



Husbandry Manual for Grey- Headed Flying Fox



Pteropus poliocephalus

Mammalia: Pteropodidae

Author: Mandi Griffith

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1 INTRODUCTION

1.1 Background

Flying foxes gather in noisy truculent colonies, sometimes living in groups of many thousand individuals. As the flying fox is a fruit eater, it leads a semi-nomadic existence, moving to new locations to follow the food sources. Strahan-R (1995) notes:

“Bats commute daily to foraging areas, usually within 15 kilometres of the day roost, a few individuals may travel up to 50 kilometres” (p439).

With the GHFF's diet of flowering and fruiting plants, it plays a vital role not only in the dispersal of rainforest tree seeds, but in the pollination of eucalypt, tea-trees, banksias and fruit trees such as mango, avocado and banana.

There are three main colony sites within the Sydney area, Gordon, Cabramatta Creek and the Botanical Gardens, the main one being Gordon where animals may be found nearly all year round. Gordon is the only NPW approved release site for rehabilitated animals.

With the colony proximity to central Sydney, research and data collection is relatively easy. Because of this, the GHFF has been studied more closely than any other bat in Australia. However, the flip side of this is that GHFF's are considered a pest as they raid suburban fruit trees as well as the trees of commercial growers

This photograph was taken at the Cabramatta Creek colony (Sydney, NSW) during an exceptionally hot day (January 2003) and shows the density of the Grey Headed Flying Foxes ('GHFF') within the colony. It is not normal behavior for flying foxes to hang low in the trees; the animals had slid down the tree in attempt to escape the extreme temperatures within the tree canopy.

This photograph further illustrates the unusual circumstances as GHFF's prefer to roost slightly apart from other individuals, with usually a bat's distance between one another. (note: this clustering of individuals may be normal for other flying foxes, such as the Little Red (*Pteropus Scapulatus*)).





1.2 Conservational Aspects for Consideration

GHFFs have enormous capacity to play a crucial part in increasing public awareness of the Australian ecology and correcting popularly held public misconceptions. As flying foxes congregate in large colonies it is a common misconception that the flying fox is prolific, whilst in fact, the numbers are decreasing. In many areas, due to lack of proper education on the flying fox, the animal is considered a pest, especially by orchardists and fruit growers. In fact, NPW will issue permits to orchardists to shoot flying foxes, with a supposed limit of 5 flying foxes per night. However, with inadequate resources to police this, there is great potential for excessive amounts of flying foxes to be exterminated.

In 1920's the government commissioned biologist Franci Ratcliffe to conduct pioneering experiments to:

"discover some wholesale method of destruction which would once and for all relieve the growers of the onus of dealing with the pest".

However, Ratcliffe's final report stated that:

"the assumption that the flying fox is a menace to the commercial fruit industry of Australia is quite definitely false ... the loss to the commercial fruit crops in Queensland is so inconsiderable as to be almost trifling".

However, since the 1920's rainforests have depleted, forestry areas have been annihilated in favour of housing complexes, and flying foxes have been forced to hit the suburbs to find food. This has impacted on people's every day lives— and perhaps left the general public with the perception that flying fox is a pest to be eradicated.

Conservationists all appear to support the crucial role the flying fox plays in Australian conservation. Schrober observes:

"the relationship between bat and plant is one of mutual advantage and profit. A true symbiosis exists between the two" (p110).

This belief is supported by Hall & Richards (2000):

"the most important reason for the conservation and management of Australian flying foxes is their undoubtedly important role in the pollination and seed dispersal of Australian forest trees" (p93).

A paper produced by the Australasian Bat Society (1999) reports:

"A recent survey of Grey Headed Flying Foxes in NSW has suggested that their numbers have declined some 35 percent over the past nine years and there is strong evidence that numbers are now declining further."





Birds disperse seeds by ingestion and elimination. This method of seed dispersal is limited by the size of the bird's gape (Rainey et al, 1995). Flying-foxes disperse larger seeds by carrying away a whole fruit in its mouth and the seed, or fruit stone is then dispersed elsewhere, sometimes quite some distance from the donor tree (Hall & Richards 2000).

Pamela Condor extols the virtues of the ecologically friendly flying fox when she describes their contribution to the Malaysian market:

"Malaysia benefits to the tune of more than \$100 million annual from the durian crop – a fruit pollinated by fruit bats" (p143)

and goes on to say:

"fruit bats make a significant contribution to ecosystem maintenance in many parts of the world. Some of the wild plants dependent on bats include avocados, bananas, dates, figs, breadfruit, peaches, mangoes, carob, sisal, kapok, chicle latex, balsa and tequila. It is economically important to maintain ancestral stocks of these and other commercially grown species in the interests of finding disease-resistant genetic material and developing better varieties" (p143)

Ironically then, the flying fox would appear to be a valuable asset to commercial growers, if only they were better educated to harness this 'free bat labour'.

In understanding the role the flying fox plays in the ecosystem, the flying fox may become the way forward, rather than a pest to be eradicated. Cleave (1999) notes:

"Most of the so called problems that arise when bats share human habitation come from a lack of understanding of these small, but fascinating mammals. The more we understand about bats, the better equipped we will be to safeguard their future". (p70)

But a cautionary word rests with Les Hall who has spent a lifetime researching bats:

"there is a simple reason why they [the bats] are moving into our cities: we have deforested so much of Australia that they have nowhere else to go. I see their trouble as a wake-up call".





2 TAXONOMY

2.1 Nomenclature

Bats are eutherian mammals of the Order Chiroptera, and the only truly flying mammals. Gliders (Order Diprotodontia, Family Petauridae) have a membranous fold of skin with which they glide, but they do not actually 'fly'.

World wide, there are approximately 925 species of bat, with over 90 being native (and in some cases endemic) to Australia. There are two Suborders, namely:

- Microchiroptera (*microbats*), which are insectivorous; and
- Megachiroptera (*megabats*) which are fruit and blossom eaters

and it is this second group to which the Grey Headed Flying Fox ('GHFF') belongs.

Class	Mammalia	
Order	Chiroptera	
Suborder	Megachiroptera	
Family	Pteropodidae	
Genus	Pteropus; 13 species in five genera, namely:	
(i)	Pteropus (Flying Fox)	7 species
(ii)	Dobsonia (Fruit Bat)	1 species
(iii)	Nyctimene (Tube Nosed Fruit Bat)	3 species
(iv)	Syconycteris (Blossom Bat)	1 species
(v)	Macroglossus (Blossom Bat)	1 species

Species Grey Headed Flying Fox

Scientific Name Pteropus Poliocephalus

Translation:

Grey Headed

Wing Foot

IUCN Status Vulnerable

2.2 Subspecies

None

2.3 Recent Synonyms

None

2.4 Other Common Names

Grey Headed Fruit Bat



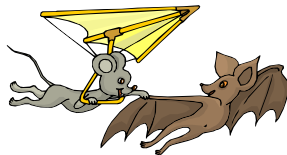


3 NATURAL HISTORY

Megachiroptera occur in tropical, temperate areas with fossils dating back to around 58 million years ago where they first appeared in the Eocene period (Hall & Richards, p5).

There is considerable debate over Chiroptera origin, as fossils have not yet been identified as an intermediary stage linking bats with their non-flying ancestors. Oldest fossils closely resemble modern ones, each with membranous tissue stretched between long 'fingers'. In her recent study comparing the embryological development of bats to that of mice, Sears-K discovered the metacarpals:

"... form from cartilage cells which divide and mature into bone in regions called growth plates. But in bats, a key region of the growth plate called the hypertrophic zone allows their digits to grow much longer. That difference is controlled by a single gene known as BMP2, one of a family of genes important for limb development in mammals." (Sears-K)



The protein produced by BMP2 is present in the hypertrophic region of bats, but not in mice. When mouse embryos were exposed to this protein the fingers elongated resembling bat fingers.

Other scientists believe bats may have originated from the primate line as their DNA is very similar. Consider the physical features, diet and social grouping of a ring tailed lemur (*Lemur Catta*) to that of the GHFF (right), and the resemblance is more than passing.



