can cause bleeding on the brain. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage. Continual close observation for signs of improvement or deterioration is essential.
Prognosis	Guarded prognosis as with all head injuries. Euthanasia required if condition deteriorates. Requires ongoing observation by an experienced rehabilitator.

Ailment	**Orphaning**
Causes	As a result of any of the above, separation, habitat destruction/disturbance
Clinical Signs	Furless or with obvious cartilaginous joints.
Treatment Plan	Provide warmth (32 - 38 ºC) and rehydration (preferably subcutaneous) – Refer Page 58. Ring Coordinator for placement determination. Orphan groups of the same species may already exist and the new orphan should be housed with others of its same species for optimal social development.
Prognosis	Prognosis very good when placed with vaccinated and experienced rehabilitator.

Secondary Clinical Reasons for Microbat Admittance into Care

Ailment	**Pneumonia**
Causes	Water submersion, exposure in wet cold weather, secondary infection related to burns, aspiration pneumonia in young pups fed milk formula
Clinical Signs	Chest breathing as opposed to abdominal breathing, lethargic, temperature.
Treatment Plan	Under veterinary supervision antibiotics such as Clavulox® or Baytril® (preferred) can be used. Physiotherapy and percussion drainage on such a small animal is to be carried out with care. Place in small container with heat support (32-38 ºC) to provide a stable temperature and provide oxygen as required. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Prognosis is very guarded. Requires treatment by an experienced rehabilitator.

Ailment	**Infections**
Causes	Injuries, hygiene issues / wound management issues
Clinical Signs	Red inflamed wound, suppurating wound, wound slow to heal, hot spots on body.
Treatment Plan	Veterinary assessment without delay is needed in all suspected infection cases. Will typically require the commencement of antibiotics relevant to the type of infection. Analgesics may also be prescribed to assist with pain management. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Guarded prognosis and may need to be placed with experienced rehabilitator.

Ailment	**Mites/ Lice/ Ticks Over-abundance**
Causes	Compromised immune system or inability to groom from any of the above issues
Clinical Signs	Body and fur covered in small mites, ticks or lice, sometimes only visible under magnification.
Treatment Plan	Manual removal with a small pair of forceps/ tweezers for small infestations or when bat is in poor condition. Kitten Revolution® Flea Treatment can be used sparingly only if the microbat is in a healthy condition. Use a 26g or smaller gauge cannula to drop a single small drop on the skin between the shoulder blades. Ensure microbat is observed for 3-5 days to ensure no adverse effect from treatment. It is normal for a small number of mites etc. to be present on healthy uninjured individuals. Ivomec® can be used in unresolved or sub-dermal parasitic infections. Microbats require constant peak body temperature during medication treatments in order for the drugs to have designed effect without organ damage.
Prognosis	Prognosis is good with intervention for light to moderate infestations. Severe infestations may have anemia complications

An unusually high tick infestation in a Gould's Long-eared Bat (*Nyctophilus gouldi*) Credit: Sarah Elizabeth Curran

Ailment	**Fungal Infections (including Ringworm)**
Causes	Poor hygiene or feeding techniques, stress, membrane restriction
Clinical Signs	Red flaking skin, dry or moist skin, odor, fur missing around neck and mouth
Treatment Plan	Veterinary identification of fungal infection via skin scrape and analysis. The prescription of antifungal wash, cream or medication and possibly the improvement of feeding and cleaning practices. Neotopic®, Surolan® or Dermotic® (generic) ointment are preferred for fungal membrane infections. It contains cortisone to reduce inflammation, is antifungal and bacterial and non-drying. Maleseb® can cause membrane drying and burning and should be avoided along with other remedies such as Tea Tree Oil.
Prognosis	Good prognosis provided treatment is giving in the early stages. Guarded prognosis when more debilitated.

Ailment	**Coverage in liquid and adhesive fluids / oils**
Causes	Use of commercially available Sticky Fly Traps and Poles, emersion in oils & other fluids
Clinical Signs	Existence of sticky residue, fractures, myopathy, friction burns and hypoglycaemia
Treatment Plan	Sticky Trap Adhesive - The microbat will need to be anaesthetized as soon as possible in order to be properly extricated from the trap (do not attempt unsedated), cleaned and further ingestion of adhesive prohibited. DISOLVIT® is a product commonly used to remove adhesive and residue. Thorough rinsing of the product from the bat is essential to avoid further complications. Fluid therapy, inclusive of intensive glucose provision is necessary. The survival rate of microbats caught in sticky fly paper is poor. Oily Residue – Use of Johnsons Baby Shampoo® and thorough rinsing of cleaning product from bat. Other Non-oily Residues – Use of Dermcare Vet® or Amway LOC® have provided successful results without impact on microbat membrane and skin.
Prognosis	Guarded

Fluid Therapy

Fluid Therapy Considerations

All microbats should be rehydrated via sub-cutaneous injection as a matter of course as soon as possible after admittance into care, so to offset death or damage of organs by potential high urea concentrations (in some species) and dehydration. The exception to this rule is when microbats have been immediately disturbed from the roost and there is no possibility of shock, injury or illness.

The amount of fluid required and the speed at which fluid absorption is required, renders rehydrating a microbat orally as generally ineffective. Many species of microbats will not drink sufficient amounts from a syringe even at full health.

Subcutaneous fluid injections should only be undertaken by a wildlife veterinarian or a vaccinated and experienced trauma carer. Where the rehabilitator is not trained in subcutaneous fluid injections, oral rehydration should commence as soon as possible (for mildly dehydrated cases only), whilst arrangements are made for the microbat to be passed to an experienced rehabilitator or veterinarian to commence sub-cutaneous fluid therapy as soon as possible.

If the microbat is to be placed under general anesthetic during veterinary assessment, oral fluids should not be offered within 2 hours of the assessment.

Oral Re-hydration

The microbat must be warm before any oral fluids are offered. Preferably this is done by placing the bat on a gentle heat source for several minutes.

Equipment needed:

- 1 ml syringe
- 23-29 gauge cannula
- Warm plain boiled water
- Glucodin® powder

For mildly dehydrated bats, mix 1 teaspoon of Glucodin® powder to 250ml of pre-boiled warm plain water. A maximum of 10% of bodyweight in fluids **over a 24hour period** should be provided to all injured, diseased and orphaned microbats. A maximum of 5% may be administered in any one treatment. As an example, a 10gm microbat should be administered 1ml of fluids over a 24 hour period.

Oral rehydration using syringe and cannula. Credit - Rachel Lyons

Using a syringe with cannula attached, gently place one small droplet of water into the open mouth or lips of the bat. If the bat is interested it will lick or lap at the water. Slowly feed the bat the remainder of the fluid to the approximate amounts below (single administration maximum amount):

Pups - 2 to 5g	approximately 0.1-0.3ml
Pups, Juveniles or Adults – 5g to 10g	approximately 0.3-0.5ml
Juveniles or Adults – 10g to 20g	approximately 0.5ml to 1ml
For larger bats	approximately 5-7% of the normal healthy bodyweight for that species.

As with all species of wildlife, dehydration is rarely addressed adequately by one treatment. It will be necessary to repeat the above administration several times (approximately 4 hourly) over the first 48-72 hours should subcutaneous injection not be forthcoming.

For moderate to severely dehydrated bats, do not use Glucodin® powder as this can create isotonic imbalance which can exacerbate dehydration. Use plain boiled water instead. Severely dehydrated bats are unlikely to be able to absorb any fluid orally due to the advanced shock they would be suffering. In these cases rehydration via subcutaneous injection is urgent.

Never give saline fluid (0.9% sodium chloride) or other fluids used for subcutaneous injections to microbats by mouth, it is intended for intravenous and sub-cutaneous injections only when used in fluid therapy. Saline fluid used orally can worsen the dehydration situation.

Subcutaneous Re-hydration

The microbat must be warm before any sub-cutaneous fluids are offered. Preferably this is done by placing the bat on a gentle heat source for several minutes.

Subcutaneous injections should only be performed by rehabilitators trained in giving injections to microbats. Significant injury and illness resulting in death can and does occur if the correct procedure and method is not followed.

Equipment needed:

- Sterile 1ml syringe or 2ml syringe if bat weighs greater than 15gms.
- Sterile 27 or 30 gauge short needles
- Alco-wipes
- Compound Sodium Lactate (HARTMANN'S Solution) preferred OR NaCl (Saline) - (warmed to 35°C approximately, sterile, non-cloudy, within date and within 1 month of initial use)
- Veterinary Glucose 2.5% and 0.45% Sodium Chloride Solution (warmed to 35°C approximately, sterile, non-cloudy, within date and within 1 month of initial use)
- Tissues and/or holding pouch

For slight to moderately dehydrated microbats (including injured, diseased and orphaned bats), 10% of bodyweight (of 75/25 mix of Hartmann's Solution and Glucose 2.5% solution) fluids **over a 24-hour period** should be provided. Typically, 5% is administered in any one treatment for slight to moderately dehydrated bats. As an example, a 10gm microbat should be administered 1ml of fluids over a 24-hour period with an initial 0.5ml administration.

For moderate to severe dehydration cases where existing or potential renal damage is likely, a bolus initial fluid administration followed by 3 consecutive days of 2 x maintenance fluid volume or 20% (of 75/25 mix of Hartmann's Solution and Glucose 2.5% solution) under the supervision of a veterinarian is recommended.

Glucose administration via subcutaneous injection and/or orally (using Glucodin mix) should be provided until the animal is rehydrated, stabilised, and any infection brought under control. Glucose component amounts as stated above must be followed and proportions not exceeded. Excess glucose can exacerbate dehydration.

The specific method of injection will not be contained in this manual, as hands on training by an experienced rehabilitator or veterinarian is necessary for all microbat rehabilitators. A separate handout containing step by step instructions will be provided to those in attendance during the training.

The above guidelines are general in nature, there are instances where alternate fluids and treatments are necessary, depending on the type of injury or condition. Always contact your veterinarian and/or coordinator prior to commencing fluid rehydration.

Wound Cleaning Process

The management of various wounds will often be required when rehabilitating bats. Some of these wounds are minor and some can require daily cleansing/treatment, dressings and changes of these dressings. The following are simple steps to be taken when cleaning and dressing wounds.

1. Organise yourself a clear space.
2. Collect all the dressings and equipment you think you may need before you begin.
3. Put all the clean/sterile items on one side
4. Have a container with a plastic bag for unclean items on the other side.
5. Wash and disinfect your hands or wear disposable gloves
6. Always work from the clean area to dirty and do dirty areas last.
7. Place used swabs and bandages straight into plastic bag, not on work area.
8. Use body temperature saline solution to irrigate. Heat in container of warm water, not a microwave.
9. Irrigation should be a gentle stream from the syringe, no high pressure.
10. Clean wound gently – no scrubbing.
11. Any cleaning pads should be used once and discarded.
12. If previous dressing is stuck, soak in warm saline until it releases. Do not pry or pull off. As this will damage the new wound bed and delay healing.
13. Do not use cotton wool; the fibres adhere to the wound tissues.
14. Use gauze squares to place gently over wound to absorb excess fluid. Use once and discard.
15. Pat dry the outer edge of wound, discard dressing.
16. Apply any creams or lotions as prescribed using 'no touch' method. I.e. squeeze contents onto wound from a height. Do not let end of tube come into contact with the wound or any other surface.
17. Cover wound with non-stick dressing and tape in place.
18. Wounds need a moist sterile environment to heal.
19. Monitor the wound – any increase in smell, discharge, redness, or swelling requires veterinary attention.
20. Protect from fly strike – cover cage completely with netting or house bat in a mesh vivarium.

How a Wound Heals

Wound healing takes place in several stages over 6-8 weeks.

INFLAMMATORY STAGE
This occurs immediately after injury. Initially blood vessels constrict to allow blood clotting, and then dilate to allow healing cells to enter wound area. White blood cells remove foreign material from site. Wound area has redness, swelling and heat. This lasts approximately 5 days.

DEBRIDEMENT STAGE
Begins 6-8 hours after the injury and lasts between 5-21 days (injury extent dependent). Macrophages (cells) remove dead tissue and promote the formation of blood vessels.

REPAIR STAGE
Once necrotic (dead) tissue, blood clots and debris is removed from a wound the repair stage begins. Granulation tissue forms and makes a bed over which skin cells can migrate.
The stage begins anywhere from 2-3 days after debridement finishes and lasts up to 4 weeks.

EPITHELIZATION STAGE (skin regrowth)
Skin cells migrate over the wound and can continue growing for several weeks.

CONTRACTION STAGE
The size of the wound reduces as the edges of the skin are pulled towards the middle of the wound.

What Factors Negatively Affect Wound Healing?

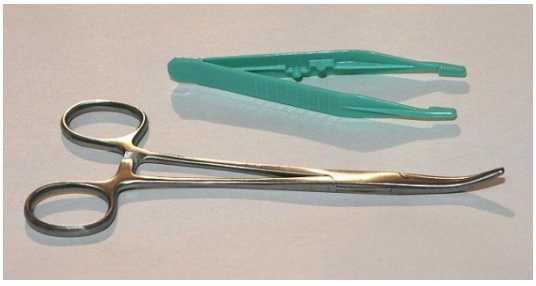
- **Using antiseptic cleaning beyond the debridement stage.**
- **Vigorous wiping.**
- **Infection.**
- **Low dietary protein.**
- **Low temperature – wounds heal faster at warmer temperatures.**
- **Stress.**
- **Dehydration**.

Basic First-aid Supplies

WOUND CLEANING
Saline Solution
Syringes
Gauze swabs
Soft swabs
Cotton Buds
Chlorhexadine or Betadine® solution

WOUND DRESSING
Non-Stick Dressing
Hypafix® - Adhesive fabric
Vetwrap®
Duoderm Gel® or
IntraSite Gel® or
Solugel® or
Flamazine®
Flaminal Hydro Gel®

EQUIPMENT
Glass or stainless-steel bowl
Scissors
Tweezers
Forceps
Haemostats
Paint brushes



To sterilise instruments soak in F10® solution half hour prior to use or boil for 5 minutes.

Medication Regimes

Any medication prescribed by your veterinarian is usually on the basis of “X amount of a dose X many times a day for X amount of days” e.g. 1ml twice a day for 4 days.

It is vital, particularly in the case of antibiotics, to ensure that the prescribed drug regime is adhered to. Sometimes rehabilitators upon seeing the improvement in an animal stop the treatment, only to find the animal suddenly regresses or shows no further improvement and requires antibiotics again. The animal would then require antibiotics for a longer period or sometimes a completely different drug would be needed as the first has lost its effectiveness.

Some medication can have side effects. Your veterinarian will advise you of these and you will need to monitor your patient to ensure that if side effects do occur, necessary action is taken as soon as is possible.

Microbats due to their very fast metabolism and ability to drop into torpor require constant peak body temperature during medication treatments in order for the drugs to have the designed effect without organ damage due to toxicity buildup.

Rehabilitators are reminded that Schedule 4 antibiotics and other medication can only be obtained from a veterinarian and should be administered as the veterinarian prescribes for each individual animal. On completion of a course of medication, the unused portion should be disposed of. Holding Schedule 4 medication “in case” is unacceptable. All medication is prescribed on a case-by-case basis and administering non-prescribed medication is illegal, as only a veterinarian can legally prescribe restricted drugs.

Schedule 2 Drugs - Painstop® and Infant Panadol® are mild analgesics (pain killers) available over the counter. They are insufficient for treatment of pain in most situations but may be included in treatment plans after more effective analgesics have been prescribed.

Rehabilitators who hold or administer non-prescribed restricted medication may be subject to disciplinary action.

The 72 Hour Rule & Beyond

The treatment provided to a microbat during the first 72 hours in care is crucial and will play a determinative role in its successful rehabilitation to release.

All microbats, even those that appear uninjured upon assessment, **should be held in care for a minimum of 72 hours for observation and DAILY RE-ASSESSMENT**. The exception to this is where it is known for certain that the microbat is uninjured and simply flew into a house immediately before being rescued or if the microbats are uninjured translocated bats (e.g. those that were removed carefully from a structure prior to demolition immediately before being brought into care).

Microbats that have an 'undetermined' diagnosis after the first full veterinary assessment should be flight tested in a secure environment, preferably at a natural flight time for bats (typically dusk when their rise from torpor). Flight testing should only occur on bats that are warm and not in torpor. If they can fly they should still be held for 72 hours and flight tested daily to ensure continued mobility. Often muscle, tendon and bruising and other inflammation injuries can worsen over the first few days, which is reason to continue undertaking DAILY RE-ASSESSMENT. Injuries, particularly burns bruising and punctures may only become apparent after the first 24 hours.

Basic Principles for Microbat Recovery

For microbats that have a clear diagnosis and treatment plan in place, some basic principles apply to expedite injury repair and rehabilitation:

NUTRITION – Microbats require advanced nutrition to enable the repair of damaged muscle, membrane, skin and bone. Microbats under treatment should be fed several times per day and a high-quality diet with all the dietary elements that support healing. The Blended Food Diet in Appendix 2 is ideally suited to microbats undertaking treatment.

HEAT SUPPORT – Microbats require constant peak temperature during medication treatments in order for the drugs to have designed effect without organ damage. Microbats that are kept in cooler conditions slow their metabolism down which can alter medication metabolizing in the body and can also slow down cell repair (i.e. healing).

PAIN MANAGEMENT – The adequate management of pain is well known in both veterinary and human medicine to considerably curb the healing and recovery time in patients. Several medicinal options exist for pain management in microbats with varying strengths and treatment durations.

HYDRATION – Adequate hydration is critical for healing. Inadequate hydration of a microbat undertaking treatment, particularly medicinal treatment, can be catastrophic and may result in significant organ failure. Certain regularly used analgesics can cause organ damage if used in dehydrated bats.

Husbandry for Adults & Juveniles

Microbat husbandry knowledge is still in its infancy to a large extent. As with all wildlife rehabilitation approaches, there are many ways of housing and many methods of feeding microbats. Given that microbats are found almost worldwide, there is much to learn from fellow rehabilitators, particularly in the United States and Great Britain where microbat care has been occurring for decades.

Microbat Housing Equipment List

The Microbat Housing Equipment List contains the following items:

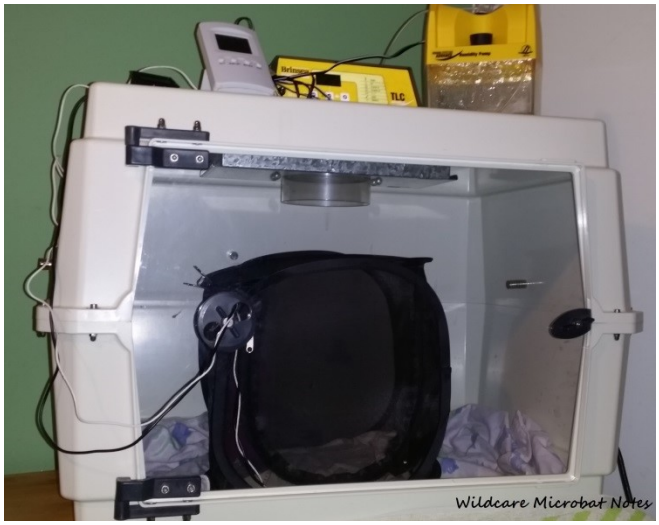
- Mesh terrarium/ vivarium
- Plastic or glass fish tanks with mesh /mesh structure on top and at least one side (clear tanks are to be painted to avoid bat stress and injury from attempting to escape)
- Shallow, heavy and small water dishes
- Mealworm dishes approximately 3cm high with vertical sides
- Flannel Pouches – small and medium size – for hanging and for orphan rearing
- Roosting Pouches
- Roosting hollows / foam hollows
- Polar fleece or flannel hanging cloths
- Cotton cage liners
- Humidicrib OR Thermostatically Controlled Heat Pad
- Terrarium covers (to create dark cave feel – towels, blanket, sheet)
- Cage enhancement items – bark, hollow branch, hanging baskets
- Plastic terrarium cover for bats requiring higher humidity environments.

Housing for Adults & Juveniles

Injured Adults and Juveniles (weaned) Under Medicinal Treatment

Injured bats are usually suffering some level of shock and/or injury when first arriving into care. They should be placed in a humidicrib in a small pouch or pillowcase until stabilized, fully hydrated and adequately medicated/ treated for their specific condition. They can either be placed in a small pouch tied off (only for short intervals) or in a small aerated container containing the pouch and water dish within the humidicrib.

Injured bats usually require rest and movement restriction (flying or other exerting movements), so placing them within a small enclosure where flight and strenuous movement is restricted is necessary to avoid further injury to existing wounds.



A Brinsea TLC® Unit with Humidity Pump and independent thermometer and humidity gauge. A small mesh cage is within making suitable set up for bats being stabilised or undergoing treatment. Credit - Rachel Lyons

Injured bats, like all creatures, will heal quicker when they are able to expend all of their available energy on repairing themselves as opposed to trying to heat themselves. It is important for speedy recovery that injured microbats are kept in their thermoneutral zone of 30-35°C (ambient temperature) where they are expending the least amount of energy thermoregulating themselves and the most amount of energy healing. Adequate nutrition and fluid support are also pivotal for efficient healing.

Various Mini-incubators are also useful as hospital enclosures for single microbats. Credit - Rachel Lyons

Further, microbats due to their very fast metabolism and ability to drop into torpor require constant peak body temperature during medication treatments in order for the drugs to have the designed effect without organ damage due to toxicity buildup.

30-35°C ambient temperature can be achieved in two different ways – either their small cage can be placed inside a humidicrib OR a thermostatically controlled heatpad can be hung at one end of a mesh vivarium and roosting pouches placed resting against the thermostatically controlled heat pad.

Other important housing features for Injured Adult and Juvenile Bats:

- A dark cover should be placed over the sides, top and rear of the cage to simulate a dark roost.
- Several species of microbat require a high humidity environment in care (eg the cave roosting Eastern Horseshoe Bat) and either housed in a humidicrib OR in a cage with a heat source, plastic roof and partial sides and several shallow small water containers (for water evaporation) to allow for a humid setting.
- Enrichment items such as small branch hollows, foam roost structures and floor caves should be placed in the cage.
- The cage floor can be covered by a cotton lining (no looped material that can snag thumbs and claws) that gets replaced every few days. Many bats like to roost under this sheet so always take care when moving and changing it – you don't want to accidentally release the bat when you shake the cloth outside.
- Microbats do not respond well to cage layout changes, ensure that major rearranges to cage furniture is undertaken in a staged fashion.
- Fresh water should ALWAYS be available within the cage. Deep water dishes (deeper than 1.5cm) can have marbles placed in them to avoid drowning. Shallow but small diameter water dishes are ideal. Water dishes should be washed thoroughly every day as microbats have a habit of defecating in their water dish.
- Approximate cage size of 40 x 40 x 40cm is ideal.

Mesh Vivarium Microbat Recovery Setup, with suspended pouches, enrichment items, heat pad and food / water dishes. Credit - Rachel Lyons

Housing for Adult or Juvenile (weaned) under observation or in longer term recovery care

After the stabilization and initial observation of adult and juvenile bats has occurred (this may take several days), the moving of the bat to a larger cage to enable observation and longer-term recovery will be necessary.

The cage should still provide a warm structure to enable bats the option of roosting near it, but the bat should also have the option of roosting in normal ambient temperature of that time of the year.

An ideal set up would include a larger mesh vivarium, with a covered heat pad hanging at one end and several layers of cloths against it that the bat can roost within. Other cloths and roost devices need to be suspended in the cooler section of the cage to enable choice. Enrichment items, a thick material covering and smooth cotton flooring should be provided. Ideally the bat is housed with species of its own kind or with compatible species (refer page 84), if the same species is not in care, with the exception of individuals suffering infectious conditions.

Enrichment items are a necessary addition to all microbat enclosures. Credit - Trish Wimberley.

Other important housing features for Adult and Juvenile Bats under observation or long-term recovery:

- A dark cover should be placed over the sides, top and rear of the cage to simulate a dark roost.

- Several species of microbat require a high humidity environment in care (eg the cave roosting Eastern Horseshoe Bat) and either housed in a humidicrib OR in a cage with a heat source, plastic roof and partial sides and several shallow small water containers to allow for a humid setting.

- Enrichment items such as small branch hollows, foam roost structures and floor caves should be placed in the cage.

- The cage floor can be covered with a cotton lining (no looped material that can snag thumbs and claws) that gets replaced every few days. Many bats like to roost under this sheet so always take care when moving and changing it.

Hanging material offers great security to microbats when feeding. Credit - Trish Wimberley

- Fresh water should ALWAYS be available within the cage. Deep water dishes (deeper than 1.5cm) can have marbles placed in them to avoid drowning. Shallow but small diameter water dishes are ideal. Water dishes should be washed thoroughly every day as microbats have a habit of defecating in their water dish.

- Approximate cage size of 80 x 60 x 60cm is ideal.

- The cage must not contain wire walls, floors or roof as a microbat can seriously injure their thumbs and feet.

- Flight practice should be provided daily if the microbat is deemed to only require short-term care. This can be done by allowing the bat to fly in a flight aviary nightly or within a semi-dark/dark room or flight tent for 1/4hr each night. If allowing flight practice to occur in a room, ensure that there is no furniture that the bat can fly and fall behind, that no ceiling fans that are on and that there is no opportunity to escape. Microbats like to land on curtains and blinds (up high), so the ability to retrieve them easily without risk of injury is important.

Mesh walls are the preferred enclosure material - wire can cause serious injury to microbats. Credit - Trish Wimberley.

Housing for Adult or Juvenile (weaned) in pre-release / flight practice

Prior to release, all bats require flight practice. Some short term (3-4 days in care) microbat rehabilitation cases do not necessarily require time in a flight cage, particularly if they have been provided flight exercise during care, however most will require a substantial length of time building flight muscles and fitness back to allow release.

Pages 88-91 detail pre-release and release methods.

Adult Diet and Feeding Techniques

Microbats suffer easily from poor nutrition and some suffer death in captivity as it is difficult to replace the complex diet they would normally get in the wild. The wild diet of many microbat species is still largely unknown.

Many microbats are difficult to feed when they first arrive in care – often requiring lots of patience on the rehabilitator's part.

Some species learn quickly to self-feed, particularly species that have some element of their wild diet as crawling insects. Other species prove very difficult if not impossible to encourage to eat on their own accord, particularly adults.

Some critical feeding points:

- Microbats must be at normal body temperature (35-39 °C) prior to being able to eat and digest food. Torporing bats (cool or appearing to shiver as they warm up) will be reluctant to feed.

- They can be warmed in your hand or placed on a warm (not hot) heater or heat pack for 5-10 minutes.

- Microbats must be fully hydrated at all times - this can determine their willingness to feed. Juveniles can often become dehydrated in care and some rehabilitators have reported several adult bats as not willing to drink water themselves, although most will when it is provided.

- Microbats eat significantly less in cooler temperatures when their enclosure is not heated.

- Feeding should initially occur in a pouch so that the bat feels secure. Certain species prefer this method throughout their care.

Most microbats prefer to feed within the security of a pouch, particularly the Free-tailed Bat family. Credit – Rachel Lyons.

- Feeding at the normal natural feeding time (dusk or soon after) also assists in food acceptance.

There are three dietary options that exist for the provision of food to captive microbats

1 – Boosted Meal worms
2 – Microbat Blended Food Diet
3 – Wild Caught Insects

Boosted Mealworms

Mealworms (*Tenebrio molitor*) are the most convenient and readily accessible insect food that is available as a substitute diet. Mealworms on their own are not a nutritious food as they are high in fat.
The typical mealworm analysis is:

- Fat 27.2%
- Protein 49.6%
- Carbohydrate 6.9gms/100gms
- Calories 471/100gms

To enhance the nutritional value of mealworms, two actions should occur. Firstly, the **mealworms should be fed up for several days** with a variety of fresh vegetables, fruit, cereals in addition to *Wombaroo's 'Insect Booster'*®. Detailed information regarding how this is done is contained in Appendix 3. Secondly, immediately prior to feeding the mealworms to the microbats, they **should be coated in a mix of '*Missing Link'*® (preferred) or *Wombaroo Small Carnivore Mix*.** Note that the product '*Wombaroo Insectivore Mix'*® is not readily liked by microbats and as such is not recommended to use.

Mealworms should be coated with 'Missing Link'® or 'Small Carnivore Mix'® before feeding to microbats. Credit - Rachel Lyons

Most, microbat species will not automatically pick up mealworms out of a dish. They are used to catching food on the wing and must be trained to pick up stationary food. Mealworms are also foreign as they are not a native insect species of Australia.

Some microbat species such as those in the 'Long-eared' family quite quickly learn to feed on mealworms in a dish once they are used to the taste. This is most probably because they are known to glean grounded insects off branches, trees and the ground in the wild.

Many species only catch food on the wing, and consequently are somewhat harder to teach to self-feed, including some species of the Mollosidae (Free-tail) Family.

In order to accustom a microbat to feeding mealworms from a dish, smalls steps must be taken. The recommended feeding process is as follows. It can take between one feed to several weeks to train a microbat to self-feed. Some never quite learn the art.

1) **Start microbats on viscera (squeezed out mealworm guts) by hand;**

Mealworm viscera. Credit - Rachel Lyons

2) **Graduate to mealworms with heads cut off fed by hand/ tweezers;**

Feeding a Little Broad-nosed Bat (Scotorepens *greyii*) a mealworm by hand. Credit - Rachel Lyons

3) **Then offer live mealworms by tweezers/ forceps**; and,

Feeding bats mealworms by forcep. Credit - Trish Wimberley

4) **Then train to self-feed** by feeding mealworms with tweezers over the mealworm dish, slowing enticing the microbat's head into the dish along with the tweezers to the point where the microbat grabs for the mealworms from the dish. Alternately for some species, they can be trained to lower themselves down a wall in their cage to a dish pushed up against the wall. The bat is enticed mealworm by mealworm fed from the tweezers to come closer and closer to the dish until it learns to pick them up from the dish itself.

Many species need training to learn how to self-feed. Bats can be lowered whilst feeding into the mealworm dish to become familiar with it. Credit - Rachel Lyons.

How many mealworms?

- A small to medium adult microbat (up to 10gms) should eat between 10-20 medium sized mealworms per day.
- A medium sized microbat (10-20gms) should eat between 20 and 40 medium sized mealworms per day.
- A large microbat (25+ grams) should eat 40+ mealworms per day plus supplementary food (refer Appendix 2) in reference to the Yellow-Bellied Sheath-tailed Bat (*Saccolaimus flaviventris*).

Some important points:

- *Never leave live mealworms in the cage of an incapacitated bat. Mealworms can inflict severe damage and even cause death to an injured bat.*

- *Avoid feeding live 'Giant Mealworms' (Zophobas artratus) to microbats as they can bite, severely injure and even eat microbats.*

- *Microbats that are fed 'by hand' for long periods of time that do not self-feed often suffer from poor fur growth and dietary deficiencies. This is because they do not ingest sufficient 'Missing Link'® (preferred) or Wombaroo Small Carnivore Mix supplementation as it mostly falls off the mealworm before they consume it. Long term 'hand feeding' bats will require at least 2 full feeds per week of the Microbat Blended Food Diet as detailed below.*

- *The possible use of insect growth inhibitors (IGI) in commercial mealworm production to delay adult (beetle) stage and prolong shelf life, is a concern. Mealworms affected by IGI have potentially lower calcium levels and softer exoskeleton which is a suspected contributing factor in several cases of microbat bone density and development deficiencies in the past few years. Substantiation of this issue is difficult due to the inability to confirm the use of IGI in the mealworm industry.*

Microbat Blended Food Diet

The Microbat Blended Food Diet is a semi-liquid diet that is often used for incapacitated, weaning and dietary deficient bats. The diet is more nutritious than boosted mealworms and is particularly useful as a transitional diet for orphans beginning solid food.

The Blended Food Diet recipe is contained in Appendix 2, along with specific preparation instructions.

The mix can be stored in the freezer for 1 month in conveniently sized ice-cube trays within a zip-lock bag, or in the refrigerator for 2 days.

The mixture should be fed via a 1ml syringe whilst the bat is in the hand. **It is not recommended that the mix be left in a container within an enclosure for self-feeding as the bat will become covered in it. Also, the mix will spoil after being at room temperature for more than 1-2 hours and can cause severe digestive issues if consumed.** Feeding with the bat wrapped in a tissue and the tissue tucked up under its chin helps reduce mess and fur being coated.

Microbat being fed the Blended Food Diet by syringe. Care must be taken to clean all residual food from the bats mouth after each feed. Credit - Rachel Lyons

Extreme hygiene must be used when feeding this diet as fungal infections around the mouth and chest of bats from residual food are common and presents as fur loss with or without redness to the skin. The microbat's mouth and fur must be thoroughly washed immediately after each feed.

A feeding technique for the Yellow-Bellied Sheath-tailed Bat (*Saccolaimus flaviventris*), who consumes a large volume of the Blended Diet. Credit - Rachel Lyons .

Wild Caught Insects

As with all wildlife species, the provision of a natural diet whilst in rehabilitation is optimal. However, this is often difficult with microbats as little knowledge exists as to the species of insects consumed in the wild, beyond insect family groups. Furthermore, it would be difficult if not impossible to capture sufficient amounts of insects to fully support the nutritional needs of a microbat. Some microbat individuals eat up to 600 mosquitoes each night or 100 mosquitos per minute (Richards, 2012).

Regardless, the provision of even some insects to encourage natural methods of food capture and to diversify the captive diet is advantageous. Insects can be captured and provided using several means:

- The mounting of a light behind a suspended white sheet outdoors after dusk will attract insects to land on the sheet, which can then be bundled up and opened in the microbat housing facility. Black lights are particularly efficient at attracting insects;
- Insect collecting by hand with a net and light; or;
- Insect collecting machine (usually requiring modification from commercial sale), including *Envirosect Bug Control's 'Mosquito and Bug Trap'*® (refer Appendix 4 for information).

The authors have attempted to document the insect species known to be eaten by particular microbat species in Appendix 7. A good insect identification book is critical if you are interested in capturing and providing native insects to rehabilitating microbats. A list of useful books is provided in Appendix 1.

'Spiderman' the rare Golden-tipped Bat (*Phoniscus papuensis*) brought into care in 2009 has a natural diet comprising predominantly of spiders which needed to be caught for him to feed on. Credit - Steve Parish.

Difficult Feeders

Sometimes, despite using proper methods, technique and the diets recommended, a bat may resist all attempts to feed it.

Dehydrated bats will often not feed readily, so as a first resort ensure that the microbat is fully hydrated. This will require the provision of sub-cutaneous fluid injection undertaken on a warmed bat by a rehabilitator that has training and experience in sub-cutaneous fluid injection and fluid therapy. An attempt to feed a warmed bat can be made in as little as half an hour after the fluid injection with often good success.

As a last resort, success has often been achieved through the combined use of fluid therapy and very small amounts of a product called Nutrigel®**.** Nutrigel® is a high energy and vitamin/mineral appetite stimulant commonly used by veterinarians for debilitated domestic animals. A small drop (0.01ml) of the thick chocolate-like paste in 0.5ml of the pup Milk recipe, Blended Food Diet or a smear on the end of a mealworm with the viscera squeezed out, is often enough to see a drastic change of interest in food. Given the high strength vitamin and minerals found in Nutrigel® and the unknown effect of such high dose supplements on a microbat's system, it is not recommended to use Nutrigel® for more than 3 days and no more than 0.05ml per day. Typically, a microbat will only need 2-3 feeds using small amounts of Nutrigel® before they show full interest in the standard recommended diet.

Water provision

Water must be provided in all enclosures for all species at all times.

Water dishes ideally should be small in diameter and shallow to avoid excess excretion within the dish and to avoid drowning. Dishes deeper than 1.5cm can have marbles placed within them to avoid drowning deaths.

It is a good idea to have at least two water dishes in each enclosure each night as microbats have an unfortunate habit of fouling their water dishes. The provision of than one dish increases the likelihood of all bats having access to clean water.

A few species will take to drinking from drippers (rodent style water drippers). The dripper needs to be accessible from the side wall of the cage.

Most microbats do not need to be trained to drink water from a water dish. Northern Free-tailed Bats (*Ozimops lumsdenae*) whilst normally not being excessive water drinkers have been observed by some rehabilitators, not to drink in captivity. Whilst this observation is rare it provides justification to pay particular attention to the drinking behavior and hydration of this species to ensure dehydration does not occur.

All bats, but in particularly the Mollosidae (Free-tailed) family, are known to suffer tooth decay when feeding on captive diets over the medium to longer term. *Petkins' 'Oral Liquid Care'*® or alternative (See appendix 4) should be added to all drinking water daily to help offset this problem. Black marks on the teeth of microbats can indicate tooth decay.

Tooth staining and decay in a Northern Free-tailed Bat (*Ozimops lumsdenae)* Credit: Rachel Lyons

Ride's Free-tailed Bat (*Ozimops ridei)* having a drink after a mealworm feed. Multiple water dishes should be available to microbats at all times. Credit - Annie Van Der Muelen

Husbandry for Microbat Pups

Pup Admittance

Northern Free-tailed Bat (*Ozimops lumsdenae*) pup. Credit - Steve Parish

Orphans arrive in care due to a number of reasons, including but not limited to:

- Tree lopping or roost disturbance by humans
- Storm events
- Displacement (first flights)
- Cat attacks
- Fall from roost and / or mother

Reuniting a pup with its mother should be an option explored where possible, but is often difficult due to the inability to see into the majority of roosts.

In the event of a pup or number of pups falling from their roost, efforts can be made (provided the pup is in good health and condition), for the pup to be placed back into the roost and observed. Nets can be placed underneath and stretching back up to the roost to allow pups to climb back up where falls are a regular occurrence.

Pup Rearing Equipment

The following equipment is required to rear pups:

- Pouches
- Thermostatically controlled heat pad
- Digital Thermometer
- Humidicrib (Brinsea® / Vetario® ICU Units)
- Digital Scales
- Cannulas
- Syringes
- Eye shadow applicators
- Forceps
- Milk formula (2 recipes)
- Sterilisation Equipment
- Johnsons lotion & baby wipes
- Tissues/ cotton pads / cotton buds – lots!

Heating

Infant microbats are unable to maintain their own body temperature (ideally 35-39ºC) until 3-5 weeks of age.

Due to their size and metabolism, **microbat pups require an ambient (surrounding air) temperature of 32º-38ºC (species and individual dependent)** to keep them within optimal body temperature, which is much higher than other mammals we rehabilitate.

We start at 35 ºC and go up or down according to the individual.

Newborn pups are likely to require ambient temperatures of 36-38 ºC and lightly furred pups graduate down to approximately 32-34 ºC.

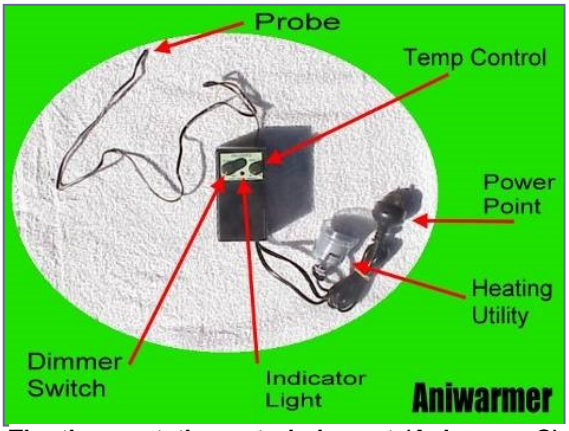
Keeping at lower temps means that they torpor and do not process food in the gut, usually resulting in fermentation and often bloat.

There are two acceptable heating options available to rehabilitators:

1) Vetario® ICU / Brinsea TLC® Humidicrib units. These are optimal and somewhat essential for rehabilitating furless pups. They reduce dehydration risk which is alarmingly common in pups even when they are feeding adequately.

2) Electric Heat Pad with Digital Thermometer and Aniwarmer® Controller (or alternate thermostat – discontinued product). *NOTE = This is the less ideal set-up as hydration levels are very difficult to manage in many species of microbat pup without humidity control. This setup typically creates a dry heat*.

A Brinsea TLC® Unit with Humidity Pump and independent thermometer and humidity gauge. A small mesh cage is within making suitable set up for pup rearing Credit - Rachel Lyons



The thermostatic control element (Aniwarmer®), together with a heat pad and digital thermometer are an alternate heating method. However, dehydration is common using this method as it creates a dry heat.

Pup Housing

Pups can be housed in standard pouches, 'pouch puppies', material folds and in some instances can roost in with adult or juvenile wild bats provided the required temperature is accommodated.

Pouches should be made of natural cotton or flannelette material, with no loose cotton strings. Do not use materials that are fluffy (such as towels) as pup thumbs and toes can be easily caught and injured. Pouches should be made and arranged so that they remain open so that pups can move into and out of the pouch as they please. Pouches must be changed at each feed as microbat pups urinate and defecate very regularly.

Standard pouches and 'Pouch Puppies' as shown above are ways to house orphan pups. Some pup species prefer to nestle into and under material, others prefer to roost with adults of the same species. Credit - Trish Wimberley.

Many bat species are happy to roost in amongst folded/clustered material. These can be simply cloths pinched and tied from the middle and hung against the wall of the enclosure. Many microbat pups will just nestle into and under any cloth material. When housed in this way, regular material replacement and cleaning is necessary.

Many species of pups can be housed with adult bats as would happen in the wild. Wild pups of the Molossidae (Free-tailed) family have been observed to not roost with their wild mother in captivity, and instead roost with particular other bats of the same species. This is somewhat consistent with the behavior of mothers and pups of this family in the wild i.e. pups roosting separately to their mothers.