Many other similarities to primates occur, such as those in brain and soft tissues and even the placenta which resembles that of a human (Bellamy-T, pers comm). Whilst this has been the basis for considerable research, so far DNA tests have proven inconclusive.

3.1 Morphometrics

It is often possible to identify individual GHFFs by their colouration/markings. Some individuals have particularly dark facial and body fur and resemble the Black Flying Fox (*Pteropus Alecto*) with which it sometimes breeds, producing hybrids (Strahan-R, p441). Basic GHFF measurements are listed below in 3.1.1.

3.1.1 Mass And Basic Body Measurements

Whilst nutrition appears to play a role in body measurements, the following is an average guide to the wild caught GHFF:

	Weight	Forearm Length	Head and Body Length
Mean	700gm	-	255mm
Min	600gm	138mm	230mm
Max	1000gm	180mm	289mm

Wingspan up to 1.5 metres

Churchill-S (p91), Strahan-R (p339).





Poor nutrition, illness or injury appears to impede physical growth within juveniles, whilst healthy animals raised without such stressors have a tendency to be larger adults.

3.1.2 Sexual Dimorphism

Due to the relatively restricted latitudinal distribution, and the migratory tendencies, no variance in body mass has been recorded in respect of the GHFF. Males have a tendency to be fuller bodied and are larger than females, sometimes weighing up to a kilo during mating season (March-April).

3.1.3 Distinguishing Features

The GHFF is a large flying fox (the males can reach up to a kilo in weight) with dark brown/black fur, often tinged with grey flecks.

The head is grey (or even silver-white grey) with a large orange/red ruff extending around the neck to below the shoulders.

The dorsal surface of forearm itself is furred, as are the legs, with fur extending down to the ankle.

Eyes are large, dark and prominent and often the muzzle has dark points.



3.1.4 Anatomy and Physiology

Forelimbs

The most notable difference between chiroptera and other mammals is their ability to fly. As can be seen from the diagrams below, the chiropteran wing is an adaptation of the mammalian forelimb. Four of the five finger digits evolved with the three phalanges in each digit elongating to form the brace for the wing membrane (*Refer 3. Natural History*). The thumb is comprised of two phalanges tipped with a large hook, which acts as a highly maneuverable free digit.

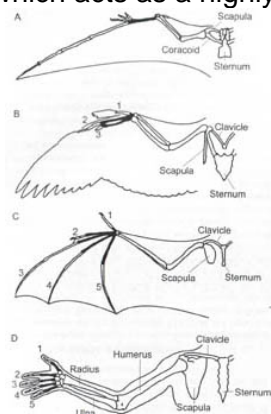


Diagram from "Flying Foxes, Fruit & Blossom Bats of Australia, Hall-L & Richards-G (p22)

Comparison of Forelimbs of:

- A. the (extinct) Pterosaur;
- B. a bird;
- C. a bat;
- D. a human.

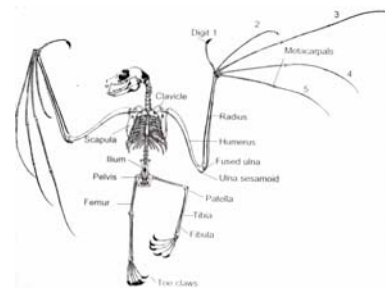
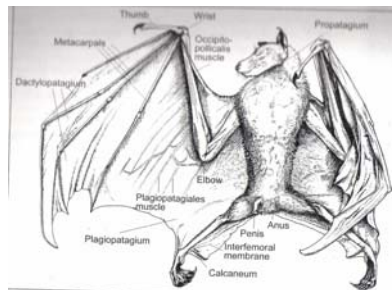
This diagram illustrates how, whilst bats have the avian ability to fly, the forelimb structure has adapted from the mammalian forelimb and closely resembles that of the human arm.

The four fingers have no nails, other than a small nail on end of the second digit (on the leading edge of the wing).





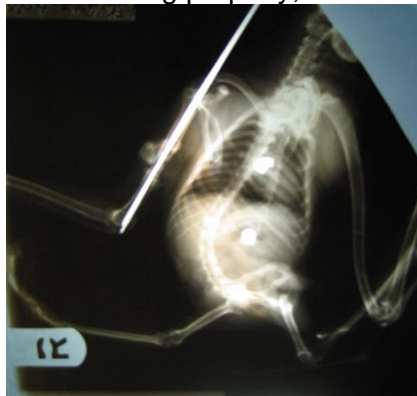
Highly elastic thin tissue forms the wing membrane which is a double layer of thin membranous tissue finely laced with veins, blood vessels, muscles and nerves. The membrane has a texture similar to that of a Pinniped flipper (pers obs). The dorsal surface of the forelimb is furry, and the membrane over the finger bones has tiny microscopic hairs to assist the GHFF in monitoring air flow during flight. The lateral ventral surface of the wing is quite furry, extending as far as the elbow of the Plagiopatagium (see diagram below).



Diagrams from "Flying Foxes, Fruit & Blossum Bats of Australia, Hall-L & Richards-G

The metacarpals all join at the base of the thumb at the wrist, which is an intricate and highly complex joint.

Damage to the wing membrane is repairable with time, however, GHFFs have a tendency to self-mutilate whenever the wing membrane is damaged so an Elizabethan collar may be need to be applied in cases of severe wing membrane damage (Bellamy-T and pers obs). Any tear to the leading edge of the Propatagium may render the GHFF unable to fly, and as this controls the ability of their ability to close the wing properly, euthanasia may need to be considered.



Finger bones are predominantly hollow and can mend, especially in juvenile animals. A break in the forearm is also fixable, providing the break isn't close to the wrist.

(left, radiograph of juvenile GHFF post pinning of humerus (right arm). Two pellet shaped discs within thoracic and lumbar region – shot gun pellets)

Hind Limbs

As flying foxes are designed for flight, their hind limbs are thin, lack muscle and their lower bodies have atrophied, so much so that the GHFF could not bear weight on its legs even if it chose to. If it falls to the ground it scuttles using the wings like rudders and pushing itself along with its legs.





The femur is rotated so the knee faces backwards, the patella is missing (almost absent) to allow the hind limb great maneuverability, and the hind limb is used for hanging, grooming, and holding food.

The feet are large and have a locking mechanism so the flying fox has to make a conscious effort to release the grip; and this is why the animals don't lose grip and fall off the branch when they are asleep.

Due to nomadic lifestyles, GHFF often shares a camps with *Scapulatus* and *Alecto*. Whilst a dark furred GHFF may at first instance appear identical to *Alecto*, on the GHFF the fur on the legs extends down to the feet, where it only extends to the knees with other Pteropus.

Cardiovascular System

One of the most common questions raised about bats is: "why doesn't the blood rush



to their heads?" Surprisingly, the flying fox has a typically mammalian cardiovascular system with no special valves, or 'upside down' heart to compensate for the inverted stance of the FF. The heart is relatively large compared to the small size of the animal, so the blood flow is not voluminous enough to flood the brain with blood.

Pulse rate: 130 beats per minute (at rest)

Temperature: Ranges between 35-40°C, with 36°C optimum when resting (Hall & Roberts, p29). When external temperatures rise over 38.5°C, the FF attempts to maintain homeostatis by panting, wing fanning and urine baths.

Dentition

GHFF has 34 teeth,

- Top row: incisors 2-2, canine 1-1, premolars 3-3, molars 2-2;
- Lower row: incisors 2-2, canine 1-1, premolars 3-3, molars 3-3.

GHFF are born with deciduous 'milk teeth' which have all fallen out within the first four weeks (refer 3.5.3 – *Techniques used to determine age in adults*)

Vision

Another myth often encountered is that of 'blind as a bat'. The flying fox has exceptional eye sight, as indicated by its large eyes. It uses eyesight and keen sense of smell to locate food.