Once pups are fully furred (fluffy) they can be housed in the same set-up as that of the adult bats, in a mesh vivarium. A heat source must still be provided to allow the pup the option of heat support.

Hydration Issues

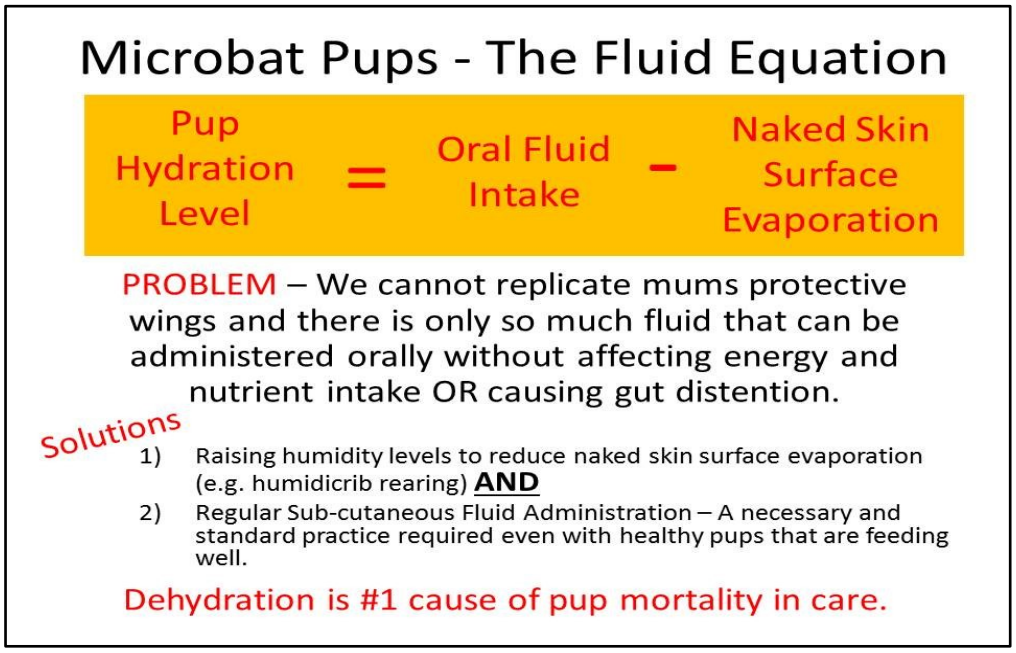
Most pups coming into care will be suffering dehydration and emaciation to some extent, even when only separated from their mother for a few hours. It is critical that all microbat pups be rehydrated once they are warm. Microbat pups should not be fed any milk until hydrated.

Many species of pups, despite our best efforts to keep them hydrated through the use of humidicribs and sufficient fluid ingestion, may still suffer dehydration whilst in care. This is due, to the large naked surface area of a microbat (without their mother to snuggle into) and fluid loss through the skin. It is NORMAL to need to provide additional fluid support to a well feeding and healthy pup.

Due to the limited ability to supply additional fluids orally without jeopardising nutrient intake (their stomach size and volume processing ability is extremely restrictive), subcutaneous fluid may still need to be given regularly to nursing pups. The need to provide additional fluids, above and beyond milk provision, has been greatly reduced due to the recent advent of affordable humidicribs.

Dehydrated and emaciated pups - note the dramatically sunken / thin abdomen and very narrow waist. Credit - Trish Wimberley

Attention to hydration levels and dehydration signs, even when pups are drinking normally, is critical. Key dehydration signals in pups include decreased plumpness in the skin, loss of silky feeling when rubbing pups skin across the shoulder blades, wrinkly look and tenting of skin on torso, dryness on the wing membranes and sometimes decreased urinary output.



Pup Feeding

Whist microbat pup mouths are designed to suckle just like other mammal species, soft artificial microbat teats of appropriate size simply do not exist.

The best alternate options that rehabilitators have been using to feed milk supplements are:

- Feeding via sponge (preferred); and,
- Feeding via cannula and syringe.

In the first instance with all pups, the sponge feeding method should be attempted. Some individual bats and species may refuse to feed via sponge and these individuals can be offered milk via cannula. **Molossidae (Free-tailed) bats are unable to lap from cannulas/syringes as pups and the sponge feeding method must always be used.**

Equipment required:

- **Foam eye shadow applicators** – they should only be used once, so buying them by the dozen/hundreds is most cost effective. Black coloured foam pieces are ideal as they allow the easy viewing of the white milk. The foam tips should be carefully peeled off the plastic wand using sterile gloves. For very young pups, the foam tip can be made smaller by cutting it in half along the external seam using sterile fine scissors. The foam tip can be trimmed to smaller shape as per the size of the bats mouth. Tips should be stored in sterile conditions (e.g. snap locked bags) until use.

- **Metal or Plastic Forceps** to hold foam tip and to assist in putting it in the bats mouth.

- **Eye dropper or 1ml syringes** for use with the foam tips. They must be cleaned and sterilized between uses.
- **23-25 Gauge cannula's**, which must be kept clean and sterilized between use.
- **1ml syringes** for use with the cannulas which must be cleaned and sterilized between uses.
- **Heat pad with several layers of covering** (to avoid contact burns) to place the pup on during feeding to keep them warm.

- **Tissues** to wrap the pup in during feeding and to clean spilt milk.
- **Hot boiled water** to heat the milk formula.
- **Warm boiled water and cotton wool buds** to clean the pup's mouth after feeding
- **Pipe cleaners** to assist in the cleaning of syringes and eye droppers.

Milk Replacers

Natural microbat milk is exceptionally difficult to replicate, particularly when there are so many different species of microbat. Milk constituents are different in different species and there has been no published study undertaken in Australia that has analysed the milk of Australian Bats to the Authors best knowledge.

Captive Milk Replacement Diets, including *Wombaroo's 'Bat Milk Replacement'*® have been trialed extensively at the *Bat World Sanctuary* in Texas (USA), and for the last several years here in Australia by the Authors.

The milk formulas contained in Appendix 2 are preferred due to their very low incidence of bloat and metabolic bone disease when compared to all other milk supplements trialed. The recipe replicates that documented in *Bat World Sanctuary's* latest edition of *'Standards and Medical Management for Captive Insectivorous Bats'*, but modified to suit Australian products and available supplies.

Of note is the difference in ingredient amounts between the Molossidae (Free-tailed) species and other microbat species. Molossidae bats have higher energy and fat needs and lower protein requirements.

Pup Feeding Process

Regardless of which methods are used, there are some standard steps needed for the correct feeding of microbats:

1) Create a clean workspace with tissues, warm water (for cleaning) and cotton wool and set up your feeding implements (syringe/eye dropper, foam tips, cannula, forceps etc.)

2) Ensure you have a heat source for pup temperature maintenance during feeding ready. Pups need to be kept warm at all times – never feed a cold pup. Place the material or tissues that you will wrap around bat next to the heat source so that it too will be warm when you are ready to use it.

3) Heat water and prepare syringe/ dropper with appropriate milk amount.

4) Take pup from its pouch/bedding and wrap in warm tissue / material.

Canula feeding juvenile microbat in enclosed hand. Credit – Rachel Lyons

5) Check its milk levels in its stomach and note down the time since last feed. You will quickly establish the required interval between feeds that is necessary to digest MOST of its milk – not all.

6) Place the bat on the heat source still wrapped, or leave the bat wrapped in your warm hand while you heat the milk in the hot water.

7) Test the temperature of the milk on the underside of your wrist – it should feel warm but not hot. Many microbats prefer their milk warmer than what would be offered to other mammal infants. NOTE – milk cools very quickly when fed via both sponge and cannula.

8) For bats being fed via cannula and syringe, you may find it easiest to hold the bat in your gently enclosed hand. Feed the bat with its body level or on a slight incline and by dropping very small drops of milk on its lips. Wait for it to respond and lick the milk off before providing any more milk. When you are feeding large numbers of pups, you will need to feed in groups with the bats laying on the heated bedding.

Foam tip feeding in the hand. Where multiple pups require feeding, they can be simultaneously fed lying on a covered heat pad. Credit - Trish Wimberley.

9) For bats being fed via sponge, lay the pup wrapped in either a tissue or a small pouch / material piece on the heated bedding OR you can encapsulate the pup in your closed hand. Place 2-3 drops of milk on the foam and then pick it up with the forceps, making sure that the forceps are as far as possible away from the tip that is to go in the pup's mouth as possible. Some pups will open their mouth when you put the foam near it and if they do you can pop it straight in and they will shut their mouth. Provided the milk on it is still warm, they will usually instinctively suck the foam. As you see the foam start to dry out, drop a couple more drops of warm milk onto the foam. For bats that do not initially open their mouths, you can carefully use the foam to lift up their upper lip and head which can cause them to open their mouth or you can press very gently down on their lower jaw with

the foam tip. As a final resort, the foam with milk can be dabbed onto the pup's teeth so that it can taste the milk and open its mouth to get more. Foam feeding does require patience initially and extreme gentleness however the vast majority of pups will have the process mastered within several feeds.

10) Continue dropping the milk onto the sponge if you are using that method OR letting the pup lap from the cannula, checking every 10 – 20 seconds until the pup has had a sufficient amount. REFER to the next section to determine this amount. **Over feeding a microbat can kill it**.

11) Once the sufficient amount of milk has been ingested and you stop feeding, the pup will either let go of the foam immediately or it may take a little time before it spits it out. **Never pull the foam from the mouth of the pup** as this can damage the gums of the pup or even snap off the small milk teeth.

Some pups require convincing to let go of the foam - let them do it in their own time and never try to pull the foam from their mouths as it can cause significant damage. Credit - Trish Wimberley.

12) With a piece of tissue or cotton wool bud, carefully wipe down the pup's mouth to remove any spilt milk. With the warm boiled water wipe the pup's mouth AGAIN, making sure you clean all areas including ears, wattles, facial pouches and all other nooks and crannies. This will help reduce the potential for fungal infection around the mouth and chest of pups which is a very common problem.

Lined up ready for a milk feed via sponge/foam. Credit - Trish Wimberley.

13) Prior to placing the pup back into its pouch and bedding, you may wish to toilet your pup. It is best to toilet your pup after you have fed it so to avoid any risk of food contamination. Refer to page 82 for further information.

Feeding Amount

Overfeeding a microbat pup is VERY easy to do and can cause death. Pups do not have a well-developed 'I'm full' signal that stops them drinking.

The risk of overfeeding in the wild with their mother is impossible due to the limited milk reserves of the mother.

The amount fed per feed varies significantly between species and individuals. **What a rehabilitator should be aiming for is the abdomen of the pup to be slightly rounded and close to the same diameter as the pup's rib cage.**

An overfed pup. Pups should be fed only enough that their abdomen is gently rounded to approximately the same width as their rib cage. Credit - Amanda Lollar.

Feeding Frequency

Microbats need to be fed milk when their stomachs are **near empty**, **not to a standard hourly 'marsupial' feeding regime**. This usually equates to approximately every 4-5 hours but varies depending upon the species, the individual pup's condition and the time of day.

The amount of milk remaining in a furless pup is very easy to view. Residual milk can be seen on the left side of their abdomen through their skin. Furred pups need to have their abdomen gently felt to establish if they are near empty.

Feeding a pup too often, before it has digested its previous milk feed, can contribute to deadly conditions such as bloat. You must allow the stomach to reach near empty before feeding each feed.

After a few feeds in captivity, pups will begin to make clicking noises when they are due to be fed, this is another good indication of their willingness to feed.

If a pup has not digested its milk within 4-5 hours, provided you have not over-fed it, it is either:

- **Being kept at too low a temperature and is torporing, OR**
- **It is dehydrated and its stomach is not functioning correctly as a result.**

Failure to digest milk within the normal timeframes can result in bloat.

Feeding Duration

Pups need milk formula until they are at least 7 weeks old, which is when they generally commence flying and catching insects with their mother. They are however **not fully independent** of their mothers until 10-14 weeks of age (species dependent) and pups have been observed still suckling at 13 weeks of age in care (Long-eared's).

Prior to being able to fly, bats generally need to grow to 90-95% of their adult skeletal size and 70% mass (Altringham, 2011). Weaning in captivity should not occur until these growth milestones occur.

The microbat blended food diet can be introduced around 2-3 weeks of age (species dependent), **the pups should have adult teeth and begin to become fluffy before this diet introduction**. The blended food diet is not to replace milk provision before weaning time.

Feeding Directions:

Developmental Stage	Furless, milk teeth	Short and silky fur, adult teeth coming through	Longer furred pup	Juvenile, 90-95% of adult skeletal size and 70% adult weight. Still dependent on mother.	Independent – Adult size >95% of adult skeletal size and >70% adult weight.
Age	0-3 weeks (species dependent)	2-6 Weeks (species dependent)	4-7 Weeks (species dependent)	>7 Weeks	10-14 weeks
Diet	Milk	Milk, with small 'taste' introductions of Blended Food Diet as they become 'fluffier'.	Milk with some feeds replaced by Blended Food Diet, Mealworm viscera and working towards whole live mealworms.	Live Mealworm (or with heads chopped off).	Live Mealworm (or with heads chopped off).

Pup Rearing Complications

Bloat and Metabolic Bone Disease were common problems with many commercially available milks prior to the use of the current milk recipes contained in Appendix 2. It is still necessary, even when fed the Milk diets in Appendix 2, to be aware and on the look-out for both complications at all times as it still can happen.

BLOAT

Causes – inappropriate milk formula, feeding too often, overfeeding, lack of beneficial bacteria in the digestive system, malnutrition or past emaciation event and gastric torsion.

Bloat is severe abdominal distention. It is life threatening and is one of the more common causes of death in pups. If bloat is suspected or observed in any pup contact your coordinator immediately. If respiratory distress is present the microbat pup needs urgent veterinary attention.

Various treatments exist to counteract bloat, however the cause of the bloat must be established and addressed for treatment to be effective. The incidence of bloat has been greatly reduced with the commencement of the new milk diets and improvements in feeding approaches.

Should bloat be encountered and is not related to over feeding, undertake the following actions initially:

1) Cease milk feeds immediately.
2) Administer Infacol® - one drop via 23 guage canula in addition to separate administration of 0.1ml plain pre-boiled warm water every two hours until bloat subsides. Should bloat not subside within 8 hours seek urgent veterinarian advice.
3) Administer one feed of plain preboiled warm water mixed with human paediatric pro-biotic powder (match head sized quantity per 5mls of water).
4) Continue with milk feeds with human paediatric pro-biotic powder (match head sized quantity per 5mls of milk formula) for several days.

Deceased pup with bloat - Little Broad-nosed Bat (*Scotorepens greyii*) that was suffering severe emaciation on rescue Credit – Rachel Lyons

METABOLIC BONE DISORDER

Causes – Vitamin D deficiency, inadequate intake of calcium, inadequate absorption of calcium.

The clinical signs of Metabolic Bone Disorder (MBD) are swelling or curvature of the metacarpals and phalanges of the bat's wings, joint inflammation, muscle weakness, spasms and convulsions.

Pup wings should be checked regularly to ensure that MBD is not developing. It is treatable when caught early but not if caught late when bone curvature is noticeable. Bats roosting with their wings slightly open are often suffering MBD. The condition is extremely painful – contact your coordinator immediately if MBD is suspected for treatment details.

The correct diet is critical in offsetting the risk of a pup developing MBD. Emaciated pups are particularly susceptible and these cases should only be attempted by an experienced rehabilitator. Contact your coordinator for more details.

Metabolic Bone Disorder - note the curvature of the bones near the joints. Credit – Rachel Lyons

FUNGAL INFECTIONS

Hair loss under the chin and around the mouth of juvenile pups is indicative of a fungal infection. The infection is caused by all milk or food not being removed after a feed, particularly when the Blended Food Diet is being provided. It is often very hard, due to the size of microbat pups and the facial shape and features of pups to perfectly clean a pup's face and body after a feed.

Ideally the infection should be diagnosed via a skin scraping by a veterinarian. Anti-fungal lotions can and should be administered, however often this condition readily rectifies itself when the pup graduates onto whole mealworms.

Fungal infections are common in young microbats that are fed milk or the Blended Food Diet. Key signs to watch for are fur loss and sometimes inflamed skin around the face and neck. Credit - Rachel Lyons.

Hygiene

Standard hygiene practices must always be followed when feeding orphaned bat pups, including;

- Hands must be washed before each bat is fed;
- All feeding utensils must be sterilised between uses in either:
  - F10® disinfectant – 10 min soak and rinse with boiled water;
  - Microwave sterilising unit; or
  - Boiling water for several minutes; and,
- Pouches and bedding must be sterilised by soaking in Napisan or similar and by drying in the sun.

Toileting

Some rehabilitators do, while others don't, toilet their microbat pups. Microbat pups can urinate and defecate on their own, however it is often easier to keep them, their pup mates and their pouches/ bedding cleaner when they are toileted.

Use a warm damp tissue or cotton pad. Stimulate pup's genital area very gently – it doesn't take much at all. Always undertake toileting after the pup's feed, not before, to avoid potential contamination issues.

Pup Cleaning

Microbats, like their larger flying fox cousins require grooming and in particular, wing cleaning.

In the wild, mother bats are constantly cleaning their pups and pups learn quickly how to do it themselves. It is a great way to establish a trusting bond with the pup as they really do love to be gently cleaned.

Using non-scented natural Baby Lotion and non-alcoholic Wipes, gently clean the pup's entire body, both sides of wings and genitals, removing any fecal matter. Cleaning should be undertaken at each feed when pups are furless and at least daily when pups are furred.

Dental brushes can assist in removing knotted or stuck fur. Refer to the 'Grooming' section of these notes for further tips.

Bat-napping – the importance of reuniting pups where humanely possible

Microbats, like their bird counterparts are often brought into care when they do not need to be. Misadventure flights, falls from roosts and curious pups often become separated from their mothers and roost. Most species of microbats in SEQ cannot take off from the ground in flight. Where a pup is grounded, the mother often cannot physically go down and get it.

Microbat mothers do a much better job at raising pups than we ever will. Reuniting pups also takes the strain and raising costs off carers and flight aviary managers.

For newborn / pinkie pups that are found. Most have just fallen from their mum either directly from the roost or as the mum has flown from the roost entry. These guys can't move far so they are usually within one or two meters from roost or roost entry. If it is plump and hydrated just put it back up into the roost entry or into roost. If this is not possible, hold and feed until dark (not before due to predators) and then put a warmed pup on the very top of a ladder on top of a cotton pouch/ surface and mum will usually fly down to pick it up when given the chance and privacy.

For just-furred and misadventure pups (remember they cannot fly until they are almost the same size as mum), they will usually be a maximum of about 20 or so meters from roost. They can flutter / glide down and can walk around a little but are usually not too far away. This reunite entails trying to find the roost and then popping the pup back into the roost entry. You can also use the ladder technique for older pups. The mums can fly down to the ladder and pick up larger pups and fly them small distances.

How to find roosts?

- LOOK for droppings on the ground and look for a small dirty stain on any hole on or under the building.
- LISTEN... in summer you can often hear them chattering, particularly late afternoon. or
- STAKE-OUT the area on dusk and watch for flyout locations - look at buildings, sheds, any hollow bearing tree, drains etc.

Roost locations can be species specific such as those of the Large Footed Myotis, which are typically within bridges, culverts or cavities close to water. Ask the landholder, as they often know exactly where it is.

We occasionally get pups not near a roost, often with umbilical cords attached. If the pup is located off the ground in a situation where mum could have easily landed, collected and taken off (i.e. an elevated position), then there is the possibility that the pup has been abandoned for whatever reason and needs to be brought into care. For grounded bats, mums may come back and try to find pup, so use the ladder technique.

Our guesstimate is that you have a window of about 3 days for reunites before the mother’s milk may be affected negatively. The quicker you can reunite the pup the better but it gives you the chance to feed up and correct mildly dehydrated pups and get them back in time (while investigation into the roost occur).

Only attempt reunites when dealing with a candidate that is healthy, plump and hydrated. Occasionally pups come to ground emaciated and dehydrated and this is possibly because mum is not around anymore and we can't guarantee they are in roost. These individual bats are best to be raised in care.

Special Husbandry Considerations

Species Housing Compatibility

As microbats are highly social, stress can be reduced in captivity when they are housed with others of their own species. Where possible, microbats in care should be coordinated between rehabilitators so that this can occur. There will be instances however when microbats of a certain species are in captivity on their own.

The next preference is for similar species to be housed together, such as the 'long-eared' species or the 'broad-nosed' species. Beyond this, individuals can be housed quite successfully with most species within the same family e.g. the verspertilionidae family.

NEVER house a Greater Broad-nosed Bat (*Scotorepens rueppellii*) with any other species of bats as they are widely known to eat other bats (carnivorous). Extreme care must be taken with housing these bats as they have been known to escape their enclosure to break into other cages to eat other bats. It is best to house them remotely from other bats in care.