Flying fox optical pathways are unusual when compared to other mammals:

“A wide overlap of binocular vision and the optic pathway from the eyes to the brain is found only in Megachiroptera and primates”

(Hall and Richards (p36))

Unlike microchiroptera, flying foxes are unlikely to fly in complete darkness, Hall and Richards go on to note:

... the visual ability of the flying foxes is considered to be equivalent to that of the cat, which is well known for both its diurnal and nocturnal visual alertness” (p37)

Hearing

GHFF have a simple external ear structure and with no ear tragus, do not rely on echolocation to navigate or find food. Hall and Richards advise:

“Audiograms for flying foxes show that their hearing is very similar to that of humans. The peak sensitivity to sound is around 11kHz, with a range of 20-40 kHz. The majority of flying fox calls have maximum energy in a 4-6kHz range.” (p38)

3.2 Distribution and Habitat

GHFF are found in coastal south-eastern Australia from Victoria to Miriam Vale in Qld and inland to the western slopes (refer Appendix 1). GHFF habituate traditional camp sites which can pose problems with urban development. When a traditional camp site is usurped for human dwellings, problems are encountered in encouraging the bats to leave the site. Camp sites are often found not far from water and usually in densely canopied vegetation, such as in gullies and hillsides. As the canopy cover is destroyed by GHFF activity, often flying foxes are seen roosting on bare tree branches, which once again poses problems when the camp is situated within suburban Botanical Gardens (refer Appendix 2).



3.3 Conservation Status

Under the Federal Government's Environmental Protection and Biodiversity Conservation Act (EPBC Act) GHFF is listed as **Vulnerable**.

This listing was recommended by the Australian Bat Action Plan as compiled by the Commonwealth Government on advice from specialist bat researches. Of particular concern is that GHFF rely heavily on nomadic food sources of large native trees such as paperbark and spotted gum to survive. As the trees are destroyed for urban development the GHFF has to travel further and target different foods to survive, so not only is it in danger of starvation, it is no longer able to assist in the regeneration of the flora. As described on the Kurringai Bat Conservation Society website:





“Serious concern for the conservation of this species is based on the curtailment of their ecological role due to further loss and simplification of forests over all land tenures. This could be exacerbated by unco-ordinated and inappropriate regional forest agreements which do not recognise the annual feeding requirements of nomadic species. Projected urban expansion in coastal areas of NSW will also reduce food resources on which the species relies annually.

Further decrease in over all population could curtail their ecological role in maintaining forest diversity by eucalypt pollination and seed dispersal of rainforest species”

3.4 Diet in the Wild

As a fruit and pollen feeder, the GHFF consumes a variety of native foods, the most common of which are listed below.

- **Nectar and pollen:** Eucalyptus (primary source of food), Melaleuca, Turpentine, various other species,
- **Fruit** from a variety of species, eg, Ficus, Terminalia, Syzgium and Egernia. Albizia leaves are sometimes eaten.

Jackson-S (p301)

As seasonal food sources may be unreliable and wide-spread, the GHFF adapts to the change by being nomadic.

Radio tracking of individual flying-foxes has confirmed that individuals move many hundreds of kilometres to prolific flowering species (Refer Annexure 3 for a more comprehensive list of native foods).



3.5 Longevity

3.5.1 In the Wild

Up to 10-15 years, probably less (Churchill-S, p90)

3.5.2 In Captivity

Typically 10-25 years. (Churchill-S, p90)

3.5.3 Techniques Used to Determine Age in Adults

Reardon and Flavel (1987) identify three stages in the flying fox life cycle as:

- | | | |
|----------|---|---|
| Juvenile | - | not fully weaned and usually less than 40 days old; |
| Subadult | - | from juvenile to adult; |
| Adult | - | fully grown and sexually mature. |

(Jackson-S)





Age identification, GHFF:

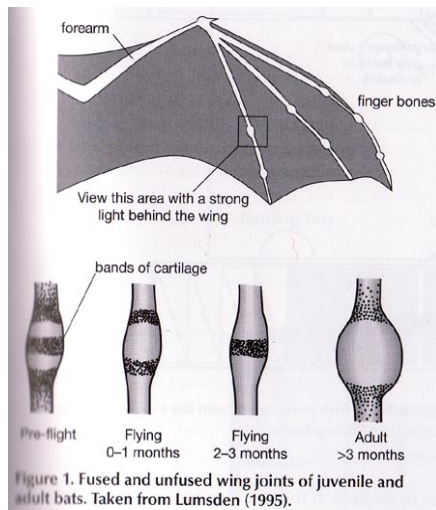
Character	Juvenile	Sub-Adult	Adult
Size (weight & forearm length)	<80% adult	80-100% adult	Adult
Teeth	Milk teeth may still be present, others needle sharp	Sharp and unworn	Showing wear
Teats (females only)	Almost invisible	Almost invisible	Clearly seen
Finger joints	Unfused, large and obvious cartilaginous bands	Not fully fused, cartilaginous band and blood vessels distinct	Fully fused, knobby, cartilaginous gap not visible.

From Reardon and Flavel (1987) and Parnaby (1992), Jackson (2004)

Weight and Forearm

An initial indicator of age in young animals is by recording weight and forearm measurements. However, measurements are not necessarily indicative of age, as once the sub-adult has reached its maximum growth potential other techniques are needed to assess the animal's age, rather than mere body mass.

Review of epiphyseal cartilage of the finger joints





Studies of GHFF have revealed a unique dentition, as described by Hall-L & Richards-G:

“the basic flying fox molar pattern presents an outer and inner ridge, separated by a shallow, rounded longitudinal furrow. During mastication the ridge fits closely into the opposing furrow and very efficiently crushes any plant material. This is a unique mastication system among living mammals...” (p32)



*approx 3 weeks old
No teeth present*



*approx 8 weeks
teeth erupting*



*approx 11 weeks. Molars visibly erupting,
recurvant teeth present.*



*approx 14 weeks. Molars present,
deciduous teeth gone. The molar pattern, as
described by Hall & Richards (above) is visible*



*Yearling female. Some
discolouration on molars
due to chewing on leaves.*

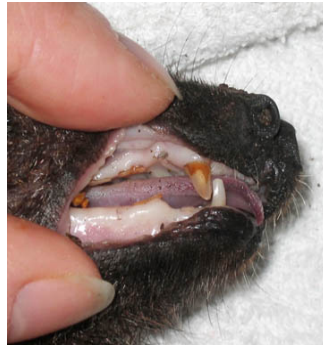


*Adult male, note some discolouration but
otherwise reasonably clean. Very long
upper canines (note left canine broken)*





Female, teeth white but ground down indicating age



Elderly female. Teeth discoloured, broken (lower canine) and almost ground into the jawline.



Elderly male – lower canines absent, teeth discoloured, molars shrunk regressing gums, canines short, thick and almost black at tips.



Elderly female – teeth all gone. Incongruously, this female is still able to chew to pulp hard fruits such as apple.

It is possible to estimate the age of GHFF not only by visual assessment of the teeth, but by analysis and counting of thin sections of the annual growth rings in the canine teeth. Such research is the focus of PhD analysis by students of Dr Kerry Perry Jones. However, as the procedure involves removal of the canines for analysis, it is of limited use on live individuals.





4 HOUSING REQUIREMENTS

4.1 Exhibit/Enclosure Design

There is a tendency for bats to be associated with nocturnal houses. As GHFF do not rely on sonar but hunt using eyesight and smell, eyesight is excellent and wild GHFF camp activity is reasonably active throughout the day. They are therefore much better situated outside (Refer 3.1.4 Anatomy and Physiology).

For some time, Taronga Zoo housed a number of GHFF in the nocturnal house, but the location was unsatisfactory. GHFF love sunning themselves and cleaning themselves in light rain showers, a nocturnal house therefore prevents natural behaviours. However, if held indoors, light cycles of 12:12 light/dark have been used – with better results reported if the light cycles more closely mimic those of natural cycles. (Jackson-S, p304)



As GHFF is highly inquisitive by nature, they will 'test drive' every corner of the aviary. It is therefore very important to ensure there are no abrasive, sharp or penetrating surfaces where wing membranes can be caught or thumb hooks caught. A variety of textures allows the animal to exercise feet and wear down claws.

GHFF lick and taste surfaces so galvanised mesh should be avoided if possible to avoid zinc toxicity. Polyethylene mesh, Teflon sprayed or non-galvanised wires are recommended (Jackson, 2002).

A clear perspex sheet placed over the aviary roof is ideal for protection against inclement weather. This allows animals to bask in full light and helps to avoid fungal wing diseases (Refer 8.3 - Known Health Problems). It also allows the animals protection from wind and rain.

As FFs may potentially carry and transmit the lyssavirus (a virus related to rabies), the enclosure should be covered in a double layer of wire, with a gap between of approximately 3cms. The double layered wire protects the bats from prying fingers, and observers from scratches and/or bites. (Refer 8.3 – Lyssavirus). EAPA suggest a mesh size of no more than 20mm (Jackson-S, p307)

As GHFF generally camp near water, if possible access to water should be provided in the form of a water feature. Care must be taken to ensure the water is located within an area over which the FFs are unlikely to roost to prevent contamination of the water by droppings and foodscraps.





Enclosures may vary in size, shape and setup, some examples follow:



Kuringai Bat Conservation Society – Educational Animals

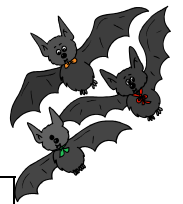


Taronga Zoo GHFF – Educational Animals



Featherdale Wildlife Park – Exhibit Animals





KBCS – Baby Crèche Cage



Wildlife Carer – Rehabilitation Aviary



Wildlife Carer - Rehabilitation Aviary





4.2 Holding Area Design

To facilitate easier catch up, the enclosure should have a low roofed area or crush cage area. This area can be used as a feeding area so animals readily enter which makes daily inspection a simpler task.

When approached, an anxious FF will generally stretch out both wings in a defensive stance, so a holding area should be at least one and a half times the wingspan to avoid wing damage.

4.3 Spatial Requirements

It is important to consider individual spatial requirements when constructing a Flying Fox enclosure. GHFF's maintain a hierarchal group structure with the dominant animal preferring certain areas within the cage; usually the highest point within the aviary. For this reason it is important that enough high areas are provided to allow more than one animal to maintain an elevated position within the aviary.

Whilst studying the activities of a Queensland flying fox colony, Dr Peggy Ebby, (KBCS) refined her study to document activities of particular individuals within a wild colony. She did this with pictorial studies, noticing that the colony swelled and reduced seasonally, dependant on the local food source. Particular individuals left the colony site to forage, but upon returning to the colony, returned to the same branch, within the same tree each night to roost. Even more remarkable, migratory animals returning to the colony site only periodically, still returned to the same branch within the same tree.



In her studies of the captive bat colony in Victoria's Healsville Sanctuary, Pamela Condor supports this observable behaviour:

"...although the walk through aviary is spacious enough to house a much larger colony, it was soon apparent that the flying-foxes preferred to use only a relatively small area at one end as a roost and loosely grouped themselves on either side of the central ridge and towards the apex of the sloping triangles beyond it." (p26)

So, individual flying fox territories within the captive colony are clearly defined. Condor goes on later to say:

"... the group was divided into 'left-siders' and 'right-siders' (relative to the centre ridge of the cage roof) (p51).

Access to a number of high peaks within the aviary will give the animals a greater feeling of security and reduce potential arguments over high vantage points.





Long Term Care

FF's experience muscular atrophy if confined in small spaces for a period in excess of a month. Where possible, the opportunity to fly within a long term enclosure should be provided (however, if this is not possible, flight condition can be returned by exercising the animals). Jackson-S quotes Fascione when he recommends a flight enclosure should be "four times the wing span and four times the body length high".

Bearing in mind that FF's are colony animals, it is not recommended that a single animal be housed alone. The following dimensions are recommended by Exhibited Animals Protection Act ('EAPA'), EAPA for a group of 4-6 GHFF's:

*	Width	4 x metres	With an additional 1.5x1.5 floor space
*	Breadth	4 x metres	required for each additional bat
*	Height	3 x metres	(Jackson-S, p307).

Short Term Care

Short term holding enclosures should be 1.5 times wing span to allow wing stretching. As the FF hangs with its head down, the height should be at least twice the body length so the animal is not hanging with its face close to discarded food and fecal matter.

4.4 Position of Enclosures

GHFF need Vitamin D, provided by sunshine to keep wing membranes healthy and fungus free. Enclosures should be well positioned in a location where they can make good use of sunshine, whilst providing adequate protection from weather extremes.

A wild GHFF colony is usually located near a water body. If possible the enclosure should be placed with this in mind, or a water feature provided, (as above).

4.5 Weather Protection

Flying foxes help to maintain their body temperature by wrapping their wings around themselves; the body temperature between body and wing membrane sometimes being as much as 10°C warmer than the outside temperature.

In hot weather, GHFF gently flap their wings to increase air circulation and thereby cool themselves. Body heat is reduced further by urinating on the wing membrane - as the urine flows over blood vessels it cools the animal.

Cold Weather

During colder months, it is necessary to provide additional warmth. This can be provided by heat lamps and it is advisable to cover lamps with a metal guard. The guard stops the flying fox from touching the hot bulb, and also provides some protection from flying glass should the bulb shatter. Monitor the GHFF's use of the lamp as on particularly cold days, the animals may be tempted to stray too close to the metal guards risking a burn to the wing membrane or ear tips. Bedding material as described below (4.6) should also be provided.





Hot Weather

Many aviaries are manufactured from aluminium that is very hot on summer days.



As GHFF's hang high up, and hot air rises, there is a risk of animals becoming dehydrated and overheated without the provision of adequate sun shade. A double roofing layer with a layer of polystyrene sandwiched between is an excellent temperature regulator.

Sprinklers placed on the roof of the aviary could be set to a timer switch to sprinkle cool recycled water onto the roof for 1 or 2 minutes of each hour on especially hot days.

Kuringai Bat Conservation Society recommend leaving the sprinklers on all day when temperatures reach over 38°C.

Alternatively, the installation of a fountain water feature, using recycled water would provide a cool area within the enclosure on especially hot days.



4.6 Bedding Material

Fabric hangings provide protection from heat, cold and stress, and provide the GHFF with a visual barrier from one another. Polar fleece, woolen blankets, sheepskins and hessian sacks are recommended.



It is important to ensure blankets are hung beneath a waterproof roof area. Although polar fleece is not a natural fibre, it does not readily absorb fluid and urine tends to drip off rather than soak in.

The flying foxes huddle into the fabric when cold, warm or anxious. Each bat will often favour a different hanging spot within the folds of the blanket.

The hangings can also be used as a behavioural enrichment tool as playful bats wait to ambush unsuspecting passers by.

Blankets could be placed in folds in proximity to the heat lamps and amongst the foliage canopy. (note: make sure the blankets cannot touch the heat lamp should a strong gust of wind blow the fabric towards the lamp)





4.7 Substrate

A smooth concrete floor, at a slight angle to permit drainage, is recommended (Jackson-S, p309).

The floor can be swept clean of debris, and then hosed, with water being channelled out of the enclosure by means of a drain.

As rodents are attracted to discarded food, it is important to ensure that the enclosure is pest proof. Many rodents will dig under the side of the enclosure to gain entry, so if a soft substrate or dirt floor is to be utilised, it is recommended that the enclosure walls are sunken into the earth and a wire mesh barrier placed beneath the dirt floor.



It is important to consider drainage as a dirt floor with poor drainage can be slippery and pool water, which makes cleaning difficult and is treacherous for the animals as they may drown if they fall to ground level.