Similarly, it is not recommended to house Yellow-bellied Sheath-tailed Bats (*Saccolaimus flaviventris*) with other species initially. Whilst no cases of smaller bats being attacked or injured exist to the authors knowledge, the possibility is there given the Yellow-Bellied Sheath-tailed's size in comparison to smaller bats. Yellow-bellied Sheath-tailed bats are also the only known microbat with recorded incidence of lyssavirus.

Some species in the wild are known to roost with other species and therefore can do so in captivity. Ride's Free-tailed Bats (*Ozimops ridei*) are known to roost in the wild with Eastern Broad-nosed Bats (*Scotorepens orion*) and Gould's Wattled Bats (*Chalinolobus gouldii*).

Always contact your coordinator when new bats enter care to ensure that grouping options for microbats are maximized and if you have any queries regarding housing compatibility.

Over-wintering & Breeding Season Issues

During winter in South East Queensland, insect activity is greatly reduced. This makes it a less than ideal time to release microbats that are anything short of being at peak physical fitness or that don't have the appropriate condition to get them through the rest of winter.

Bats that have been in care for an extended period of time or that have recently suffered any level of injury, dehydration or malnourishment will not be of adequate fitness and body condition to be released during late autumn and throughout winter. These bats should be over-wintered.

Obviously during winter temperatures drop, often below optimal temperatures for microbat recovery, especially when the bat is not residing in environments and social situations they would naturally choose to help them survive the winter.

Over-wintering microbats should be housed indoors, with heating support of variable temperatures, access to plenty of food and their body condition assessed regularly.

Further and importantly, it must be noted that in late autumn/ early winter many species are mating. It is highly recommended that **males and females be separated from early to mid-April (for most species) until late June as mating usually occurs during this time.**

Mating and pregnancies in captivity should be avoided at all costs as we simply cannot provide the appropriate maternal nutritional support in care to produce optimally healthy offspring. Further, pregnant

mothers and mothers with offspring that have been in care for more than a few days cannot be released until the young are completely independent, which extends rehabilitation time considerably.

Males that are housed together during mating time will often fight or attempt to mate with each other and can disturb each other enough to induce malnourishment and death (due to repetitive torpor disturbance) and injury. **Male microbats during mating time should be housed singularly or at very low densities.** For most species in the wild, males will roost solitarily or in small groups during the winter period and as such, captive housing must accommodate the ability for male bats to roost individually in the enclosures – i.e. provide many roosting options if housing more than one male bat in the same enclosure.

The decision to over-winter needs to be seriously considered and discussed with your relevant coordinator for the following reasons:

- Important life cycle events, namely breeding, occurs in winter which are important for bat populations;
- Muscle fitness and condition loss can occur rapidly when in care and consequently the ability to re-build muscle condition and fitness post-overwintering is often very difficult for some species to ever achieve. This is extremely relevant to the larger species such as Yellow-bellied Sheathtails and Northern Freetails.
- Conditions such as teeth decay and gum infections, particularly in the Mollosidae family, occur in captivity over time with increasing prevalence the longer the bat has been in care. The condition is particularly difficult to manage and many are euthanased.
- Some species are extremely stressy and have a very poor survival rate for that reason alone. These species include Large Footed Myotis, Little Bentwing Bat and Eastern Horsehoe bat.

Bathing and Grooming Microbats

Young and temporarily incapacitated microbats need to be groomed, usually after feeds when they would do so normally. The main grooming tools commonly used are a dental brush and a wet tissue/ paper towel/ gauze pad / baby wipe soaked partially in warm boiled water.

Young pups require daily cleaning and care must be taken to ensure all parts of the wing and tail membranes are kept clean and fresh to avoid fungal and bacterial infections.

Natural vitamin E cream, Johnsons Baby Lotion® (Pink) or clean saline water can be used to clean the wing and tail membranes.

Often microbats enter care in quite filthy states and may need to be washed, however only ever AFTER they are stabilized. Bats that are very dirty may need baths or may need anaesthetizing to allow a full clean to be undertaken safely.

The microbat can be immersed up to their neck level in a warm bath or warm gentle running water. Johnsons Baby Shampoo® can be used to clean the wings and body fur before being immersed up to the neck in warm water again to thoroughly rinse off. Great care must be taken to avoid water touching or splashing into the eyes, mouth or ears of the bat. The bat then needs to be cloth dried or very gently blow dried (with mini hairdryer) and kept heated.

Debilitated and young microbats require grooming - dental brushes are one tool that can assist. Credit - Rachel Lyons

Identifying Microbats in Care

Often several microbats of the same species are in care at the same time and it is always necessary to distinguish bats from each other for the following reasons:

- Each microbat needs to be released back to their original location where feasible:
- To manage medication requirements of each bat; and,
- To manage feeding methods needed for each bat – some bats may need to be hand fed and others may be self-feeding.

The banding of bats is not warranted in microbat rehabilitation due to the risk imposed with banding injuries. Likewise, the older practices of ear notching and tattooing are not used for the same reasons.

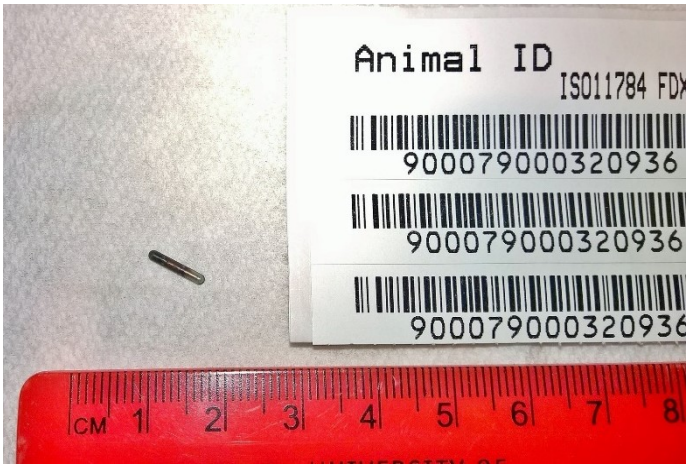
A much safer option is to use non-toxic paint pens that are manufactured for the marking of domestic livestock. Different coloured pens can be used for different purposes, for example, bats requiring hand feeding, those on antibiotics, those from a certain location etc.

From experience pen markings can last for between 2 days and 2 weeks, depending on the bat. Marking on the back of the ears and on the back of the radius bone, (areas that it can't be licked off), tend to last the longest.

In 2017, SEQ carers commenced microchipping of bats that were processed through the Noosa flight aviary. The undertaking was extremely successful. No rejection of chips (Mini-microchips - ISO 11784/11785 FDX-B Size – 1.4mm x 8mm) was observed. The chipping helped identify a returning to care bat and allowed us to determine survival success in the wild.

Chips need to be inserted to the bat while under anaesthetic by a veterinarian. The use of glues to hold the entry point of the chip closed in the hours after insertion was often needed. There were however observed cases of bats grooming the glue and attached fur off, creating small bare patches of skin. This was the only side-effect and only on some of the bats.

Non-toxic Paint Pens to aid in the identification of individual microbats – use a cotton bud to apply. Credit - Rachel Lyons



Mini chips have been used successfully in microbats to ensure correct ID in care. Credit - Rachel Lyons

Pre-Release and Release

Releasing a microbat is a rewarding experience. However to ensure a rehabilitators hard work is to ultimately be of benefit to a rehabilitated microbat, there are some critical guidelines that should be followed.

Preparation for release should begin on the day that the animal comes into your care.

Pre-release

When an adult microbat has recovered from a long (2 weeks +) term injury or a juvenile bat has been raised and is suitable for release, it first must spend time in a flight aviary to enable muscle tone to develop and aerobic fitness to reach a suitable level to allow sustained flight.

Wildcare's Sunshine Coast Microbat Flight Aviary (8 x 8m). Credit - Rachel Lyons.

Each species of bat has different flight styles in terms of speed and maneuverability. Consequently, each species has individualized requirements for flight aviary size and the length of time they may need to reach peak muscle tone and aerobic fitness.

Most species require a minimum flight aviary cage size of 7 x 7 m. Some species that fly within dense vegetation, such as the Gould's Long-eared Bat, can build sufficient flight strength is smaller aviaries of 3 x 3m in size. Other larger species such as Yellow-bellied Sheath-tailed bats fly very fast, and need much larger flight aviaries bigger than 16m x 16m.

Appendix 7 attempts to identify the flight aviary size and length of time of stay for each species brought into care in South East Queensland. These values will likely be modified over time as more and more bat species are tested in the various cage sizes.

Within the flight aviaries, each microbat must be able to undertake sustained flight and show evidence of natural prey capture.

Sustained flight is defined for the purpose of this manual as non-stop flight for several minutes at a time, over multiple times within a half hour period.

In order to test for natural prey capture, infra-red camera or direct visual observations must be made to determine if a bat is able to capture natural prey on the wing.

The modified insect capture unit can be used to catch the natural diet of the species, and insects released into the flight aviary. Alternately 'black light' units can be installed within a flight aviary to attract insects, but must be timed to switch on and off.

Based on research, many species of microbats learn to catch food on the wing after being 'taught' through observation of the activity by wild adult bats. For this reason, it is desirable to house juveniles with wild bats of the same species for a length of time in the flight aviary to enable this information transfer to occur. There is absolutely no point releasing a reared microbat if you are not sure if it can catch prey on the wing.

Many microbats do not adjust well to the move from the smaller rehabilitation cages to the flight aviary environment and often stop feeding and become stressed. It is recommended to initially place the smaller rehabilitation cage with the same layout but open within the flight cage or pre-release aviary, to allow a smoother stress-free transition.

Flight aviaries must be lined with shade-cloth mesh as opposed to wire which can damage a microbat's wings, in particular their thumbs and also their feet.

A flight / release tent - note that roost and feed stations are up high and off the ground. When outdoors, microbats seek roosts as high as possible and most species instinctively know not to go to the ground. Credit - Trish Wimberley.

Critical Release Abilities

In order to give microbats the greatest chance of survival, prior to release they ALL must:

- **Be able to undertake sustained flight of the style and speed relevant for their species and to have done so for a suitable length of time (1 month typically) to gain strength and fitness;**
- **Be able to catch their natural food on the wing; and**
- **Be of good weight and adult size for the species.**

Many large fully meshed camping tents make great flight cages for those species that fly in small spaces. Credit - Mary Crichton.

Releasing Adult Bats

Adult bats must be release back into their colony or forage area at the point of capture regardless of the time spent in rehabilitation. Microbats form very strong life-long bonds with their colony mates and often have very defined mating, roosting and foraging territories. Bats released outside of their home ranges have been known to attempt to fly back, often over hundreds of kilometers. This is by no means an ideal thing as the bat would undergo undue stress and exertion attempting to do so. Attempting to fly long distances over cleared habitat for many microbat species is a possibly death sentence.

Microbats should only ever be released after dark (shortly after dusk is ideal as many predators are still about on dusk – e.g. Kookaburras) and in periods of good weather and significant insect activity.

Microbats will not attempt to fly if they are cold / torporing, so must either be allowed to warm up in their own time or be artificially heated by being held in the hand for several minutes until the shivering action ceases. Bats should not be forced to fly by being thrown into the air.

Adult microbats being release should only be fed a small amount of food (approximately 1/3 of normal nightly feed) prior to being released and should be well hydrated.

Suitable methods of release include:

- Direct release of warmed bat from the hand held outstretched and as high as possible. Microbats usually need to spend some time (up to half an hour) stretching their wings in preparation for flight, echolocating and emitting communication calls to locate roost mates before they fly off. Some individuals will not fly off if they do not hear response calls from their colony mates. If this is the case try again another night at a different time.
- Release from a Microbat Box. Where a number of bats are being released at the one time (typically translocation cases), a microbat box can be installed on site to allow the microbats to fly off at their own accord. The box must be checked nightly until you are confident that the bats are actually taking off and not just starving to death in the box. Nest boxes can be made with sliding removable floors/entry points to enable the nest box to be installed in day-light hours and then opened after dusk. **The bats must be familiar with the bat box after voluntarily spending a minimum of 3 days using it in captivity.**
- Soft release from a tent. Species that fly in small spaces (eg Eastern Broad-nosed and Gould's Long-eared Bats) can be soft released at the point of capture location from a large mesh camping tent. The bats must spend some time in the tent before it is set-up at the release site so that they feel safe in the tent and use it for security. Ideally the tent should be located at the release site for a couple of nights before being opened and then should remain at the release site until it is definitely not being used anymore.

Microbat nest box suitable for some crevice dwelling species. Credit - Rachel Lyons.

Note – NEVER release a mother microbat with pups before discussing the issue with your coordinator. Mother and pup releases are very difficult, with young usually abandoned if appropriate steps are not taken.

Releasing Hand-Raised Orphans

Orphans are often in captivity for a long period of time, and in that time form strong bonds with other bats in care, including wild adult bats. Getting to know who is mates with who and housing candidates together as early as possible can aid considerably in selecting suitable release sites for hand-raised orphans.

Orphans ideally should be released at their point of capture back into their maternal group. This is possible and highly desirable for groups of orphans all from the same location.

Where several individual young come into care from several different locations, they can be grouped and raised together. They will form strong bonds and should be released together after spending time with some wild adult bats of the same species.

Should any of the adult bats housed with the juveniles be amenable and appear to bond with the young, attempts should be made to release the young at that wild adults point of capture.

Microbats should only ever be released after dark (not at dusk as many predators are still about – eg Kookaburras) and in periods of good weather and significant insect activity.

Release methods for orphaned young:

- Soft release from the rehabilitators facility provided that the species being released is known to occur in the area.
- Soft release (with nest boxes installed elsewhere on site, if applicable for the species) from a large mesh camping tent at the point of capture of a bonded wild adult bat or a known roost site of the same species. The tent and bats should spend several days at the release site to become familiar with the area and to enable communication with wild local bats to occur. The bats must spend some time in the tent before it is set-up at the release site so that they feel safe in the tent and use it as a security.

Research Studies of Post-release Survival

Limited studies on the success of release of rehabilitated bats exist globally, with all known and published studies undertaken in Europe. The results of all studies are encouraging and indicate that provided we undertake rehabilitation appropriately and provide adequate flight practice opportunity, that rehabilitated bats including orphans can survive in the wild.

Two studies were undertaken by Kelly et al in the UK in 2012. In the studies, 10 *Pipistrellus spp*. bats were radio-tracked and 39 ringed. They included hand-reared pups from newborn age onwards and that were soft released from accustomed bat box fitted to outside of large flight aviary after prolonged flight practice. Results indicated varied success – several were retrieved within first few days, however 5 of 39 (13%) returned to the box within 38-1389 days post-release, with evidence of two surviving winter.

An Italian study by Serengeli in 2012 involving hand-reared *Pipistrellus kuhlii* bats, saw 21 bats reared in a bat box with flight access. The box was relocated to known species habitat with wild roosts, remote from flight aviary for release. The study showed there was evidence of about 50% survival at 2 weeks however it could he higher than this figure as tags were lost and others had battery issues. Interestingly, the hand-reared bats were observed hunting within 4 hours of release despite having no training to do so in captivity. Further there was evidence of integration with local wild colonies.

Post survival research **in relation to pre-release practices** in hand-raised microbats is restricted to a single study undertaken in Europe. Despite the study by Kelly (2008) having a small sample size, its results were consistent with expectations in relation to the impact of flight practice aviary size and duration of flight practice provided.

Tracked bats provided with limited time in fight aviaries and/or flight practice within a small aviary were found either grounded or perished, presumably from myopathy, within 3 days of release. Only those that had

extended flight practice in larger cages (relevant to the species) demonstrated survival in the wild. The study comprised 3 groups:
Group 1 (5 bats) - limited pre-release flight training and over-wintering – RESULT - four were recovered, grounded, within 48 h and the signal from the fifth bat lost on day two

Group 2 (2 bats) - prolonged pre-release flight training, but with limited space (3 x 2m) – RESULT - Both bats in the second group flew strongly on the night of release but on the second and third nights only one emerged and flew briefly. Signal stationary after this.

Group 3 (5 bats) - prolonged pre-release flight training in large flight cage (7 x 4m) – RESULT - tracked for between five and ten nights, indicating that they were able to survive independently following release.

In Australia, two separate unpublished examples have been noted of survival success of hand reared pups. The pups were micro-chipped and released either in known habitat of species or at original point of capture. Both integrated with the resident colonies and were observed more than a month after release.

Flight practice aviary size and flight practice duration is directly linked to the survival or otherwise of rehabilitated bats in the wild.

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Appendices

Appendix 1 – Identification Books and Resources

Appendix 2 – Captive Diets

Appendix 3 – Mealworm Farming & Preparation

Appendix 4 – Equipment & Supplement Sources

Appendix 5 – Suggested Drugs and Dose Rates

Appendix 6 – Assessment Form

Appendix 7 – SEQ Main Species Information Charts
- Sheath-tailed Bats (Emballonuridae)
- Horseshoes (Rhinolophidae)
- Free-tailed Bats (Molossidae)
- Evening Bats – Enclosed Tail (Vespertilionidae & Miniopteridae)

Appendix 8 – 2018 AWRC Conference Paper

Appendix 1 – ID Books / Resources

Insect ID Books / Resources

Storey, R & Zborowski, P. (2010). *A Field Guide to Insects of Australia.* Sydney: New Holland Publishing . ISBN - 9781877069659

Hangay, G & Zborowski, P. (2010). *A Guide to the Beetles of Australia.* Melbourne: CSIRO Publishing. ISBN – 9780643094871

http://anic.ento.csiro.au/insectfamilies/

Microbat ID Books / Resources

Churchill, S (2008) *Australian Bats.* Sydney: Allen and Unwin. ISBN - 9781741754612

Hall, L. (2009). *A Wild Australia Guide: Bats. Brisbane: Steve Parish Publishing.ISBN – 9781741935141*

Menkhorst, P. & Knight, F. (2001) *A Field Guide to the Mammals of Australia.* Melbourne: Oxford University Press. ISBN – 9780195573954.

Richards, G & Hall, L. (2012) *Bats Working the Night Shift*. Melbourne: CSIRO Publishing. ISBN – 9780643103740.

Van Dyck,S, Gynther,I,& Baker,B. (eds) (2011) *Field Companion to the Mammals of Australia. Sydney: New Holland Publishing. ISBN - 9781877069819*

Van Dyck, S & Strahan, R (eds) (2008) *The Mammals of Australia.* Sydney: New Holland Publishing. ISBN – 9781877069253.

http://www.allaboutbats.org.au

Nest-box Books

Franks, S & A (2003) *Nest Boxes for Wildlife.* Melbourne: Bloomings Books. ISBN – 1876473207.

Appendix 2 – Captive Diets

Note – we are continually improving and updating our recipes as we perfect them – stay in touch on the 'Queensland Microbat Rehabilitation Forum' on Facebook for the latest.

Milk Replacement Diet A – Milk for Most Bat Pups

- 100mls fresh goats milk **or** same volume reconstituted powdered goats milk
- 1.5 scoops of S26 Soy Powder (or equivalent Soy Milk Powder)
- 2 mls Megaderm® Supplement
- 2 level tsp (4.3g) dried egg white powder (Egg Albumin) **or** white of 1 medium egg (which equates to 3.5g of protein approximately)
- ¼ teaspoon of Human Paediatric Pro-biotic Powder **or** Protexin®

Store in refrigerator immediately and discard after 24hrs.

Milk Replacement Diet B – Milk for the Molossidae Family Pups

- 100mls fresh goats milk **or** same volume reconstituted powdered goats milk
- 2 Scoops of s26 Soy Powder (or equivalent Soy Milk Powder)
- 3mls Megaderm® Supplement
- ¼ teaspoon of Human Paediatric Pro-biotic Powder **or** Protexin®

Store in the refrigerator immediately and discard after 24hrs.

Blended Food Diet Recipe

- 1.5 cups frozen mealworms (that have been prepared as per Appendix 3)
- ½ cup cold water
- 2 teaspoons of Missing Link®
- 1/8 teaspoon of Soluvet®) vitamin powder
- ½ teaspoon of Liquid Oral Care® (when feeding to Molossidae species in particular)
- ½ teaspoon of Megaderm® Supplement
- 1 scoop S26 Soy Powder or equivalent soy brand

On high speed in a glass blender mix ½ cup of cold water and gradually add the frozen mealworms and blend until it is the consistency of honey. Make sure the mixture remains cool as it can spoil if overheated. Add the remaining ingredients, blend quickly and store immediately in ice cube trays within a snap locked bag in the freezer. The frozen food can be kept for up to 30 days. When needed pop out a frozen cube and allow it to defrost in the fridge. Thawed mixture can remain in fridge for 2 days for use. Do not refreeze once defrosted.

Makes 2 ice-cube trays – feeding approximately 6 small bats per cube per night.
3 teaspoons of Missing Link® instead of 2 can be used if Megaderm® cannot be sourced.

Needs to be hand-fed to bats – do NOT leave in enclosure for self feeding – refer pg 69.

***Saccolaimus flaviventris* (Yellow-bellied Sheath-tailed Bat) Diet**

In addition to providing mealworms and the Blended Food Diet, the following should be offered regularly:

- Beef heart cut into very small pieces (it can be frozen until needed), then dipped in Small Carnivore Mix® or Missing Link®.

***Phoniscus papuensis* (Golden Tipped Bat) Diet**

Contact Rachel Lyons.

Meal Worm Coating Instructions

After preparing mealworms as described in Appendix 3 treat the mealworms as follows;

To approximately 300gms mealworms sprinkle 2 teaspoons of Missing Link® or Wombaroo Carnivore Mix® (can be alternated) immediately before feeding.

Do not add calcium powder to mealworms as this can result in hypercalcemia which causes various problems including kidney failure and death.

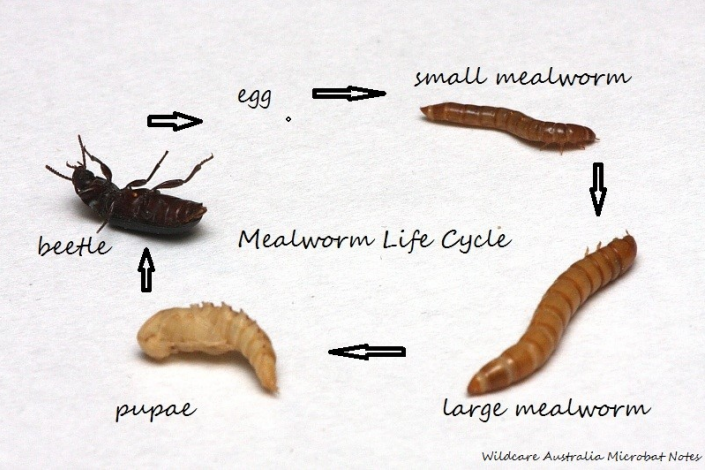
Appendix 3 – Mealworm Farming & Preparation

The following is a guide to one method of farming and preparing mealworms prior to coating and feeding to microbats. Mealworms are extraordinarily expensive to buy and are often difficult to source, so establishing your own mealworm farm is a very good idea.

Breeding Process

The mealworm lifecycle is as followed:

- Eggs (1-2 weeks)
- Mealworm (10 weeks)
- Pupa (1-2 weeks)
- Beetle (2-3 months)



Equipment

Equipment/ Materials needed:

- 4-5 Tubs or a set of 4-5 drawers used to store mealworms at different developmental stages. The base of the top draw should be carefully cut out with a stanley knife and a fine mesh (eg fly screen mesh) glued in its place with a glue gun or equivalent.
- Sieves / sifter
- Tweezers
- Medium – see below for the different mediums for the different drawers.

Start with a handful of mealworms, leave them in wheat bran / pollard medium for a few weeks and allow them to develop into pupae and then beetles. Once pupae and then beetles have developed you can commence the breeding program.

Drawer Set-up

In the 4-5 drawer unit, the top drawer with the mesh base is where the beetles are stored. The beetles lay eggs in the medium which then fall into the 2nd draw. The 3rd draw is to grow up small mealworms and the 4th drawer is for further growing up and prepping mealworm for consumption. The 5th draw if you have one is for storing mealworms to allow them to turn to pupae and then to beetles, after which they are transferred into the top draw. Alternately you can just leave a handful of mealworms aside in a small container which will eventually turn to pupae then beetles.

A mealworm farm utilising plastic drawers, one of many methods of mealworm husbandry. Credit - Rachel Lyons

Beetle Drawer - The beetle drawer is the top drawer. It needs to have the base cut out carefully with a stencil knife and then a layer of mesh (insect screen) heat glued across the base. The beetle draw medium is natural whole rolled oats with vegetables (see list below) placed on a plastic dish for extra nutrients. The beetle eggs fall through the mesh into the second drawer. A container of water that is tall and inaccessible to the beetles can be placed into the drawer in times of very dry weather. More eggs will be laid when there is some humidity in the drawer. In the event that you are using tubs as opposed to draws, the beetles can be placed in wheat bran / pollard mix and after a month or so rotated to a new tub to allow the initial tubs egg harvest to hatch and grow on.

Egg Hatching Drawer – The egg hatching / baby mealworm drawer medium can be either pollard (preferred) or wheat bran with vegetables placed on a plastic dish. Once tiny baby mealworms are visible (about a month) move the drawer or the contents of the drawer to the level below (growing up drawers). Set up the drawer again to catch the next batch of eggs.

Small Mealworm Growing up Drawers – Medium can be either pollard (preferred) or wheat bran with vegetables placed on a plastic dish. Food must be available constantly to grow the worms up quickly. Once the mealworms are of medium size, move them to the next drawer for final prepping and gut loading.

Medium to Large Mealworm Prepping / Gut loading Drawer – The mealworms spend their last two weeks (minimum) acquiring the most amount of nutrients as possible so that they are as healthy as possible for the microbats that consume them. This can either be done by adding extra vegetables in addition to blended chick starter (unmedicated) granules (60% by volume), Wheat Bran (38.5% by volume) and Calcium Carbonate Powder (Balanced Calcium®) (1.5% by volume) OR Wheat Bran (50% by volume) and the new *Passwell* Product '*Insect Booster*'® (50% by volume).

Sieving mealworms from the medium to prepare to feed to microbats. Credit – Rachel Lyons

Pupae Development Drawer or Container – ¼ inch wheat bran or pollard is all that is required. No food needs to be provided as you want the mealworms to pupae quickly. Transfer the beetles to the beetle drawer as soon as they appear.

Other pointers:

- Generally, the warmer the temperature, the faster the lifecycle of the meal worm. Excess mealworms can be stored in the fridge to slow their metabolism so that they do not develop quickly. They do require a couple of days out of the fridge to rehydrate and feed every two weeks during fridge storing.

- Foods that can be added: potato, pumpkin, carrots, cabbage, lettuce, sweet potato, wholegrain bread. Most fruits create mould too quickly and should be avoided. Make sure the food doesn't touch the bedding or it will cause the bedding to rot and/or get mouldy. Put it on a plastic lid.

- Mealworms prefer the dark and should be kept out of direct sunlight. However, studies have shown that mealworms develop faster when provided with some light. You can leave the mealworm growing up drawers permanently half pulled out.

- Check your farm every few days and remove any dead beetles/pupa/worms. Replace the bedding once it begins to look grainy (this is mealworm excrement), if it gets mouldy or if it smells.

Appendix 4 – Equipment & Supplements Sources

Item	Purpose	Possible Source
FOOD/ DIETARY SUPPLEMENTS		
Missing Link Wellness Blend®	Supplement for Blended Food Diet (refer Appendix 2) and mealworm coating	Various including: www.animalhealthstore.com.au
Petkin Liquid Oral Care® Or Fresh Breath by Tropiclean®	Water supplement to aid in oral hygiene in bats, particularly Molossidae species in care	Various including: www.thevetshed.com
Small Carnivore Mix®	For gut-loading mealworms	www.wombaroo.com.au
Balanced Calcium® (Calcium Carbonate etc).	For gut-loading mealworms	Most Vets
Insect Booster® (Passwell)	For gut-loading mealworms	www.wombaroo.com.au
Megaderm®		Various including: www.vetnpetdirect.com
S26 Soy Milk Powder®	Milk ingredient	Supermarkets and chemists
Egg White Powder (Albumin)	Milk ingredient	Ebay, some Grocery Stores and Health Food Stores
Mealworms / Crickets	Main food	Most pet shops or in bulk from mealworm producer – ask in Microbat Facebook Forum for local suppliers
Pollard	Meal worm medium	Farm stores and agricultural shops
Wheat bran	Medium for mealworms	All grocery stores
Soluvet® (powdered vitamin supplement)	An ingredient in Blended Food Diet (refer Appendix 2)	Most Vets or Pet Shops
Protexin®	Probiotic powder for Milk and Blended Food Diet	Most Vets
MEDICATIONS / WOUND TREATMENT		
Painstop®	Analgesic to have on hand	Any chemist with prescription from vet
Infant Panadol®	Analgesic to have on hand	Any chemist
0.9% Sodium Chloride (Saline), Hartmanns and 2.5% Glucose Fluids	Sub-cutaneous injection fluids. Nacl can also be used for Wound Flushing	Any veterinarian
Alcowipes	Injection site steriliser	Any veterinarian, chemist
27 and 30 Gauge Needles / 1ml Syringes	Injection equipment	Any veterinarian, chemist
Manuka Honey	Antiseptic lotion for superficial / minor wounds	Any chemist or health food store
Chlorohexadine / Betadine®	Antibacterial wash / fluid	Any chemist
Intracite® / Solosite® / Solugel® / Duoderm Gel®	Wound covering until Veterinarian assessment	Most chemists (order may be required)
Flaminal Hydro Gel®	Membrane healing	Most chemists (order usually required)
Hypafix®	Wound covering – Adhesive fabric	Any chemist – may require ordering
Vet Wrap	Wound stabilisation	All veterinarians, most pet stores
Glucodin®	Oral rehydration ingredient	Supermarkets, chemists

HOUSING AND EQUIPMENT		
Non-toxic Acrylic Animal Markers	Identification marking of bats in care	Various including - www.thefarmstore.com.au
Mini-microchips - ISO 11784/11785 FDX-B Size – 1.4mm x 8mm – no bigger!	Identification of bats in care – to be inserted by veterinarian	https://www.minimicrochips.com.au/pet-microchips/iso-11784-11785-fdx-b-microchip-2-detail.html Other suppliers exist.
Rare Earth Magnets	Super strong magnets for attaching foam housing/ roosting structures to mesh cage walls	www.aussiemagnets.com.au
Enviro Bug Control Capture Device®	Device for attracting and capturing insects (adaptation required)	Various including - Enviro Bug Control envirobugcontrol@yahoo.com.au
Mesh Cages / Terrariums	Housing for rehabilitating microbats	Bat World Sanctuary (Rescue Cage) http://www.geckodan.com/product-category/the-bugshop/pop-up-cages/ Ebay Mesh camping cupboards
Intensive Care Units/ Humidicribs (Brinsea®, Vetario®, RCom® and other brands)	Housing and heating for injured/rehabilitating adults/ juveniles and orphaned pups	www.wapoultryequipment.net.au www.tkpoultrysupplies.com.au http://eshop.bellsouth.com.au
Heat Pads	Heating for injured/ rehabilitating adults/ juveniles and orphaned pups	Electronic/ homeware stores / EBay
Jewellery Scales	Weighing microbats	Ebay
Vernier Callipers	Measuring microbats	Ebay, Bunnings/ hardwares
Microscope Head Set	Assessing microbats	Ebay
Eye Shadow applicators	For milk feeding certain species	Any chemist or buy in bulk off Ebay.
Forceps	Holding foam during milk feeding	Most veterinarians and medical facilities
Cannula	Feeding equipment	Any veterinarian

Appendix 5 – Suggested Drugs and Dose Rates

This information is provided for VETERINARY USE ONLY to assist veterinarians with the INITIAL ASSESSMENT and EMERGENCY TREATMENT of sick, injured and orphaned microbats. The drugs listed are for routine treatment only – culture and sensitivity results would indicate the most appropriate drug treatment regime. Suggested drugs and drug doses are either adopted from Exotic Animal Formulary (3rd Edition) (Carpenter, JW – Saunders 2004) or advised by Dr Claude Lacasse (Australia Zoo Wildlife Hospital, QLD) or Dr Tania Bishop (Dayboro Vet Clinic / Australia Zoo Wildlife Hospital, QLD).

ANAESTHETIC

Drug	**Composition**	**Dose Rates**
Isoflurane®	Isoflurane	5% for induction and 2-3% for maintenance with oxygen flow rate of 1-2 litres per minute

ANALGESIC

Drug	**Composition**	**Dose Rates**	**Administration Amount for a 10gm Microbat**
Methone®	Methadone hydrochloride	0.3-0.5 (S/C or I/M) - severe trauma/ fractures etc. – use with caution as can depress CV system. 0.1-0.2 (S/C or I/M) for severely stressed animals or severe soft tissue injury. 4 to 6 hourly	Veterinary administration only.
Temgesic® (preferred over Methone®)	Buprenorphine hydrochloride	0.01mg/kg 8 to 12 hourly – (S/C or I/M)	As advised by Veterinarian.
Metacam®	Meloxicam	0.2mg/kg (SID – P/O I/M or S/C) Oral dosages should be diluted with Lactulose	As advised by Veterinarian – not to be used until bat is hydrated.
Painstop®*	Paracetamol 24mg/ml Codeine 1mg/ml	15mg/kg of Paracetamol component 6-8 hourly (P/O)	0.0063ml 4-8 hourly P/O
Infant/Baby Panadol Drops®*	Paracetamol 100mg/ml	15mg/kg 6 hourly – (P/O)	0.0015ml 6 hourly P/O

*Non-scheduled drugs

Continued over-page

ANTIBIOTICS (General Wounds and Lacerations unless otherwise specified) –

Drug	Composition	Dose Rates	Administration Amount for a 10gm Microbat
Betamox®	Amoxicillin	20 mg/kg BID S/C or I/M	As advised by Veterinarian.
Clavulox®	Clavulanic acid 35mg/ml Amoxicillin 140mg/ml	24 mg/kg P/O BID or S/C, I/M SID	As advised by Veterinarian.
Baytril®	Enrofloxacin	5 mg/kg S/C or I/M or P/O SID	As advised by Veterinarian.
Antirobe®	Clindamycin	11 mg/kg P/O BID – For bone and anaerobic infection.	As advised by Veterinarian.
Flagyl® Used in combination with Clavulox® as a preferred alternative to Antirobe®	Metronidazole	15mg/kg P/O, S/C or I/V BID - severe sepsis, bone and anaerobic infection or protozoal infections (rare)	As advised by Veterinarian.

ANTI-PARASITIC / ANTHELMINTICS

Drug	Composition	Dose Rates	Administration Amount for a 10gm Microbat
Ivomec®	Ivermectin	0.2 mg/kg S/C or P/O Single dose	As advised by Veterinarian.
Vetdectin® and various other brand names	Moxidectin	0.2 mg/kg S/C or P/O Single dose	As advised by Veterinarian.

MISCELLANEOUS

Drug	Composition	Dose Rates	Administration Amount for a 10gm Microbat
Ilium Selvite E®	Vitamin E 45.6mg/ml and Selenium 2.5mg/ml	1ml/30kg for 3 days IM	As advised by Veterinarian.
Zantac®	Ranitidine	1mg/kg IV or S/C BID	As advised by Veterinarian.
Carafate®	Sucralfate	Smallest amount possible of a ground tablet	As advised by Veterinarian.
Redipred®	Prednisolone sodium phosphate	0.5mg/kg P/O BID daily then wean down to SID, then every second night	As advised by Veterinarian.
Solucortef®	Hydrocortisone sodium succinate	5mg/kg IV or S/C usually single dose	As advised by Veterinarian.

PREFERRED METHOD OF EUTHANASIA

- Anaesthetizing via Isoflurane initially then Injection of Sodium Pentobarbitone

Appendix 6 – Microbat Assessment Form

Microbat Assessment Form

Rehabilitators Name		Rehabilitators Telephone	
Species		ID Code	
Sex Age	☐ Male ☐ Female ☐ Baby ☐ Juvi ☐ Adult (only determined by looking at wing joints)		
Rescue Date	/ / 20	Rescue Time	☐ AM ☐ PM

Caller Details

Callers Name	
Callers Address	
Callers Telephone	
Rescue location	
Animal History *e.g. road trauma/cat attack*	

Initial Assessment

Demeanour	☐ Bright ☐ Alert ☐ Depressed ☐ Moribund ☐ Distressed ☐ Other
General body condition	☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor ☐ Emaciated
Fur condition	☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor
Breathing	☐ Normal ☐ Rapid ☐ Slow ☐ Laboured ☐ Open-mouthed ☐ Noisy
Mobility	☐ Normal ☐ Other
Injury discharges or conditions	
Result of initial assessment	☐ Immediate euthanasia ☐ Requires Care ☐ Veterinary assistance required ☐ Immediate release (only after consultation with coordinator)

Thorough Physical Assessment

Weight	Gms F/a
Sedation	Name of Drug: Dose Rate:
HEAD	
Symmetry	☐ Normal ☐ Other
Eyes	☐ Normal ☐ Other

Ears	☐ Normal ☐ Other
Nostrils	☐ Normal ☐ Other
Mouth	☐ Normal ☐ Other
LEGS/WINGS	
Right wing	☐ Normal ☐ Other
Right rear leg foot	☐ Normal ☐ Other
Left wing	☐ Normal ☐ Other
Left rear leg foot	☐ Normal ☐ Other
BODY	
Fur condition	☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor
Body condition	☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor ☐ Emaciated
Anus	☐ Normal ☐ Other
Penis/ vulva	☐ Normal ☐ Other
Tail condition	☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor
Abdominal palpation	☐ Normal ☐ Other
Mucous membrane	☐ Normal ☐ Other
General findings or comments	

DETAILS OF VETERINARY EXAMINATION

Date/time	/ /20 Time: am/pm
Veterinarian	
Diagnostic Aids	☐ Radiography ☐ Blood ☐ Faecal ☐ Other
Veterinary Diagnosis	
Treatment Management	

FINAL OUTCOME

Released ☐	Date / /20 At (location)
Euthanased ☐	Date / /20 By (name)
Transferred ☐	Date / /20 To (name)

Appendix 7 – SEQ Microbat Species Information Charts

Photo Credits:
All photos credited to Les Hall, with the exceptions of:

- *Chalinolobus dwyeri*, *Chalinolobus morio*, *Austronomus australis*, *Chalinolobus picatus* – all credited and used with permission from Michael Pennay
- *Rhinolophus megaphyllus*, *Myotis macropus* and *Phoniscus papuensis* – credited to Steve Parish
- *Oximops ridei* and *Saccolaimus flaviventris* – credited to Rachel Lyons

SHEATH-TAILED BATS (Emballonuridae)

<table>
<tr><td>Species:</td><td colspan="3">Saccolaimus flaviventris</td><td colspan="2">Yellow Bellied Sheath-tailed Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Large bat with dark black fur on the back and white to yellow fur on the belly. Males have a throat pouch containing glandular material and females have a ridge in the same location but no pouch.
Weight – 30-60g
Forearm – 66-82</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Predominantly beetles but also grasshoppers, crickets, leafhoppers, shield bugs and flying ants.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Wet and dry eucalypt forest, open woodland, acacia woodland.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating in August, young born Dec/Jan typically in colonies of up to 100.</td><td>Seasonal Movements</td><td colspan="2">They migrate south between January and April.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Tending solitary as they are territorial, but small colonies (mixed sex) usually in small numbers (2-6) in late winter and spring and colonies up to 100 have been documented when young are born in Dec/Jan.</td><td>Wild Roosting Habit</td><td colspan="2">Large tree hollows typically.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Nest box, hanging pouch, suspended foam cave.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast and straight above the canopy or lower if in non-vegetated areas. Tight lateral turns when pursuing prey.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>Unknown - Known to fly one-directional in 6m x 30m but not sustained flight. Require 4m + height.</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="3">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Orphans rarely in care – limited information available.</td></tr>
<tr><td>Specific Diet (refer Appendix 2)</td><td>Specific Diet (refer Appendix 2)</td><td>Milk Formula B (Refer Appendix 2) via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand feed, and can be trained to self-feed with perseverance They have been known to stop self-feeding after several weeks.</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, firewood collection</td></tr>
<tr><td>Development Information</td><td colspan="6">Orphans rarely in care – limited information available.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Largest of the microbat family in this region
• Typically a very placid bat
• Individuals of species have tested positive for Lyssavirus.
• Some self-feed well but have been known to stop self-feeding – keep a close eye on them.</td></tr>
</table>

HORSESHOE BATS (Rhinolophidae)