A dirt floor can be made pest proof, whilst retaining good drainage, by building up layers:

Layer	Component	Reason for incorporation
1	Wire mesh - 0.5cm square	Rodent proofing
2	Blue shale to a depth of 6 cms	If a rodent does manage to get through the wire mesh, the slate falls in on the rodent as it attempts to dig through
3	River sand to a depth of 4 cms	This absorbs water in heavy rain, is reasonably soft should the FF crash land, and it facilitates easy cleaning by raking.





When animals are first placed within a dirt floor enclosure they should be monitored to ensure they are not ingesting the substrate materials.

A wide strip of copper sheeting around the base of the enclosure to a height of 20cms will prevent slugs from crawling through the wire mesh. This will also deter rodents as they are unable to crawl up the slippery surface.

4.8 Enclosure Furnishings

In considering GHFF roosting patterns, the introduction of new cage furniture (and relocation of existing furniture within the enclosure) should be carefully considered to



avoid undue stress to the occupants. At the same time, it is important to enhance the FF's environment with variants, such as additional branches, fragrances, etc to simulate inconsistencies encountered in a natural environment.

To encourage flight exercise, the enclosures should be uncluttered. However, the placement of soft furnishings such as ropes, towels and hessian sacks will encourage the FF's to fly from one item to another.

As anybody who has visited a flying fox colony will attest, FF's arrive in great numbers and prefer to roost within a tree heavy with foliage. Cleave (1999) notes:

"... the accumulation of their acidic droppings can kill off the foliage, making the bats rather conspicuous. They will eventually seek another, more secure roosting tree" (p66).

As the FF does not generally eat a lot of foliage, but merely uses it for camouflage and the occasional tidbit, left over or uneaten browse can be placed in the exhibit as it is removed from other exhibits.



Incorporation of a leaf canopy may impair visibility of the animals, however, if carefully placed, the canopy can allow clear visibility from the side or underneath, providing good cover overhead. Movement of the animal will be increased, as animals are forced to navigate their way amongst leaves and up and down branches, rather than merely traversing a wire cage roof. Before placement within the enclosure, care must be taken to remove any sharp edges, sticks or burrs to minimise risk of wing membrane damage.

Keeper obstruction for cleaning is negligible as the canopy is at the top of the enclosure, rather than at ground level.





Placement of fruit leaves, such as banana and mango leaves may be beneficial. Banana leaves are large providing good cover from harsh sunlight, provide a pleasant fragrance for the animals and the potential to chew on a leaf whilst idly roosting. Additionally, large leaves hold pooled rainwater allowing the FF's to lap rainwater from the leaves after a shower.

As GHFF hang from the enclosure roof by their feet, a wire roof can be cold in winter and hot during summer. A softer, springier lining would be beneficial such as thick gauge prawn netting (as pictured left). The netting is:

- easy to erect;
- has good elasticity without being insubstantial,
- allows the FFs to clamber around and fly to without the risk of catching themselves on the cage wire;
- an exercise enhancement promoting 'branching' activity to increase circulation to the shoulders and reduce the risk of respiratory infections;
- acts as an additional barrier to any birds or wild flying foxes that may alight on the top of the cage;
- inexpensive (or sometimes free) to acquire as damaged netting is regularly discarded by prawn fishermen who are only too happy to allow somebody to take it away for them;



As FF's do not chew or gnaw, there is minimal (to no) risk of them ingesting any of the fibres.

The netting should be placed along the roof of the aviary (as below) and affixed with strong cord or wire. By allowing peaks and troughs, the FF's will be forced to navigate their way up and across them as they clamber across the roof.



food buckets

netting peaks

apples suspended on wires





By selecting green netting, the illusion of a tree canopy may be enhanced. The netting does not interfere with any externally placed weather protector (to keep the FF's dry during rain).

The netting can be hosed on particularly hot days that in turn lowers the temperature within the enclosure. Many animals will lick water droplets from the netting after hosing.



If installing netting, two factors should be borne in mind.



Firstly, the FFs should be prevented from climbing underneath the netting and getting between the netting and the enclosure roof.

This is done by bordering the netting with a length of timber and sandwiching the netting between the roof and the secured timber length.

Secondly, if there is insufficient gap between the suspended netting and the enclosure wire roof, FFs may still be able to hang from the enclosure roof by placing their feet through the netting and hanging on the wire.

Whilst this does not pose a problem to the FF, it can make catch up of the animal more difficult when trying to prize toenails from the wire roof.





5 GENERAL HUSBANDRY

5.1 Hygiene and Cleaning

Good exhibit hygiene is essential to reduce FF odours caused by faeces, urine and discarded fruit. During hot weather, fruit flies and cockroaches are attracted to fruit buckets, so prompt removal of uneaten food will reduce insect infestation.



If uneaten food is left on the exhibit floor or in food buckets, the High Protein Flying Fox supplement quickly sours and causes a growth of fungus. Additionally, cut fruit ferments in hot weather.

It is important that the previous night's uneaten fruit is therefore not available for FF's to snack on during the day. Fresh fruit can be supplied for daytime consumption in the form of apples on wires, which will minimise fruit fly infestation.

Food and water dispensers should be replaced with fresh containers on a daily basis. The spout on water dripper bottles should be checked and cleaned as it can become clogged and jammed with bits of fruit and food supplements.

The enclosure floor should be swept clean and then hosed. Hosing reduces odours and cleanses the area of any secretions left by pests such as rodents, slugs and snails.

Faecal build up has been linked to Histoplasmosis, which is an infectious disease caused by inhalation of the fungus *Histoplasma capsulatum*. Infection is by inhalation of the fungus spores, rather than from a host animal, and the fungus is found within soils enriched by bat (and bird) excreta. It is usually restricted to sites inhabited by microchiroptera, such as within caves, rather than GHFF colony sites. By ensuring enclosures are regularly cleaned, any risk is minimised as fungus does not get a chance to build up. (Jackson-S, p313)



Wire mesh can be cleaned with a stiffly bristled brush. Baked on faecal matter may need to be scraped off with a thin blade, such as a paint scraper.





Jackson-S suggests using a 1% bleach solution to remove odours, and then rinsing thoroughly. Alternatively, a Sodium Bicarbonate-Water solution may be utilised.

When necessary, blankets/polar fleece should be removed for washing. As FFs rest within the blankets for security, fresh blankets should be hung as the soiled blankets are removed.

Whilst cleaning the enclosure, observe the animals as they rest and move around. Injuries may not immediately be apparent, but may become noticeable as the animal moves.
(refer s8.1 Daily Health Checks)



5.2 Record Keeping

For the purposes of accurate record keeping, each animal should be given a unique identifier number. Databases developed by the International Species Information System (ISIS) and maintained by the Conservation Breeding Specialist Group (CBSG) document information through:

Database	Acronym	For information on
Animal Record Keeping System	"ARKS"	General information on births, transfers and deaths;
Single Population and Record Keeping System	"SPARKS"	Breeding studbook for species
Medical Animal Record Keeping System	"MedARKS"	Veterinary information

(Jackson-S, p313).

Regular notes assist with data collection for the purposes of improved husbandry procedures, but also are vital when selecting animals for transfer to other organisations and/or for participation in breeding programs (Refer Annexure 4).

If an animal's condition changes, care records may be referred to. Notes may contain information such as:

- Birth date, sire and dam;
- Arrival date at institution;
- Identification number of the individual, and/or name allocated;
- Date of introduction into enclosure and groupings;
- Social groupings – including movement of the individual to another enclosure, or introduction of other individuals into the group;
- Reproductive behaviour and/or condition;
- Breeding data; pairings – interaction with other members within the FF group;
- Behavioural changes or problems;
- Weights and measurements;
- Diet – including what is fed, how much is eaten, food preferences;
- Veterinary attention, including check ups, medications or treatments;
- Anything else that may be relevant or helpful for husbandry procedures.

Jackson-S (p313)





5.3 Methods of Identification

Visual Identification

Whilst it may take a while for a new keeper to familiarise themselves with each individual within a captive colony, generally FF's are easily identified by their individual markings. Some have dark facial fur, some are nearly ghost grey, some have a dark red ruff, whilst others may have a ruff of a caramel colour. Body size, weight and sex all give the FF a unique appearance.