<table>
<tr><td>Species:</td><td colspan="3">Rhinolophus megaphyllus</td><td colspan="2">Eastern Horseshoe Bat</td><td colspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Generally grayish brown fur which is slightly lighter on the belly with pale white tips – orange variant exists. Medium size microbat but very finely boned. Ears large with no tragus. Has complex horseshoe shape nose-leaf.
Weight – 7-13g Forearm – 44-52</td><td colspan="2"></td></tr>
<tr><td>Natural Diet</td><td colspan="3">Predominantly moths (non-eared species), but also beetles, flies, crickets, bugs, cockroaches and wasps are gleaned on the wing.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Mature wet and dry eucalypt forest, rainforest, open woodland.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating late June, single young born November. Late sexual maturity in both species (males 1.5 yrs, females 3 yrs). Known to live until 7 years.</td><td>Seasonal Movements</td><td colspan="2">Disperse in winter, females congregate in humid caves with minimal airflow in Sept/Oct.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Tending solitary in winter, other times small groups (less than 20) but females congregate in maternity colonies up to 10,000 individuals but typically smaller.</td><td>Wild Roosting Habit</td><td colspan="2">Caves and old mines predominantly, also found in drains, buildings (including showers), tree hollows occasionally. Temp range – 12-33°C, Humidity 85-100%. (Jackson, 2007)</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Suspended material or foam cave from center of roof.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Short broad wings enable hovering flight and highly maneuverable flight</td></tr>
<tr><td rowspan="2">Sml-Med Tank Terrarium with heat source and HIGH HUMIDITY (a must) option</td><td rowspan="2">Large Mesh Terrarium – or small tent with higher humidity</td><td rowspan="2">Humidicrib (med-high humidity is important)</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m</td></tr>
<tr><td>Minimum Duration</td><td>3 weeks</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Must have the right humidity to successfully rear young</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Milk Formula A (Refer Appendix 2), via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand-feed, difficult to get self-feeding - perseverance needed.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Ceiling fans, cat attacks, car hits</td></tr>
<tr><td>Development Information</td><td colspan="6">Young full size at 6 weeks, weaned at 8 weeks, but not independent until 10-12 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• They hang by their toes in a pendulum style from the centre of caves and cages in captivity, and they swivel from toes to view surrounds.
• Typically easy to handle / placid
• Dehydrate very easily as usually spend daytime in caves with high humidity.</td></tr>
</table>

FREE-TAILED BATS (Molossidae)

<table>
<tr><td>Species:</td><td colspan="3">Ozimops lumsdenae</td><td colspan="2">Northern Free-tailed Bat (Formerly Beccari's Free-tailed Bat)</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Heavy-set, muscular and robust bat, largest in Ozimops family. Short grayish to light brown fur on back and paler underneath. Musky smell. Triangular ears that do not join with dark brown ear skin
Weight – 20-30g Forearm – 46-52mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Predominantly aerial moths and beetles gleaned above canopy, but also bugs, lacewings, flies and grasshoppers. Can capture non flying prey as they are very agile and fast on surfaces.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Most forest types – hunting along creek lines and above canopy.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Single young birthed October to January (peak December).</td><td>Seasonal Movements</td><td colspan="2">No seasonal movements known</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Colonies up to 50 known.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, house roofs and walls, power pole boxes</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging cloths from side walls favoured. But love to hide under cloth over a heat mat.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Short, narrow and pointed wings. Flying fast (rapid beats – 28km/hr) and straight with gentle turns but no tight or abrupt maneuvers, favour semi-open conditions.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy-moderate</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Milk Formula B (Refer Appendix 2) fed via sponge only.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand-feed, easy to get self-feeding. But will allow you to keep hand feeding – can be quite lazy.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, house/wall demolitions</td></tr>
<tr><td>Development Information</td><td colspan="6">Eyes open at birth, skin darkens at 1.5-2 weeks, fine fur (charcoal on back and silver on front) at 3 weeks of age (weight approx. 4g and FA 24mm), weaned at approx. 8 weeks but not independent until 10-12 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Can show teeth when in fear, are highly vocal when disturbed, lovely chatter otherwise.
• Prone to becoming over-weight in care.
• Males can become quite aggressive causing injuries to other bat, particularly during mating season.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="3">Micronomus norfolkensis</td><td colspan="2">Eastern Coastal Free-tailed Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Dark brown to reddish brown on the back and slightly lighter on belly. Ears are triangular but not joined. Slightly heavy set/muscular in build.
Weight - 6.8-10.5g Forearm – 36-38.3 mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Unknown in wild.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Coastal dry forests, woodlands and agricultural areas.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Single young born November to December. Lactation occurs until end of January and young are flying by late January / early February.</td><td>Seasonal Movements</td><td colspan="2">No information available.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Known to roost in same and mixed sex pairs but often solitary. Often found roosting with Eastern Broad-nosed Bats and Gould’s Wattled Bats.</td><td>Wild Roosting Habit</td><td colspan="2">Hollows of large old trees, buildings, under tree bark.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch however they will often prefer to sleep vertically under cage mat.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast flyers that forage in openings and gaps in forest areas – up to 6km from roosts.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m</td></tr>
<tr><td></td><td></td><td></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Moderate</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Milk Formula B (Refer Appendix 2) fed via sponge only.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand-feed, difficult to get self-feeding because of flighty behavior. Dish placed under hanging pouch where it feels safe is the best method of self-feeding training.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping and building demolitions</td></tr>
<tr><td>Development Information</td><td colspan="6">Eyes open at birth, furred at 2-3 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Species is erratic/ skittish in behavior normally and are extremely mobile on ‘all fours’.
• Best to feed in a pouch / material fold as they require security to eat.
• Do not fly within houses /small rooms.
• Mothers do not typically roost with their young nor carry them in captivity.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Ozimops ridei</td><td colspan="2">Ride's Free-tailed Bat (formerly Eastern Free-tailed Bat)</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Rich brown above and slightly lighter creamier brown on belly. Ears are triangular but not joined. Slightly heavy set/muscular in build.
Churchill – 6.3-11.2g Forearm – 30.6-34.5 mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Known in Victoria to include bugs, flies, beetles and moths.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest, melaleuca forest, tall open forest, riparian open forest, woodland.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Single young born November to December. Lactation occurs until end of January and young are flying by late January / early February.</td><td>Seasonal Movements</td><td colspan="2">No information available.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Known to roost in same and mixed sex pairs but often solitary. Colonies of several hundred bats have been recorded. Often found roosting with Eastern Broad-nosed Bats and Gould's Wattled Bats.</td><td>Wild Roosting Habit</td><td colspan="2">Hollows of large old trees, buildings (ceilings and walls), under tree bark.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch however they will often prefer to sleep vertical under cage mat.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast flyers that forage in openings and gaps in forest areas – up to 6km from roosts.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m</td></tr>
<tr><td></td><td></td><td></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Moderate.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Mealworms or Blended Food Diet (refer Appendix 2)</td><td>Milk Formula B (Refer Appendix 2) fed via sponge only.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand-feed, difficult to get self-feeding because of flighty behavior. Dish placed under hanging pouch where it feels safe is the best method of self-feeding training.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping and building demolitions</td></tr>
<tr><td>Development Information</td><td colspan="6">Eyes open at birth weighing 2g FA 17.2-4mm furless, skins start to darker at 5-8 days of age at weight around 3.3g FA 22mm, starts to fur up (very fine) at 2 weeks weighing around 3.5g and FA 27mm. Fluffy fur at 1 month, weaning at 6-8 weeks, but not independent until 10-12 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Species is erratic/ skittish in behavior normally and are extremely mobile on 'all fours'.
• Best to feed in a pouch / material fold as they require security to eat.
• Do not fly within houses /small rooms.
• Mothers do not typically roost with their young nor carry them around in captivity.
• One account of individuals killing other individuals in captivity – monitor closely.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="3">Austronomus australis</td><td colspan="2">White-striped Free-tailed Bat</td><td>  </td></tr>
<tr><td>Description</td><td colspan="5">Shiny dark fur all over body with the exception of a white stripe along the sides of the belly where the fur and wings meet. Sometimes have white patches of fur on chest. Throat pouches exist in both sexes. Thick lips with short vertical wrinkles. Weight – 26-35g (males) 32-48g (females) Forearm – 57-65mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths, beetles and grasshoppers, but also ants and non-flying beetles indicating they also feed on the ground or on stationary areas.</td><td>Feeding Habit and Habitat in SEQ</td><td>Rainforest, open forest, agricultural and urban areas.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in late August, single young born mid December to late January. Young weaned by May.</td><td>Seasonal Movements</td><td>Migrates south in summer, north in winter (March and October). Requires night-time temperatures of less than 21 degrees to dissipate flight heat.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Gregarious and form large maternity colonies of up to several hundred in summer. However do roost singly or in groups of up to 25 at other times or year.</td><td>Wild Roosting Habit</td><td>Large Tree hollows with trunk cavities.</td></tr>
<tr><td>Captive Roost Type</td><td>Hanging pouch, likes to use various pouches sometimes against heat source sometimes without also likes a small cave-like hollow and under heated cloth on floor.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Very fast (61km/h) and direct flight high (50m) above the canopy. Poor maneuverability</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m - or larger</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Very gregarious bat, highly social (needs companionship), will cohabitate with other larger microbats.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula B (Refer Appendix 2) fed via sponge only.</td><td>Ease of Adult Feeding</td><td colspan="2">Can be difficult to hand-feed, difficult to get self-feeding when stressed. Needs contact and grooming to feel safe and will then happily self-feed. Thrives on routine.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping.</td></tr>
<tr><td>Development Information</td><td colspan="6">Born with eyes open, furred within 3-4 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Humans can hear echolocation calls (not just communication calls).
• Very agile on the ground.
• Adults difficult to get started feeding, juveniles not so bad
• Roosts are prone to heat stress events</td></tr>
</table>

EVENING BATS (Vespertilionidae)

<table>
<tr><td>Species:</td><td colspan="3">Chalinolobus dwyeri</td><td colspan="2">Large-eared Pied Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Shiny black fur on its back, brown belly usually with a strip of white fur on the sides of the body where the membrane joins. The white fur runs down to form a ‘v’ shape on the pubic region. Large ears pronounced wattle (lobe).
Weight – 5.5-12.2g FA Length – 36.8-45mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Not known.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Tall open forest (wet and dry), rainforest edges, riparian areas and woodlands.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating Autumn and early winter, maternity camps of up to 40 females give birth to single or twin young (common) from November with young independent by late February</td><td>Seasonal Movements</td><td colspan="2">Moves between different structures throughout the seasons – no major migrations known.</td></tr>
<tr><td>Social Structure</td><td colspan="3" rowspan="2">Found individually and in colonies up to 40 at different times of the year. They remain loyal to the same caves year after year.</td><td>Wild Roosting Habit</td><td colspan="2">In twilight areas of caves, mines, cliff crevices clustered in indentations/ domes on the ceiling of the structures. Also known from fairy martin mud nests and tree hollows.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch and foam cave structure.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Relatively slow with rapid but shallow wing beats – flight is direct but only moderately maneuverable – mostly fly below 10m.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Rare to come into care as pups – limited information to date.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Rare to come into care – limited information to date.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping.</td></tr>
<tr><td>Development Information</td><td colspan="6">Rare to come into care as pups – limited information to date.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">Rare to come into care – limited information to date.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Chalinolobus picatus</td><td>Little Pied Bat</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="3">Black fur on back and belly with a white fringed flank extending to the pubic area – similar to C. dwyeri, but with smaller ears.
Weight – 3-8g FA Length – 31-37mm</td></tr>
<tr><td>Natural Diet</td><td colspan="2">Moths only species currently known.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Dry forest and woodland. Recently know to make routine 34km round trips to hunting areas from roost.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="2">One or two young born in November.</td><td>Seasonal Movements</td><td colspan="2">Unknown</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Forms mixed colonies of up to 50 known in often permanent roosts, but usually colonies are smaller and around 10 individuals. Often known to roost alone however and move roosts regularly but within same vicinity.</td><td>Wild Roosting Habit</td><td colspan="2">Old mines, tree hollows, buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch.</td></tr>
<tr><td rowspan="4">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast and highly maneuverable (darting, swooping and diving) – flying close to and gleaning from vegetation.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 4m high. (Under review)</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Rare to come into care as pups – limited information to date.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Can be stressy but when comfortable with captivity will feed ok.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="5">Tree lopping, caught in buildings.</td></tr>
<tr><td>Development Information</td><td colspan="5">Rare to come into care as pups – limited information to date.</td></tr>
<tr><td>Other Specifics</td><td colspan="5">Rare to come into care – limited information to date.</td></tr>
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<table>
<tr><td>Species:</td><td colspan="2">Chalinolobus gouldii</td><td>Gould's Wattled Bat</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="3">Brown to black with black on head and shoulders, short muzzle, ears short but broad, large wattle (lobe).
Weight – 6.8-15.8g FA Length – 36.6-45.9mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Bugs and moths predominantly but also winged ants, cockroaches, flies, beetles, cicadas, caterpillars and field crickets.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">All habitats – most widespread bat in Australia</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating May to June, fertilization late winter and single or twins born in October – November.</td><td>Seasonal Movements</td><td colspan="2">Move between several roosts of different nights, can enter hibernation in Southern Australia</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Males usually solitary however can form bachelor groups. Females can roost alone but usually form longer lasting groups up to 80.</td><td>Wild Roosting Habit</td><td colspan="2">Cluster. Tree hollows favoured but also roosts in houses and nest boxes. Temp Range – 28°C Approx. (Jackson, 2007)</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch / material</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast flight (up to 36km/h) with abrupt zig zagging and vertical angles within and below the tree canopy 5-15km often from roost.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3 m.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="3">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Provided routine is observed this little bat is no trouble. Easy to get to self-feed.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Routine is important and will happily run out to meet the food dish</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, predation due to early roost emergence, building demolition or roost displacement.</td></tr>
<tr><td>Development Information</td><td colspan="6">Typically weaned at 8 weeks but not independent until 10-12 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Murmurs (like buzzing bees) often when in hand and feeding or when disturbed.
• One of the most common bats found in urban areas.</td></tr>
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<tr><td>Species:</td><td colspan="2">Chalinolobus morio</td><td>Chocolate Wattled Bat</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="3">Chocolate coloured fur all over, short muzzle with steep forehead, short and broad ears, tragus short and curving forwards, wattle (lobe) moderately developed.
Weight – 5.5-13g FA Length – 33-42.4mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths and beetles predominantly, but also termites, flies, bugs ants.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest, wet and dry eucalypt forest and woodlands – following water courses and feeding in the same area each night up to 5km from roost.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in Autumn and winter. Females give birth to one or two young in Oct-Nov.</td><td>Seasonal Movements</td><td colspan="2">No significant migration.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Males usually roost alone, females can congregate in roosts up to 70 in trees and 400 in buildings and caves. Bats move between roosts very regularly.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, buildings, under exfoliating bark, fairy martin mud nests, culverts and caves.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, hollow logs, caves etc</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Fast and direct up to 28km/hr– rapid wing beats, very agile and maneuverable hunting. Fly usually in the open zone between the top of the understorey and the canopy.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy - provided routine is observed this little bat is no trouble.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy - routine is important and will happily run out to meet the food dish.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost disturbance in buildings</td></tr>
<tr><td>Development Information</td><td colspan="6">Young born 25% of females weight at birth (twins combined 35%).</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Makes a distinctive ‘buzzing bees’ chatting noise when disturbed or feeding.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="3">Chalinolobus nigrogriseus</td><td colspan="2">Hoary Wattled Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Black to dark grey fur with white tips (frosting), wattle (lobe) is poorly developed, medium sized broad ears.
Weight – 7.5-10g (WA bats smaller) FA Length – 32-38mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Beetles, moths, flying ants and mosquitoes predominantly – but also including spiders, mantids, earwigs, crickets, bugs, flies and lacewings.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Quite diverse - Floodplains, swamps, open eucalypt forests, riparian rainforests and urban areas - emerging early in the evening.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs pre-June most likely. Females give birth to twins in October and November.</td><td>Seasonal Movements</td><td colspan="2">No significant migration known.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Unknown</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows and occasionally rock crevices.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, hollow logs, caves etc</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Moderately fast flyers (up to 34km/h) below canopy level. Agile with highly maneuverable hunting techniques – prey range 3-5m.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Moderate – dehydrate quickly.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Relatively easy.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping.</td></tr>
<tr><td>Development Information</td><td colspan="6">Juveniles have almost black fur with little frosting / silver fur tips</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Relatively placid bat but suffers from stress easily in captivity – incoming bats should have glucose therapy in first few days.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="3">Falsistrellus tasmaniensis</td><td colspan="2">Eastern Fallistrelle</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Larger microbat, dark brown (with slightly lighter belly) in colour with long but slender ears that extend well beyond the head. Outer ear has a small notch. Muzzle sparsely furred. Tragus is more than half of the length of the ear.
Weight – 16-28.5g FA Length – 45.3- 56.3mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths, beetles (larger prey) and some bugs, ants and flies.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Tall wet eucalypt forest with dense understorey, riparian rainforest, open forest. Known to hunt 12km from roost.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating – large spring ‘early summer. Single young are born in December.</td><td>Seasonal Movements</td><td colspan="2">No significant migration known.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Roosts in colonies of 3 to 80, usually in separate species groups although mixed colonies have been observed. Often roost singly and use different roosts each night within a 750m area. Home range of 136ha.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, caves, buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, hollow logs, caves etc.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Swift and direct, within or just below canopy, with darting patterns during hunting.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Rare for pups to come into care – limited information to date.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Difficult to hand-feed, difficult to get self-feeding.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping.</td></tr>
<tr><td>Development Information</td><td colspan="6">Rare for pups to come into care – limited information to date.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">Rare to come into care in SEQ – limited information to date.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Miniopterus australis</td><td>Little Bent-winged Bat</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="3">Velvety chocolate brown bat with slightly lighter belly. Ears short round and triangular, short muzzle and domed head. Pointier nose than most other microbats.
The Bent-wingeds have a shorter second phalange but an extra-long third phalange in the second finger which enables them to fold the wing back towards the body when at rest.
Weight – 5.2 – 8.3 FA Length – 37.2-40.8</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Beetles, moths, flies, spiders, ants and wasps.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest, vine thicket, wet and dry eucalypt forests, melaleuca swamps and coastal forests.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in July-August, there is delayed implantation in September and single young are born in December. Caves and large colonies provide the necessary temperature and humidity required to keep pups warm.</td><td>Seasonal Movements</td><td colspan="2">Colonizes in traditional summer caves or cave like structures and disperses in winter.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Gregarious and form tight clusters in their roosts which are predominantly caves or cave like structures. Roosts range in size up to 200,000 bats. Often roost with Common Bent-wingeds.</td><td>Wild Roosting Habit</td><td colspan="2">Caves, abandoned mines, tunnels, storm water drains and buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging clothes and foam cave structures</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Rapid but with high maneuverability between the shrub and canopy layers.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Unknown – young left in cave so rarely in care.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand feed and catch on to self-feeding relatively easily.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Cat attacks, car hits, ceiling fan hits</td></tr>
<tr><td>Development Information</td><td colspan="6">Cave roosting pups – rarely in care.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• High humidity bat and temperature sensitive – must be kept warm over winter regardless of condition
• Very stress species in care – difficult to keep alive – incoming bats should have glucose therapy in first few days
• Often found roosting alone and exposed in SEQ in late March- April – presumed separated from others during coastal migration and suffering extreme myopathy as a result.</td></tr>
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<table>
<tr><td>Species:</td><td colspan="2">Miniopterus orianae</td><td colspan="2">Large/ Common/Eastern Bent-winged Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Velvety dark reddish brown to dark brown bat with slightly lighter belly. Short muzzle and domed head with pointier nose than most microbats. Ears are short, rounded and triangular. Three subspecies exist.
Weight – 10.6-20g FA Length – 45.2-50mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths, cockroaches, flies and beetles.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Wet and dry eucalypt forest, open woodland, melaleuca forest and open areas. Foraging areas up to 65km from roost.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in May-June, there is delayed implantation in late August and single young are born in December to mid January. Caves and large colonies provide the necessary temperature and humidity required to keep pups warm when they are left in crèches at night.</td><td>Seasonal Movements</td><td colspan="2">Congregates in large colonies and summer and disperses within territory range in winter.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Gregarious and cluster roost in colonies up to 100,000 bats.</td><td>Wild Roosting Habit</td><td colspan="2">Cluster. Traditionally used caves and cave like structures such as abandoned mines and road culverts. Temp Range – 10-30°C, Humidity 80-90% (Jackson, 2007).</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging cloth or foam cave structure.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Very fast and level with quick dives. Flies high in forested areas and low in non-forested areas.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat and high humidity set-up</td><td rowspan="2">Large Mesh Terrarium – or small tent with high humidity set-up</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td>Minimum Duration</td><td>1 month.</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Unknown – young left in cave so rarely in care</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to hand feed and catch on to self-feeding relatively easily.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Cat attacks, car hits, ceiling fan hits</td></tr>
<tr><td>Development Information</td><td colspan="6">Weight at birth 2.8g, , can fly by 7 weeks, weaned at 66 days (10 weeks), weight at weaning 12.5g</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Large Bent-wingeds have an excessive appetite, often eating 30-40 mealworms per night in captivity.
• The M. Schriebersii are extremely long lived (22 years +) and are known to fly up to 300km in one night.
• Require high humidity rehabilitation and rearing conditions – individuals can be very stress.
• Quite a delightful bat to rehabilitate.
• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Myotis macropus</td><td colspan="2">Large Footed Myotis</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Generally grey brown fur but can vary to reddish brown. Ears long and tragus long and straight. Large feet and long calcar.
Weight – 5-12g FA Length – 36-42mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Forage over water for insects that live on or just below the surface which they catch by dipping and skimming their large feet across the water. Species collected include various tiny aquatic insects, water boatmen, backswimmers, water spiders, whirlgig beetles, small fish (only 1% of diet) and prawns. Also known to catch insects in flight including moths, beetles etc.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="3">Strong association with permanent waterways with surrounding vegetation.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">In SEQ, typically one young per year (but up to 3 in northern Australia), born in November after mating in early August.</td><td>Seasonal Movements</td><td colspan="3">No significant migration known.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Do form colonies of hundreds, but typically roost in groups less than 15 in defined harems of one male and up to 12 females. Single males often found roosting alone.</td><td>Wild Roosting Habit</td><td colspan="3">Roost near water in caves, mines, tunnels, drain holes, tree hollows, fairy martin mud nests.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="3">Hanging pouch, foam caves</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="3">Fairly slow and moderately maneuverable.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td colspan="2">8 x 8 x 3m high.</td></tr>
<tr><td>Minimum Duration</td><td colspan="2">1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="3">Difficult to rear at all ages – High mortality rate.</td></tr>
<tr><td>Mealworms & Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms & Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="3">Moderately difficult to feed juveniles, often difficult to feed adults.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Culvert excavations, large rain / storm events and ‘floating’ bats in rivers.</td></tr>
<tr><td>Development Information</td><td colspan="6">Lactation lasts for 8 weeks and mother and young forage and roost together for a further 3-4 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Very difficult to rear pups and juveniles.
• Highly stressed bats when on their own, but can be housed with Ride’s Free-taileds and Eastern Broad-nosed with success. Incoming bats should have glucose therapy in first few days
• Moderately cranky bat.
• This is a little bat that you would aim to get back out asap to minimize chance of loss.
• Suffers dietary deficiency when in care for extended periods – contact Author (Lyons) for modified recipe currently being trialed.
• Require higher humidity.</td></tr>
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<table>
<tr><td>Species:</td><td colspan="3">Nyctophilus bifax</td><td colspan="2">Eastern Long-eared Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Light to dark rich brown with red tinged fluffy fur often slightly lighter on belly. Low rounded and hairless ridge on the poorly developed muzzle behind the noseleaf. Ears long (19.2-27.1mm) and the glans penis in a square ended cylinder with flat urethral opening on underside. Leaner more lightweight bat for its size than most other genus. Weight – 5-13g FA Length – 37-46.8g</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths and small amounts of ants and beetles. Will land on ground to hunt.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Typically rainforest, riparian forest and mangroves in SEQ. Also known from tall open forest and dry woodlands. They perch hunt from branches typically on the edge of the tree canopy.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Twin young are born in October. Lactation extends to mid-late December.</td><td>Seasonal Movements</td><td colspan="2">No significant seasonal migration known.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Less social - Mainly roost singly (male and female) but known to roost in loosely grouped colonies of up to 7 in number. Roosts are changed frequently but there is strong association to a group of trees – most roosts used within 250m of each other.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, under loose bark, epiphyte clumps, within foliage, under and within buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging clothes, small hanging baskets.</td></tr>
<tr><td rowspan="2">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Highly maneuverable and fly readily within fairly confined spaces</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td>Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions
Minimum Duration</td><td>3 x 3 x 2m. no greater than 5 x 5m
3 weeks.</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Somewhat difficult to rear from unfurred, easy to rear from furred.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed adults and they readily self-feed within a few days of care without training.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost displacement, indoor trappings are common (bat found starving and dehydrated).</td></tr>
<tr><td>Development Information</td><td colspan="6">Twins born eyes closed and furless and weight approximately 1g, cutting fur within 1 week and roosting independently from mum and fully furred by 4 weeks, flying well and weaned by 6 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• ‘Grumpy bats’ dislike being handled, very readily bite and offer defensive noises.
• Juveniles of wild captive mums do not know how to eat mealworms so must be taught by rehabilitator.
• Wild captive mums often dump/attack one pup – so keep a very close eye on them.
• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days</td></tr>
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<tr><td>Species:</td><td colspan="3">Nyctophilus geoffroyi</td><td colspan="2">Lesser Long-eared Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Light grey fur on back and lighter often white fur on belly. Hairs are bi-coloured and darker at base, high muzzle ridge with distinctive ‘Y-shaped’ groove behind the noseleaf. Ears are long (17.6-25.3mm).
Weight – 3.9 – 8.5g FA Length – 17.6-25.3</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths, crickets and grasshoppers preferred however various wingless insects are also eaten. They can land on ground to capture prey. They use echolocation, normal listening and visual means for locating and capturing food.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Diverse range of habitats including urban areas.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in April, with females storing sperm over winter. Ovulation and fertilization in late August/ September. Twins born October to November, weaned by early February.</td><td>Seasonal Movements</td><td colspan="2">Migration not observed.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Usually roost alone or in groups of two or three. Maternity colonies of up to several hundred have been recorded but normally range to 15 females with an adult male often present.</td><td>Wild Roosting Habit</td><td colspan="2">Solitary. Hollow trees, buildings, crevices, urban articles (hanging sack, clothes), mud fairy wren nests. Temp Range – 12-18°C (Jackson, 2007).</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging clothes and small hanging baskets</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Flight is slow but highly maneuverable usually close to vegetation and into the understorey. Can take off from ground level.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m no greater than 5 x 5m</td></tr>
<tr><td>Minimum Duration</td><td>3 weeks</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Somewhat difficult to rear from unfurred, easy to rear from furred.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed adults and they readily self-feed within a few days of care without training.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost displacement, indoor trappings are common (bat found starving and dehydrated).</td></tr>
<tr><td>Development Information</td><td colspan="6">Twins born eyes closed and furless and weight approximately 1g, cutting fur within 1 week and roosting independently from mum and fully furred by 4 weeks, flying well and weaned by 6 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• ‘Grumpy bats’ dislike being handled, very readily bite and offer defensive noises.
• Juveniles of wild captive mums do not know how to eat mealworms so must be trained.
• Wild captive mums usually dump/attack one pup – so keep a very close eye on them.
• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days</td></tr>
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<table>
<tr><td>Species:</td><td colspan="3">Nyctophilus gouldi</td><td colspan="2">Gould's Long-eared Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="5">Grey to grey- brown fur with ash grey belly. Ears are long (24.3-30.1mm). Muzzle ridge is moderately developed. Glans penis is divided by groove lengthways into two cylinders. Weight – 5.2-9.9 and FA Length – 36.3-41.8mm (in QLD)</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths and beetles predominantly however crickets, flies, cockroaches, ants and spiders also eaten. They can land on ground to capture prey. They use echolocation, normal listening and visual means for locating and capturing food.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest, wet and dry eucalypt forest, woodland and urban areas.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating occurs in April, with females storing sperm over winter. Ovulation and fertilization in late August/ September. Single young or twins (50% of time) born October to November, weaned by early February.</td><td>Seasonal Movements</td><td colspan="2">Migration not evident.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Males roost alone of in small loose groups of up to 6. Females form colonies of often over 20.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, dense vegetation, under bark, bat boxes.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging clothes, small hanging baskets, nest boxes.</td></tr>
<tr><td rowspan="4">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Slow but highly maneuverable, usually below the canopy and 2-5 m above the ground. Can take off from ground level.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m no greater than 5 x 5m</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>3 weeks</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Somewhat difficult to rear from unfurred, easy to rear from furred.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed adults and they readily self-feed within a few days of care without training.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost displacement, indoor trappings are common (bat found starving and dehydrated).</td></tr>
<tr><td>Development Information</td><td colspan="6">Twins born eyes closed and furless and weight approximately 1g, cutting fur within 1 week and roosting independently from mum and fully furred by 4 weeks, flying well and weaned by 6 weeks.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• 'Grumpy bats' dislike being handled, very readily bite and offer defensive noises.
• Juveniles of wild captive mums do not know how to eat mealworms so must be taught by rehabilitator.
• Wild captive mums usually dump/attack one pup – so keep a very close eye on them.
• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days</td></tr>
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<table>
<tr><td>Species:</td><td colspan="2">Phoniscus papuensis</td><td>Golden-tipped Bat</td><td colspan="3" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="3">Dark brown wooly fur with golden tips. Sparse golden fur (like frosting on tips) also on ears, forearms, radius, metacarpals, legs, tail membrane and thumbs. Long and sharp canines that fit into pouch on bottom lip. Ears are funnel shape with long pointed tragus. Pointed nose. Large tail membrane.
Weight – 5.3-9.3g FA length – 34-40.3mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Orb weaving spider specialist (only one in the world). Spiders consist of approx 90% of diet in summer and 100% of diet in winter. Small quantities of beetles, moths, flies and bugs ingested also. Bats suck the spiders dry before swallowing the abdomen, not observed to eat the legs or head.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest and moist closed and open forest where orb weaving spiders are prevalent.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Young born Nov-possibly mid January.</td><td>Seasonal Movements</td><td colspan="2">Not observed.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Males roost singly, females and young observed roosting in groups of 5 to 20 bats. Roosts are changed every day or so but are all within approximately 350m of each other.</td><td>Wild Roosting Habit</td><td colspan="2">Hanging dome shaped nests of scrub wrens and gerygones, usually around waterways. Known also from hollows and epiphytic moss clumps.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging clothes high in cages and small hanging baskets/ cane caves.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Slow flying and can hover and maneuver well and along with broadband frequency sweep calls that don’t travel to far, allow them to snatch spiders from webs without getting stuck or caught.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>3 x 3 x 2m</td></tr>
<tr><td>Minimum Duration</td><td>3 weeks</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Unknown</td></tr>
<tr><td>Orb weaving spiders (Eriophora transmarine – Garden Orb-weaver and Nephila Sp – Golden Orb-weaver fed safely) and mealworms</td><td>Orb weaving spiders (Eriophora transmarine – Garden Orb-weaver and Nephila Sp – Golden Orb-weaver fed safely) and mealworms</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Moderately easy to feed adults easy to get to self-feed from dish</td></tr>
</table>