Temporary marking



Plastic bird identification bands work well as temporary identifiers for juvenile animals, but due to the inquisitive nature of the FF they are easily removed.

Paint

Nail polish markers on toe nails and thumb claws is easily applied, is unobtrusive to the animal and is less easily tampered with by the FF. Nail varnish markers are still visible up to a month after application.

Punch Marking

Using a tattoo kit, small holes in the form of numbers are punched through the outstretched plagiopatagium at a location between the fifth digit and the body. The holes heal within 10 days whilst the numbers are still visible in the form of scar tissue, for up to 6 months after application. This is not an ideal method of marking as not only is it a temporary, it also requires catch up of the animal to outstretch the wing to read the number marking. (Jackson-S, p316)

Necklaces

Necklaces have been utilised for wild animal studies within Australia, and have been identified for use in captive populations. Fabricated from stainless steel ball-chains with a butt-end band for identification purposes, the necklaces are durable and if fitted properly, appear to cause little discomfort to the animals

Necklaces may not be suitable for some captive animals as skin irritation has been reported, especially in obese animals, or when food accumulates under the necklaces. (Jackson-S, p315).

Passive Integrated Transponder (PIT) Tags

PIT Tags are a permanent method of identification and have been used successfully on bats weighing over 10gms. Using a cannula, a small tag is implanted between the scapulae. The insertion point should be sealed with a dab of *Vetbond* tissue glue to prevent the tag from slipping out.





Individuals are then identification by means of a PIT tag reader which can be scanned by catch up of the individual, or by placement of the reader within a heavy traffic area of the enclosure, such as by food buckets or entry to the sleeping area.

Whilst PIT tags are reasonably expensive when compared to other means of identification, they provide valuable information when tracking individuals. GHFF released by care group *Wildlife ARC* are implanted with PIT tags prior to release. Individuals are tracked as they leave or enter the release cage allowing researchers to collect valuable data. For instance, data showed that some hand-raised females released from the cage returned to the cage the following year to 'park' babies there whilst they went out alone to forage for food. The next morning, the females returned to the release cage to collect the babies and then departed again to spend the day within the wild colony. (Kerryn Parry-Jones, pers comm)

Tattoos

Tattoos are applied to the patagium as a means of visual identification. Tattooing is not commonly undertaken with GHFF as it has limited success and reapplication of the tattoo is often needed. (Jackson-S, p313)

Ear Notching

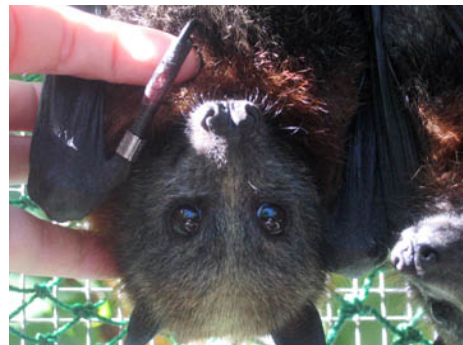
Whilst ear notching has been successfully used for identifying common blossom bats, it is not commonly used a means of identifying GHFF. (Jackson-S, p313)

Thumb Bands

Longer term identifiers are stainless steel or monel butt-end identification band applied to the thumb hook. The right thumb hook is used to identify females, and the left thumb hook for males.



Bands are applied with pliers and squeezing the band shut around the thumb. The band should be loose enough so it doesn't irritate and cut into the thumb, but not so loose that it falls over the thumb claw.



Care must be taken to apply the band properly so thumb hook damage doesn't occur. Observe the animal after application of the band as some animals may self-mutilate in an attempt to remove the band.

Banding is regulated by the Australian Bird and Bat Banding Scheme ("ABBBS") and bands applied under license. Each band has a unique identifier number which can be tracked back to the individual bander. Recently a banded wild GHFF was found dead and the band was tracked back to a release undertaken 12 years previously (FFICN website posting, December 2004)





6 FEEDING REQUIREMENTS

As noted in '3.4 Diet in the Wild', flying foxes can travel great distances in search of food. Indeed some FFs have been tracked as travelling from Queensland to Melbourne to follow the food source. As with any animal, individual FFs have specific food preferences. Hall & Richards (2000) advise:

"There is strong evidence from radio-tracking studies that colonies of this species (GHFF) have some individuals that primarily select blossom and others that mainly select fruit" (p79)

Logistically, it is virtually impossible to replicate the wild diet of nectars, pollens and fruits the wild GHFF may encounter in one night.

6.1 Captive Diet

An 'old wives tale' used to be that flying foxes eat and defecate out of their mouth. This tale undoubtedly came into being by observing the FF manner of eating, in which they extract the nutrients by chewing the fruit, then swallow the juice and spit out the pulp. The FF digestive system does not easily tolerate fibre so homogenised and pureed fruits should be avoided.



Flying foxes eat 25-35% of their body weight in fruit daily, so each average sized adult should be offered approximately 350gms of chopped fruit per day (plus supplements).

Offer at least three varieties of fruit, ensuring that 2/3rds of the captive diet is comprised of hard fruit

such as apple and pear. If possible, offer two varieties of apple, for example red delicious and one other – red apple appears to be favoured over green (pers obs).

The remaining 1/3 of fruit can be made up of soft fruit such as rockmelon, pawpaw, grapes, melon, peaches, plums, fresh figs, mangos and any soft fruit in season. (NB: wild bats in rehabilitation should not be fed stone fruit. Orchardists believe this encourages FF's to raid orchards).

To reduce wastage, fruit should be chopped into bite sized pieces, as shown in the photograph above.





Flying foxes may hold a large piece of fruit in their hind claw to bite smaller pieces from a large piece of fruit. In captivity, with a ready abundance of food, the animals will often take a bite and then drop the remainder on the floor (pers obs).

Further, some animals will flick unattractive staple foods (ie apple) out of the food bucket to get to the more desirable soft fruits beneath. Hall and Richards note:

“Taste buds are located on the tip of the tongue of the GHFF which suggests [they] sample and test their food when feeding...” (p68)

If food wastage of staple foods is occurring it may be necessary to feed in two servings, the first serving of hard fruits (which are needed to keep teeth clean and exercise jaw muscles) and the second serving with the soft fruits added. Alternatively, reduce the amount of soft fruit offered to limit the animals' choice.

Banana, due its high fibre content should be offered sparingly. Although not common, some FFs like citrus fruits, so mandarins and orange can be occasionally added. Similarly many flying foxes like sweet vegetables such as canned sweetcorn kernels.

Fresh herbs such as parsley, thyme, mint are used as behavioural enrichment olfactory tools.

When selecting fruits for use in the daily diet, it is prudent to reserve one particular favorite fruit as a special treat. This can be used in behavioural conditioning and training purposes.

Hall and Richards describe studies on the GHFF brain which show:



“From the large size of the olfactory lobe, it can be deducted that smell plays an important role in social behaviour and navigation, and it is the main sensory system for the location of food.” (p34)



So, where possible, fruit should be freshly chopped to be especially palatable. Grzelewski-G jokes:

“... you can forget the vampire cliches. If these bats flew in through your bedroom window at night they'd head straight for the fruit bowl, not your jugular” (p92)





Diet throughout the year may vary depending on fruit availability. Extra food should be offered in breeding season (from October through to January) if females are raising offspring, and a dietary supplement added to daily food rations. (refer below '6.2 Supplements' for dietary supplements).

6.2 Supplements

Dietary supplements should always be added to GHFF chopped fruit. Wombaroo has tailored a supplement to the dietary requirements of the Flying Fox, namely "High



Protein Supplement" which aims to boost the protein requirements of fruit and nectar eating animals. 7-10gms of High Protein Supplement should be added to 350gms of chopped fruit, per bat.