	or Blended Food Diet (refer Appendix 2) 1.	or Blended Food Diet (refer Appendix 2) 1.			
Rehab Reasons	Ceiling fan hits only known reason for care to date, however cat attack also a possible threat				
Development Information	Unknown				
Other Specifics	• This species was presumed extinct from 1897 to 1981 when it was rediscovered, increasing numbers of sightings may indicate a population increase. • Lightning quick bite but generally placid and easy to handle • Refer to you-tube video (search 'golden tipped bat') for techniques used successfully to feed spiders – extreme care must be taken.				

<table>
<tr><td>Species:</td><td colspan="2">Scoteanax rueppellii</td><td>Greater Broad-nosed Bat</td><td colspan="3">  </td></tr>
<tr><td>Description</td><td colspan="5">The one and only species in the world belonging to the Scotorenax genus, wooly reddish brown fur, slightly paler on belly. Ear slender and triangular, triangular tragus. Often confused with the Eastern Fallistrelle but only has two not four upper incisor teeth.
Weight – 20-39.8g FA – 50.5-56.2mm</td></tr>
<tr><td>Natural Diet</td><td colspan="2">Large beetles predominantly, spiders, grasshoppers, moths, flies, ants, bats and small marsupials.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Tall Forest in deep gullies and ranges, melaleuca swamp, rainforest open woodland, cleared areas.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="2">Single or twins born December to January.</td><td>Seasonal Movements</td><td colspan="2">Significant migration not known.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="2" rowspan="2">Maternity colonies formed in trees with males excluded during this time.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, under bark and occasionally buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, hollow logs, man-made caves</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Flies high but at moderate speed, limited maneuverability. They hunt above or against tree canopies and perch hunt.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Will easily self-feed do not put any other smaller bats in or near at feed time as they see these as food</td></tr>
<tr><td>Rehab Reasons</td><td colspan="5">Tree lopping.</td></tr>
<tr><td>Development Information</td><td colspan="5">Not known. However development is similar to smaller cousin the Little Broad-nosed Bat.</td></tr>
<tr><td>Other Specifics</td><td colspan="5">• Greater Broad-nosed Bats need to be housed separately and with no other species as they have been known to eat bats and small marsupials both in the wild and in captivity – even breaking into adjoining cages to eat other bats.
• Can be cranky and vocal when young and feeling insecure.
• Placid as adults and highly prone to becoming obese in care.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="3">Scotorepens greyii, inclusive of potential Scotorepens (undescribed)</td><td colspan="3">Little-Broad-nosed Bat and potential new species, Central-eastern Broad-nosed Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="6">Brown to grey-brown with lighter belly, fur is bi-coloured with base of fur lighter than the tips. Ears are broad and tragus has a narrow and pointed tip. Broad furless muzzle.
Greyii – Weight – 4-8.5g FA Length – 27.3-35mm
Undescribed – Weight – 6.1-9 FA Length – 31-34.6mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Beetles, bugs, ants, moths, termites, flies and lacewings indicating they catch prey in flight and also glean it off vegetation.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Melaleuca forest, tall open forest, open woodland, escarpments, watercourses.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating late August, single or twin (common) young born in October and November, flying and foraging with mothers in mid December and weaned in January.</td><td>Seasonal Movements</td><td colspan="2">There are indications of seasonal movements but not studied sufficiently.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Roosts of between two and twenty bats known. Often found roosting with Ozimops ridei.</td><td>Wild Roosting Habit</td><td colspan="2">Hollows or tree hollow type structures, buildings, hanging material.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouches.</td></tr>
<tr><td rowspan="4">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Moderately fast and agile – continuous forages, hunting close to tree tops, habitat edges.</td></tr>
<tr><td rowspan="3">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="3">Large Mesh Terrarium – or small tent</td><td rowspan="3">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="3">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="3">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy to rear but often require sub-cut fluids despite eating adequate formula amounts.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed juveniles and adults, adapt to self-feeding on their own in time.</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost disturbance, ceiling fan hits, cat attacks, building entrapments.</td></tr>
<tr><td>Development Information</td><td colspan="6">Flying by mid-December, weaned by mid January (10 weeks)</td></tr>
<tr><td>Other Specifics</td><td colspan="6">Often feisty character and strong biter, but settle well over time in captivity to be quite docile. Show teeth readily.
Need to separate males from females and place males into smaller groups of 4-5 if overwintering to avoid weight loss and injury from incessant ‘trying to mate’ males from late May to Late July.
Easy for bats to became overweight in captivity, while some never put on weight even when eating large amounts.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Scotorepens orion</td><td colspan="2">Eastern Broad-nosed Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Dark and stocky bat, rich dark brown, pug nose broad ears, tragus narrow and pointed. Has eight spines on the head of the glans penis
Weight – 7-14.1g FA Length – 32.4-38.8mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Not known.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest and Eucalypt Forest/woodland – foraging under the canopy + urban areas</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Single young born October to December</td><td>Seasonal Movements</td><td colspan="2">No significant migration known.</td></tr>
<tr><td>Social Structure</td><td colspan="3" rowspan="2">Known to form colonies in tree hollows and buildings. Very social in captivity, females almost always roosting together and males roosting together at different times of year. Often found roosting with Ozimops ridei.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows, buildings</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch and cloths</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Not identified in literature however observed in care to be slower flyers and fairly maneuverable.</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy to rear but often require sub-cut fluids despite eating adequate formula amounts.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed juveniles and adults, adapt to self-feeding on their own in time.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost disturbance, ceiling fan hits, cat attacks, building entrapments.</td></tr>
<tr><td>Development Information</td><td colspan="6">Not documented.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Often feisty character and strong biter, but settle well over time in captivity to be quite docile. Show teeth readily.
• Need to separate males from females and place males into smaller groups of 4-5 if overwintering to avoid weight loss and injury from incessant ‘trying to mate’ males from late May to Late July.
• Easy for bats to became overweight in captivity, while some never put on weight even when eating large amounts.</td></tr>
</table>

Species:	***Vespadelus darlingtoni***	**Large Forest Bat**	Photo TBA when sourced.

Description	Long furred (darker at base) dark brown to reddish brown, dark skin, small angular shaped penis, bump on nose bridge (felt not necessarily seen). Weight – 6-8.3g FA Length – 32.5-37.2					
Natural Diet	Qld (northern species extent) diet not known – but known to eat ants, flies, bugs, moths, spiders, beetles, termites in VIC and TAS. Foraging ranges up to 300ha and individuals fly up to 6km to forage areas.			Feeding Habit and Habitat in SEQ	Rainforest, wet and dry eucalypt forest, mixed coastal vegetation	
Breeding Characteristics	Mating in March and through winter, fertilization in spring and young are born late Nov to Dec.			Seasonal Movements	No significant migration observed.	
Social Structure	Colonies up to 80 bats known but typically groups of 5-6 females and solitary males encountered. Males and females do not share roosts.			Wild Roosting Habit	Large live tree hollows, 20-40m high with roost entrances 15-20m above ground. Buildings also used.	
				Captive Roost Type	Hanging pouch, wood hollows and foam caves.	
Captive Housing	Injured Adult	Juvenile (weaning)	Orphaned (unweaned)	Flight Characteristics	Fly fast and are less maneuverable, avoiding thick vegetation	
	Humidicrib or Sml-Med Mesh Terrarium with heat source option	Large Mesh Terrarium – or small tent	Humidicrib or Sml-Med Mesh Terrarium with heat source	Pre-release / Flight Practice Facilities	Minimum Dimensions	8 x 8 x 3m high.
					Minimum Duration	1 month
Captive Diet	Injured Adult	Juvenile (weaning)	Orphaned (unweaned)	Ease of Rearing	Rare to come into care as pups.	
	Mealworms or Blended Food Diet (refer Appendix 2) 1	Mealworms or Blended Food Diet (refer Appendix 2) 1	Milk Formula A (Refer Appendix 2) fed via cannula.	Ease of Adult Feeding	Rare to come into care – limited information to date.	
Rehab Reasons	Tree lopping.					
Development Information	Juveniles are free-flying by late January/early February.					
Other Specifics	• Rare to come into care – limited information to date. • Stressy bat in care as adult – incoming bats should have glucose therapy in first few days					

<table>
<tr><td>Species:</td><td colspan="2">Vespadelus pumilus</td><td colspan="2">Eastern Forest Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Small dark chocolate brown bat with dark black base of fur, very long and thick and slightly lighter underneath. Small angular shaped penis, glans penis is blunt shaped and flat along the top.
Weight – 3.5-5.5g FA Length – 28.4 – 33g</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Moths, beetles, flies, ants/wasps and bugs.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Rainforest, moist eucalypt, Bunya/Hoop pine plantations. Foraging range is small (4-6ha).</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating in April, twin young are born in October. Little else known.</td><td>Seasonal Movements</td><td colspan="2">Roosting sites change slightly in summer (near waterways) and winter (more upslope).</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Maternity colonies up to 50 bats in large hollows in November. Males roost alone except in April during the mating season.</td><td>Wild Roosting Habit</td><td colspan="2">Large old trees in various shaped hollows, epiphytic ferns. Roosts all located within 100m of each other and are changed regularly – usually on creek banks or slightly further upslope.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, wood hollows and foam caves.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Moderately slow and fairly maneuverable, foraging within canopy and under-storey of mature forest</td></tr>
<tr><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td rowspan="2">Large Mesh Terrarium – or small tent</td><td rowspan="2">Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Rare to come into care as pups – limited information to date.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Moderately easy to feed – slower to learn to self feed.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, roost disturbance.</td></tr>
<tr><td>Development Information</td><td colspan="6">Rare to come into care – limited information to date.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Vespadelus troughtoni</td><td colspan="2">Eastern Cave Bat</td><td colspan="2" rowspan="2">  </td></tr>
<tr><td>Description</td><td colspan="4">Light brown with ginger tipped fur, fur on belly has dark brown base and fawn tips. Penis is pendulum shaped and swollen at the tip. Glans penis laterally compressed, blunt with deep furrow on underside.
Weight – 4.5-6.7g FA Length – 32.3-36.4mm</td></tr>
<tr><td>Natural Diet</td><td colspan="3">Mosquitoes but other than this – diet unknown.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Woodland, wet and dry eucalypt forest in close association with sandstone or volcanic escarpments. Foraging small areas up to 33 ha.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Young born late October to November. Pups are left at roosts clustered during the night (with mum returning at least once), however are moved regularly to new roosts every few days.</td><td>Seasonal Movements</td><td colspan="2">No significant migration observed.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Generally roosts in small groups however colonies of up to 500 individuals are known.</td><td>Wild Roosting Habit</td><td colspan="2">Well lit areas of caves and mines, rock overhangs, boulder piles – in crevices and cracks, abandoned fairy martin nests under bridges/culverts and buildings.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, foam caves.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Not recorded but likely moderate speed and moderate maneuverability.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="2">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Rare to be in care as pups – limited information to date.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula A (Refer Appendix 2) fed via sponge or cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Rare to be in care – limited information to date.</td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping</td></tr>
<tr><td>Development Information</td><td colspan="6">Rare to be in care as pups – limited information to date.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Uncommon bat.</td></tr>
</table>