Wombaroo supplements the basic fruit diet by providing:

Min Crude Protein	52%
Min Crude Fat	2%
Max Fibre	5%
Max Salt	0.8%

Wombaroo is comprised of whey protein, soy protein, ground cereals, maltodextrin, dextrose, lysine, methionine, vegetable oils, omega-3 and omega-6 fatty acids, vitamins A, B1, B2, B6, B12, C, D3, E, K, nicotinamide, pantothenic acid, biotin, folic acid, choline, inositol, calcium, phosphorus, potassium, sodium, magnesium, zinc, iron, manganese, copper, iodine, and selenium (*Wombaroo website, Oct 2004, Refer Annexure 5*)

Wombaroo is available in 250gm, 1kg and 5 kg packs. Once the pack is opened, shelf life is enhanced by storing the powder in the freezer.

If Wombaroo is not available, 'Complan' can be added at a rate of 1tsp per 350 gms fruit.

Other occasional supplements can be added to the fruit such as:

- Glucosamine Chondroitin – joint food
- Ester C – vitamin C powder
- Sandoz Calcium Syrup
- VetaFarm Blossom Nectar

During hot weather, many hand tame flying foxes often lick the skin of the keepers (pers obs). Churchill-S notes flying foxes:

"... appear to eat the salt glands from mangroves" (p90)

for this reason, the provision of a salt or mineral lick may further supplement dietary requirements.





6.3 Presentation of Food

GHFF naturally bicker over food, with each individual coveting another's food station (Refer 9.2 Social Behaviour). It is therefore important to provide a number of feed buckets (ideally one per animal) and at various locations within the enclosure. As FF's invert to defecate/urinate, sometimes a mis-aimed evacuation can end up in a food bowl spoiling the food. For this reason it is preferable to only half fill the feed buckets and to locate the food at a number of different locations (pers obs).



Maintaining variety within the captive flying fox diet, but at the same time being mindful of the need to avoid extra work for the keeper is a difficult compromise. Obviously it is impossible to replicate the feeding patterns of the FF, however, it should be possible to provide enough feeding activities to stimulate natural foraging and hunting techniques. (Refer Annexure 6 for suggested behavioural enrichment activities)

A simple activity such as placing whole apples on a piece of wire requires the animal to work for their food (an unfurled metal coat hanger works well). The picture above shows each apple with a small nick out of it to allow the animal an easier initial bite into the fruit.

Another feeding aide is a wire cage, such as that used for feeding wild birds. Placement of soft fruit within the cage, and then suspension of the cage on the aviary roof encourages the animal to 'hunt' the banana and consume by licking, rather than gobbling it down quickly. It takes many hours to lick a banana flat, where otherwise the fruit would be consumed in a number of large bites.



Rather than placing food in stainless steel food dishes, it can be placed in plastic



buckets and suspended from the roof. The FFs will be required to use their muscles to reach and hang over the food buckets, rather than just slouch on the side of the cage to feed over a metal D-cup. Once familiar with this system, the buckets can be suspended on thick ropes whereby the FFs must fly, leap

or clamber down the ropes to reach food. A rope length of a metre is a good length.





An unpeeled banana suspended at the untethered end of a flexible hose or cord encourages the flying fox to work out ways to restrain the flexible hose and employ muscular strength to hold the hose steady whilst they forage.

(The flexible hose as used on the tap, pictured here would provide an ideal starting point for adaptation).



A treat of Wombaroo Leadbeater's mix placed within a drip feeder, (such as that used to feed honeyeater birds, pictured here) can be placed in the enclosure amongst the foliage. This provides extra nutrition, behavioural enrichment in a non-standard food treat, and pleases the flying fox who favours pollens and nectar over the usual fruit diet.

Blossoms such as gravillia and bottlebrush could be added on alternate days, and their interest maintained by spraying the blossoms with a fine spray of Wombaroo Nectavore mix.

6.4 Water

GHFF's quickly become dehydrated during hot weather, it is advisable to always provide water in at least two different locations within the enclosure.

Bowls

Water bowls can be placed within the enclosure at an elevated position and allow the animals easy access to water. However, animals often visit the water bowl during feeding and the water can quickly become fouled by foodstuffs.

Drippers

Water droppers, such as that used for feeding rodents, can be positioned outside the cage, so the dispenser tip protrudes through the bars. This keeps the water clean and fresh, encourages the animal to lick the water, rather than sticking their whole face in a water bowl, and facilitates quick and easy replenishment and cleaning for the keepers. Some dropper bottles contain a filler level indicator (such as the plastic marker shown in the photograph), so on hot days water levels can be regularly checked from a distance without having to physically remove the water container to check.



Water drippers also eliminate the risk of harmful and disease carrying contaminants being spread by slugs or snails that may literally drop in for a bath. They should be checked regularly for malfunctions, ie the ball bearing can become jammed or freeflow giving an inaccurate record of water consumption.





It is well documented that flying foxes will drink whilst on the wing. In a report published in *Victorian Naturalist*, H. Loyn (1981) describes:

“... flying foxes gliding down over creek, skimming its surface with their bellies, then licking the water thus collected in their fur.”

Unless captive FFs are housed in a large flight aviary, it is unlikely they will attempt to replicate the behaviour of their wild cousins. However, the instillation of a water fountain and small pool feature would enhance the look of the exhibit, providing the FF with an opportunity to drink fresh, flowing water and increase humidity levels during exceptionally hot arid days. The feature should have sloped, tractable sides to allow the animal to crawl out if it falls in.

Care must be taken to ensure the water feature is placed in an open area where it will not be fouled by droppings should the bats choose to roost over the water.





7 HANDLING AND TRANSPORT

7.1 Timing of Capture and Handling

To avoid excessive stress and wing damage, it is preferable to catch a GHFF whilst the animal is roosting; ie, during daylight hours. Expediency and confidence are the keys to catching and restraining a flying fox.

7.2 Catching Tools

Towel

A large towel is ideal. The towel should be wide enough to wrap around the FF's body as it hangs, and long enough so the lower edge can be lifted and doubled up over the FF so it is totally enclosed within.



Gloves

As GHFF's initial reaction on capture is to shriek, flail wings and attempt to use large canine teeth to bite, handlers may prefer to also use thick gloves on catch-up. Gloves act as a barrier against Zoonotic diseases but reduce the catcher's ability to accurately determine the amount of force applied to delicate wing bones

Harp Trap

In large enclosures an adaptation of Tidemann and Loughland's Harp Trap (1993) can be used. The GHFF's claws are unable to grip the strands of fishing line and they slide down the trap into the (gloved) hands of the catcher.



The trap should be portable and moved around the enclosure as the FF's will learn to avoid the trap. Tidemann advocates the use of steel butchers' gloves inside the leather gauntlets as added protection against bites.

Hand Held Net

A large hoop net, with a long pole to reach the height of the enclosure, can be used. Care must be taken not to damage the FF's wings as the FF will flail and struggle once caught.

7.3 Capture and Restraint Techniques

EPA regulations require a GHFF enclosure to have a 3 metre roof height, so it may be difficult to isolate and catch up a GHFF without some pre-planning. By regularly feeding the animals in a restricted part of the enclosure it will make the task of catch up much less arduous (*Refer 4.1 Exhibit/Enclosure Design*).

As predators such as owls avoid being bitten by gripping the bat by the back of the neck, restraining a FF by clutching the back of its head often engenders aggressive fear. Whilst being mindful to maintain a firm grip on the animal, consider this may be engendering additional struggling as you restrain the FF. By allowing the feet to grip and firmly (but not tightly) restraining the wings, the FF should remain reasonably calm without having to grip the neck too tightly.





Step 1.

Before approaching the bat, position your hands at an appropriate distance on the towel*. With the towel held loosely at your waist height approach the bat quickly, confidently and quietly. As you are within reaching distance of the bat, lift the towel, as shown above. Do not approach the bat holding the towel up as it will scare the bat and make it harder to catch. Use enough speed so you are quick enough to cut off the bat's means of escape, but not so much that the bat becomes stressed and either races towards you, or spreads its wings in a defensive pose making it harder to wrap.