<table>
<tr><td>Species:</td><td colspan="2">Vespadelus vulturnus</td><td>Little Forest Bat</td><td colspan="3">  </td></tr>
<tr><td>Description</td><td colspan="4">One of the smallest bats in Australia, brown to pale grey fur with paler belly fur that is darker at the base and creamy coloured at the tip. Tragus white to pale grey and ears and wings fairly pale also. Pendulous penis and glans penis is round and bulbous.
Weight – 3-6.5g FA Length – 23.5-32.8g</td><td colspan="3"></td></tr>
<tr><td>Natural Diet</td><td colspan="3">Only flying prey are taken and diet varies seasonally – mostly moths, bugs and beetles but also flies, wasps, flying ants/termites, grasshoppers.</td><td>Feeding Habit and Habitat in SEQ</td><td colspan="2">Wet and dry eucalypt forest, alluvial eucalypt forest, woodland. Foraging up to 1.5km from roost.</td></tr>
<tr><td>Breeding Characteristics</td><td colspan="3">Mating during winter, fertilization occurs in spring and young (mostly singles but sometimes twins) born late October to December. Young are left at roost at night.</td><td>Seasonal Movements</td><td colspan="2">Migrates.</td></tr>
<tr><td rowspan="2">Social Structure</td><td colspan="3" rowspan="2">Colony sizes vary from solitary to 120 and males and females typically roost separately.</td><td>Wild Roosting Habit</td><td colspan="2">Tree hollows (dead trees and dead branches of live trees) and buildings. Hollow entrances are very small. Usually near water.</td></tr>
<tr><td>Captive Roost Type</td><td colspan="2">Hanging pouch, wood hollows and foam caves.</td></tr>
<tr><td rowspan="3">Captive Housing</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Flight Characteristics</td><td colspan="2">Very acrobatic as purely aerial hunters.</td></tr>
<tr><td>Humidicrib or Sml-Med Mesh Terrarium with heat source option</td><td>Large Mesh Terrarium – or small tent</td><td>Humidicrib or Sml-Med Mesh Terrarium with heat source</td><td rowspan="2">Pre-release / Flight Practice Facilities</td><td>Minimum Dimensions</td><td>8 x 8 x 3m high.</td></tr>
<tr><td colspan="3"></td><td>Minimum Duration</td><td>1 month</td></tr>
<tr><td rowspan="3">Captive Diet</td><td>Injured Adult</td><td>Juvenile (weaning)</td><td>Orphaned (unweaned)</td><td>Ease of Rearing</td><td colspan="2">Easy to rear – but often require subcut fluids despite consuming sufficient milk quantities.</td></tr>
<tr><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Mealworms or Blended Food Diet (refer Appendix 2) 1</td><td>Milk Formula B (Refer Appendix 2) fed via cannula.</td><td>Ease of Adult Feeding</td><td colspan="2">Easy to feed juveniles and adults. Require training to self feed.</td></tr>
<tr><td colspan="3"></td><td></td><td colspan="2"></td></tr>
<tr><td>Rehab Reasons</td><td colspan="6">Tree lopping, cat attacks, caught in buildings, roosting in pool umbrellas.</td></tr>
<tr><td>Development Information</td><td colspan="6">Young are free flying and foraging in mid-January.</td></tr>
<tr><td>Other Specifics</td><td colspan="6">• Require training to self-feed
• A fairly placid bat.
• Stressy bat in care as adult – incoming bats should have glucose therapy in first few days.</td></tr>
</table>

Appendix 8 – 2018 AWRC Conference Paper

Microbat Rehabilitation – 10 ways to boost your chances for a successful outcome.

Rachel Lyons – Rachel@wildcare.org.au

Australian Wildlife Rehabilitation Conference
Sydney – 2-5th July 2018

Microbats are unlike any other species we rehabilitate. Over the years and after many losses, we have learnt to abandon many standard flying fox and marsupial rehabilitation concepts in order to achieve successful outcomes.

Microbat rehabilitation could be described as a new frontier, this is despite microbats comprising almost a fifth of all of the mammal species in Australia. We are learning the ropes with our precious wildlife vets by our side, sharing trials and tribulations with each other.

To our advantage, unlike many Australian mammal species, microbats are present in most continents of the world. With our microbat rehabilitator peers, particularly in Europe and in North America, we are able to share our collective knowledge and research.

This paper will outline 10 critical concepts in RAPID STYLE that have significant influence in rehabilitating microbats to improve release survival in the wild.

1) Hydration and dealing with microbats naturally high blood urea concentration.

Microbats have large lungs and over 80% naked body surface, meaning they can lose large amounts of water very quickly (Altringham, 2011).

The daily water turnover rates have been measured for several bats and is alarmingly high. One research experiment of an 8gm North American bat species indicated that daily fluid turnover was up to 67% of body mass or 5.36mls (Neuweiler, 2000). Many bats can obtain their fluid intake from the food they eat alone, however most bats require additional fluid intake.

The blood urea concentration of insectivorous bats is 4-5 times higher than that of other mammals of similar size, and is highest immediately after feeding (Neuweiler, 2000). This is despite microbat kidneys having the same functional ability of other mammals. Fluid intake and adequate hydration acts to dilute the blood urea concentration to acceptable levels, however the huge metabolic rates and energy requirements of microbats also influence the situation (Personal Communications – T. Bishop, 2017).

Microbats deprived of fluid, can die very quickly from urea poisoning often before any signs of obvious dehydration appear, particularly if the fluid deprivation occurs immediately after feeding (e.g. injury during or after feeding preventing movement to watering location).

As a result, all microbats regardless of typical dehydration signals, should be rehydrated via sub-cutaneous injection as a matter of course as soon as possible after admittance into care. The only exception to this rule is when microbats have been immediately disturbed from the roost and there is no possibility of injury or illness.

The amount of fluid required and the speed at which fluid absorption is needed to offset urea poisoning and/or dehydration, renders oral rehydration of microbats as generally ineffective. Many species of microbats will not drink sufficient amounts orally even at full health. Subcutaneous fluid injections should however only be undertaken by a veterinarian or experienced and vaccinated rehabilitator trained in fluid therapy.

2) The importance of glucose in microbat stabilisation.

Bats due to their high metabolic rate can very quickly and easily become hypoglycemic and if left untreated can become hyperglycemic due to the Somogyi effect (Personal Communications – T. Bishop, 2017). Blood glucose levels can continue to fluctuate without intervention, eventually leading to death.

All incoming bats should receive glucose as a component of initial fluid rehydration procedures (Per Coms Bishop 2017). Glucose should be provided over a number of days, particularly for bats that were admitted with moderate to severe dehydration, emaciation or those that have infection (Personal Communications – T. Bishop 2017). Stressy species of bat, including but not limited to Large Footed Myotis, Little Forest, Little Bent-wing and Long-eared Bats should also be provided with additional glucose through at least the first 72 hours.

3) Heterothermy and its implications for treatment and wound healing.

The thermoneutral zone for a microbat, where it consumes the least amount of energy and oxygen, is 30-35°C. Outside of this ambient temperature, the bat must consume large amounts of energy to maintain a constant body temperature of 35-39°C (Neuweiler, 2000).

In addition to specific roost selection, Microbats have also developed an evolutionary solution to reducing energy requirements in times of cool temperatures and/or food shortages, called heterothermy. A heterothermic animal can consciously and in a regulated way, reduce their body temperature to save energy and then consciously return to normal temperatures (Neuweiler, 2000). Two purportedly different physiological and behavioural mechanisms for heterothermy are evolved energy saving solutions for microbats in situations where temperature is below their thermoneutral zone. These solutions being: torpor (diurnal lethargy) lasting up to several hours; and, hibernation lasting up to several weeks.

When a microbat is torporing or hibernating, their metabolic rate is significantly slower which has an impact on everything from wound healing duration through to medication metabolization.

Microbats require constant peak temperature of 30-35°C (or higher if a pup) during medication treatments in order for any treatment drugs to have designed effect without organ damage, and to facilitate healing as quickly as possible. Microbats undertaking treatment are best housed in temperature-controlled situations and provided ample nutrition to lessen the incidence of entering torpor.

4) Understanding your species – microbats are not one and the same.

The two major sub-orders of flying foxes and microbats were believed to have separated about 64 million years ago, with the most recent evolutionary change within the suborders and families occurring 30 million years ago. Consequently, bats are considered ancient, with all families and genera that we know of today in existence in some form 30 million years ago (Churchill, 2008).

Over this 30 million years, the species of microbats present today have evolved often very different adaptations to suit the habitat, and food they rely on.

Most notably for rehabilitation, microbat species have different flight characteristics. Flight speed, maneuverability and agility is related to wing shape, bat weights, feeding styles, roost types, prey species behavior and forage habitat types.

Flight characteristics dictate the rehabilitation needs of each species. Some species, typically the slow highly maneuverable flyers, will undertake sustained (5 min +) flight in small spaces (e.g. 3 x 3m). Other high speed but less maneuverable flyers need large areas (over 16 x 16m) to undertake sustained flight.

Australian microbat diets are also hugely varied and are species and location specific, with limited studies having been undertaken in Australian species to date.

Orphan raising also requires different rehabilitation approaches for different species. Some species are born with eyes open, others not. Some pups cling to mum for the first weeks of life, other species park their pups with other bats, only returning to feed them when required.

Some species give birth to only single young while others routinely have twins.

Different microbat families also have marked differences in milk composition (Lollar, 2010).

5) Socio-cognitive issues – structure, communication and avoiding stress.

A German study published in early 2011, using data collected over 20 years, confirmed what many microbat rehabilitators around the world had observed for many years - that highly complex social structures exist within local populations and colonies of bats. These high-level socio-cognitive skills, on par with the likes of elephants, dolphins and primates, enable bats to maintain lifelong personal social relationships and wider friendship networks with friends and relatives (Kerth, 2011).

The outcomes of the Kerth (2011) study has recently been supported by a study by Godinho et al. (2015) identifying strong and often exclusive social structures in Australian Gould's Wattle Bats.

Microbats when removed from their home roost and taken various distances away have been observed to return even from several hundred kilometers away (Barbour, 1979). No doubt due to the strong social and personal bonds they have with other individuals in their roost groups.

The consequence of the above points has significant impact on the way rehabilitators raise and release orphans and how adult bats are rehabilitated and released.

Adult and all bats older than a few weeks when entering care, should always be released within a very close distance (within 100m) of where they were found. Most rehabilitated bats at release are not at their peak health, fitness and muscle strength due to being injured or ill. To require them to fly several

or tens of kilometers to their original point of capture to join their roost mates is counterproductive to the purpose of rehabilitation.

Special consideration should also be made to the releasing of microbats that arrived in care as very young pups. The close emotional relationships made with other bats in care should dictate the release arrangements.

In 2017, SEQ carers started chipping bats coming through our Noosa flight aviary so that we can insure bats are returned to their point of origin.

Due to chipping of a pup this year we were able to prove that even when pups come in very young that they re-integrate back into their original family colony. The pup came in at 4 weeks old, was processed through the pup milk and blended food stages and put in the flight aviary for around two months learning to fly and hunt before being released back at his point of origin. Approximately a month later a house wall was demolished one house away during renovations and a single bat was non-fatally injured which was found to be chipped and our hand-reared pup. To be alive 1 month after release, meant he could hunt and fly well and most interestingly he reintegrated back into his maternity group.

Big thanks to Australia Zoo Wildlife Hospital for covering the costs and time to undertake the chipping this year.

6) Wonderful wings – how they heal and what damage can they sustain.

Microbat anatomy and physiology has evolved to suit the essential functions of flight and foraging style, and the delicate energy, fluid and thermoregulatory balances that accompany them.

Wing anatomy not only tells us a story about their foraging style – long thing wings are your fast flyers and migrators while short/fat wings are typically your cluttered habitat flyers, they also help us with ID and age determination.

It is consequently important to have a good understanding of wing structure and wing injury viability.

The wings and legs are typically the only skeletal aspects of a microbat that most rehabilitators will see without access to radiographs and are also the most common bones that are damaged due to injury and developmental problems.

In our manual we have developed diagrams that show the viability of the various wing and leg skeletal injuries and membrane injuries.

Regarding membranes - Unlike flying fox wing membranes, dieback with most microbat species is typically limited. Their ability to heal right back to the trailing wing edge is repetitively observed and provided they have access to initial veterinary medication treatment, good nutrition and are housed within their thermal neutral zone whilst healing, membrane healing can be remarkable.

The challenge is to achieve full flight function (flight lift and maneuverability) to enable capture of prey on the wing. Different species can handle bone injuries and membrane deficiencies (extent and location) better than others. The difference mostly relates to the type of wing shape and flight style they inherently have. Detailed membrane injury and bone viability guidelines have been developed based on historical experience (Lyons & Wimberley, 2017).

7) Developmental stage identification – knowing what dependant juveniles look like.

Juvenile bats achieve near adult size and weight relatively quickly and are often difficult to identify to the untrained eye. Prior to being able to fly, bats generally need to grow to 90-95% of their adult skeletal size and 70% of their adult mass (Altringham, 2011). They look very much like an adult microbat but they are not.

Large numbers of juvenile bats, still reliant on maternal nutrition, enter care in spring and summer after premature or first flights.

Unfortunately many pups have been euthanased over the years after they were deemed to not fly, in the mistaken belief they were adults. Further, many more were treated inappropriately for their age from a dietary perspective.

The main definitive way to identify a juvenile is to ascertain the existence of cartilaginous bands on the joints between the metacarpals and phalanges. Very young microbats will have large bands/ gaps that appear white in colour when a light source is shone from behind the wing. Juveniles will have two white bands until several months of age in most species. Adults do not exhibit the bands as the cartilaginous gap is not obvious to the naked eye.

Correct developmental stage identification is essential in determining the viability of a patient and initial treatment. Increasingly, many Microbat rehabilitators are going to great lengths in attempting to reunite juvenile microbats that are in good condition, back with their roost mates as soon as possible. And we are seeing some great results in this endeavor. I have had microbat mums fly down to my upheld hand to pick up a fallen pup.

8) Diets – avoiding problematic ingredients.

Natural microbat milk is difficult to replicate, particularly when considering there are so many different species of microbat, and that milk composition changes significantly over the stages of lactation (Lollar 2010). There has been very limited studies undertaken in Australia that have analysed the milk of Australian microbats.

Significantly different compositions of milk exist for one family of bats called the Molossidae's compared to other microbat families (Lollar 2012). Molossidae bats have higher energy and fat needs and lower protein requirements.

Most captive milk replacement diets have been trialed extensively at the Bat World Sanctuary in Texas (USA), and for the last 10-15 years here in Australia by several rehabilitators. Independently, we have found increased incidents of bloat and metabolic bone disorder (MBD) with the use of bovine based milk formulas, even when homogenized (Lollar, 2012) & (Lyons & Wimberley, 2017). Preferred milk diets currently are goat milk based, with different supplementation provided for the different microbat family groups. Captive milk diet composition is an area where significant improvements still need to be made.

An emerging issue is the nutritional quality of mealworms, which form the basis of the adult microbat diet in care. The need to boost general mealworm nutritional value is ever present and various products are now being used to do so. The possible use of insect growth inhibitors (IGI) in commercial mealworm production to delay adult (beetle) stage and prolong shelf life, is however an additional concern. Mealworms affected by IGI have potentially lower calcium levels and softer exoskeleton which is a suspected contributing factor in several cases of microbat bone density and development deficiencies in the past few years. Substantiation of this issue is difficult due to the inability to confirm the use of IGI in the mealworm industry.

We have developed different methods for increasing nutritional value of mealworms – including Boosted mealworms (which are mealworms fed on a good diet for a number of days and then sprinkled with Missing Link immediately before feeding to the microbats) and also the development of a 'Bat Blended Food Diet' for nutritionally deficient or injured bats and weaning pups.

9) Pup rearing – basic do's and don'ts

- ***Temperature***

Infant microbats are unable to maintain their own body temperature (ideally 35-39ºC) until 3-5 weeks of age (species dependent).

Due to their size and metabolism, microbat pups require an ambient (surrounding air) temperature of 32-38ºC (species and individual dependent) to keep them within optimal body temperature. Ambient temperature provision is much higher than that provided for other Australian mammals we rehabilitate.

I start at 35 ºC and go up or down according to the individual.

Newborn pups are likely to require ambient temperatures of 36-38 ºC and lightly furred pups graduate down to approximately 32-34 ºC.

Keeping at lower temps means that they torpor and do not process food in the gut, usually resulting in fermentation and often bloat.

- ***Feeding Frequency***

Overfeeding a microbat pup is VERY easy to do and regularly causes death. Pups do not have a well-developed 'I'm full' signal that stops them drinking.

The amount fed per feed varies significantly between species and individuals. What a rehabilitator should be aiming for is the abdomen of the pup to be slightly rounded and close to the same width as the pup's rib cage after feeding.

Microbats need to be fed milk on demand when their stomachs are near empty, as opposed to the standard 'marsupial' feeding regimes. This usually equates to approximately every 4-5 hours but varies depending upon the species, the age, the individual pup's condition and ambient temperature.

Feeding a pup too often, before it has digested its previous milk feed, can contribute to often fatal conditions such as bloat. It is necessary to allow the stomach to reach near-empty state before feeding at every feed.

The amount of milk remaining in a furless pup is quite easy to view. Residual milk can be seen on the left side of their abdomen through their skin. Furred pups need to have their abdomen gently assessed by feel to establish if they are near empty.

If a pup has not digested its milk within 4-5 hours, provided you have not over-fed it, it is either:
- Being kept at too low a temperature and is torporing, OR
- It is dehydrated and its stomach is not functioning correctly as a result.

- ***Fluids***

Many species of pups, despite our best efforts to keep hydrated through the use of humidicribs and providing fluid ingestion via milk, may still suffer dehydration whilst in care. This is due, to the large naked surface area of a microbat (without their mother to snuggle into) and fluid loss through the skin. It is NORMAL to need to provide additional fluid support to a well feeding and healthy pup.

Due to the limited ability to supply additional fluids orally without jeopardising nutrient intake (their stomach size and volume processing ability is extremely restrictive), subcutaneous fluid may still need to be given regularly to nursing pups. The need to provide additional fluids, above and beyond milk provision, has been greatly reduced due to the recent advent of affordable humidicribs.

Attention to hydration levels and dehydration signals, even when pups are drinking normally, is critical. Key dehydration signals in pups can include decreased plumpness in the skin, loss of silky feeling when gliding pups skin across the shoulder blades, tenting of skin on torso, dryness on the wing membranes and sometimes decreased urinary output.

10) Flight practice – it really is a case of 'do' or 'die'!

The ability to undertake sustained flight prior to release is critical. Microbats hunt on the wing and need to be able to do so immediately upon release.

In order to give microbats the greatest chance of survival, prior to release they ALL must:

- Be able to undertake sustained flight of the style and speed relevant for their species and to have done so for a suitable length of time (1 month typically) to gain strength and fitness;
- Be able to catch their natural food on the wing; and
- Be of good weight and adult size for the species.

When an adult microbat has been without flight for more than a week, or a juvenile bat has been raised in captivity, prior to release it first must spend time in a flight aviary to build muscle tone and aerobic fitness.

While the flight cage minimum size does varies between species, most require a minimum flight aviary cage size of 7 x 7 m. Species that fly within vegetation, such as the Gould's Long-eared Bat, can build sufficient flight strength in smaller aviaries of 3 x 3m in size. Other larger species such as Yellow-bellied Sheath-tailed bats fly very fast with low maneuverability and need much larger flight aviaries to undertake sustained flight, larger than any available in Australia at present.

Post survival research in relation to pre-release practices in hand-raised microbats is restricted to studies undertaken in Europe. While the study by Kelly (2008) had a small sample size, its results are consistent with expectations. Tracked bats provided with limited time in fight aviaries and/or flight practice within a small aviaries were found either grounded or perished, presumably from myopathy, within 3 days of release. Only those that had extended flight practice in larger cages (relevant to the species) demonstrated survival in the wild.

Unfortunately the availability of sufficiently sized pre-release flight aviaries is lacking in most areas of Australia for the majority of species.

Further Information.

The *Australian Microbat Rehabilitation Forum* is a Facebook group and is a friendly place to share microbat rehabilitation issues, knowledge and experience with over 600 members world-wide.

Within the 'Files' section of the Forum is always the latest version of '*Introduction to the Care and Rehabilitation of Microbats*' – an Australian Rehabilitation Manual authored by Rachel Lyons and Trish Wimberley.

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With an extensive background in the conservation/ecological management sector (her day job), Rachel has a keen interest in ensuring ecological principles and natural history is adequately incorporated into wildlife rehabilitation practices.

Rachel's interest in microbats started over 15 years ago when she learned of the absence of scientifically sound information regarding care and rehabilitation of the various species in Australia. She set about researching as much as she could and in 2011 collaborated with Trish Wimberley of the Australian Bat Clinic to develop a full day training workshop and extensive manual on Microbat Rehabilitation.