(Some people prefer to position the towel between themselves and the bat. It is safer for you as it puts the towel between you and the bat, but harder to do as you can't see what the bat is doing).



Step 3.

With your right hand, bring the end of the towel up so the head and body are totally enclosed. Whilst maintaining pressure on the bat's feet with your left hand, prize the toes off the branch with your right. It is important to make sure the bat feels it is gripping on to something as it will be more relaxed and less likely to struggle. Remember, the bat must exert a conscious effort to release its grip, so it is naturally difficult to prize the feet from its perch.

* Please note, this handler is not wearing gloves. It is recommended that all bat handlers wear gloves as an added precaution against bites and Zoonotic diseases.



Step 2

Quickly wrap the towel around the bat and grip both ends of the towel in your left hand. At the same time apply very slight pressure to the bat's feet so the towel is tightly closed around the bat's ankles and the bat's body is enclosed in the wrapped towel. If the bat struggles unduly, or if you have attempted to wrap whilst the wings were open, release and start again. Wing bones are very delicate and can break easily. Also if the wings are raised, it means the head isn't contained. The wings could part the towel allowing the bat to escape, to gauge you with its thumb hook or to poke its head through the fold and bite you (probably all three).



Step 4.

If you are holding the bat in your left hand, position the bat's toes over your left index finger so it feels it is hanging. With your right hand, neaten up the lower edge of the towel. Bring the lower edge up to your left hand and grip the edge with the other fingers on your left hand. This releases your right hand to open up cage/aviary doors. If holding the bat as above, be mindful of the head in case it somehow manages a freak bite through the towel.





This picture shows a rescue from a barbed wire fence using an adaptation of the towel technique as outlined above. The GHFF's wings and head are restrained by means of the towel, leaving the hands free to unhook the feet. In this instance, the lower edge of the towel protects the bat and rescuer from becoming entangled in the lower strands of barbed wire.



Once the bat is free from its hanging, the towel is bundled around the body, making sure the feet are secured, to give the bat the feeling of security. The handler's hands hold the wings against the bat's body, and the head (and teeth) are positioned away from the handler's hands. Despite its ordeal, this bat immediately calmed down when wrapped like this.

7.4 Release



Step 1.

When placing a flying fox into a carry cage or aviary, it is important to ensure the feet are securely placed on a branch before releasing the towel. Allow the GHFF's feet to extend slightly from the top of the towel.



Step 2.

Whilst still maintaining your grip on the bat's ankles and lower edge of the towel, position the bat's feet on the branch. Slightly release the pressure on the bat's ankles so it grips the branch.



Step 3.

Lift the towel away from the bat and drop it away. NEVER just flick the towel open and let the bat crawl out. The first thing it will do is to try and get as high as it can, and this usually involves trying to climb up your face. A dropped towel may also tear wing membrane and/or break bones.

If the GHFF is to be released into the wild, it should be released just prior to dusk, when the animal is beginning to get active. Do not release during the hottest part of the day as the FF may not immediately find shelter and will overstress from heat and unfamiliarity with its new environment.

If possible, release at a known colony roosting site so the FF can follow the colony out to forage. If the FF has been in care for a number of days, ensure it has eaten before release so it is not forced to leave the release site to forage before it has found its bearings.





Observe the animal post-release to ensure it is able to fly properly, even a large rehabilitation aviary will not give a clear indication of whether a FF will be able to sustain flight and gain lift.

A release method employed by Wildlife Information and Rescue Services ('WIRES') for FF's with questionable flying ability is to release at a large football field beside a colony site, where there is a tree on the perimeter of the colony site. The tree should be large enough to attract the FF, but not too large to prohibit a hasty climb by the releasors should the need arise.

The person with the FF stands about 50 metres away from the tree, with 4-6 helpers standing in a semi-circle between the releasor and the tree. When released, if the FF cannot fly properly it will usually come to ground between the releasor and the tree, at which point it is quickly gathered up by one of the helpers and returned to rehabilitation until ready for release. As this method is not infallible it is wise to try and include someone in the group that can climb trees at a rapid rate (WIRES training manual).

7.5 Weighing and Examination



Juvenile animals can be securely wrapped in a cloth and placed within a plastic bucket on top of electronic scales. Providing their feet are secured, they will be happy to rest quietly for a brief interlude on the scales.

Larger animals may be placed within a cloth bag and suspended on a spring scale for weighing.

The physical examination should include the recording of a forearm measurement, as well as examination of:

- eyes,
- ears,
- oral cavity for condition of teeth, gums, mucous membrane colour;
- body condition including checking fur for ectoparasites,
- unusual odours or discharges,
- feet including claws,
- wings, including thumb and finger joints and wing membrane damage/discolouration/fungus;
- general scars, cuts and abrasions, old or new.

(Refer Section 8.2. Physical Examination)



7.6 Transport Requirements

For transportation, GHFF should be provided with a sturdy box. Be mindful that in transit the FF may panic and attempt to thrust thumb hooks or feet through any box openings, so any openings in the box must be small enough to allow the animal to hang, yet large enough that toe joints and/or thumb hooks cannot be caught.





It is also important to ensure the box can be easily carried without the necessity for the handler to push fingers through holes leaving them susceptible to bites/scratches.

7.6.1 Box Design

IATA (1999) specifications for GHFF transport box is that it should be approximately:

30cms wide x 40 cms high wide x 30 cms deep. (Jackson-S)

The roof should be ventilated and 1cm² wire is recommended to enable bats to hang during the trip.

The box should permit easy access and removal to the GHFF and be secure to prevent an in-transit escape. As GHFF urinate often and copiously, it is wise to include a solid floor to prevent fluid spillage onto car seats.

(Refer to Annexure 7 for travel box build specifications to IATA standards).

Other options for short trips are:



A **petpack**, with a roof suitably fitted with wire to enable the bat to hang. The petpack should be tall enough that the GHFF can hang without its face touching the floor of the cage and deep enough that the FF can hang at the rear of the cage away from the door. A towel can be clipped and draped inside the front opening door for security. This particular pet pack has ventilation slits that are large enough to allow free air flow, yet small enough that thumb hooks and limbs will not protrude and be damaged. It meets Australian standards for airline transport. (note slightly convex sides; so if petpack is stored closely between

flat surfaces, the air flow will not be restricted).

A **Cat carry cage** lined with a large soft towel. The towel is clipped inside the cage to protect wings/limbs. The towel extends and covers the door. It is important to clip the towel along the front and lower edge to prevent the GHFF from crawling between the towel and bars during transport. Identification paperwork should always accompany the GHFF in the event the handler and animal are separated.

A small **keyring tag** with relevant details and affixed to the cage is a simple and effective animal identification tag. It also serves to identify the travel cage for return, should the animal be transported one way.





7.6.2 Furnishings

As GHFF preference is to hang from the wire at the highest point of the transport box, cage furniture (such as a stick or bar) is not required. Sticks and/or branches may snap during transit leaving a sharp edge which can cause injury, or the FF could panic and get wings trapped around the bar.

A small towel or absorbent paper on the transport box floor is advisable.

7.6.3 Water and Food

Should be provided, taking care that water is offered in a non-spillable container. If the FF is familiar with using a water dripper bottle this may be utilised, and fruit juice can also be offered in this manner.

7.6.4 Animals per Box

There is a risk that individuals will attempt to clamber on one another during transport. This risk is minimised by transporting individuals separately.

7.6.5 Timing of Transportation

If possible, GHFF's should be transported during the day when they are more passive. Avoid transportation during the hottest part of the day and do not leave unattended animals within transport boxes in a hot vehicle or in the sun.

7.7 Release from Box

Depending on the release area it might be necessary to remove the GHFF from the transport box prior to release into the enclosure. (Refer to 7.4 - Release). Otherwise, stand inside the enclosure and hold the transport box beside the wire mesh. Open the transport box door and allow the FF to climb out and make its way up the side of the cage. Do not open the box door towards you as the FF will probably thumb hook at your clothes and use your face as a ladder to climb out.



(left) Incorrect way to transport GHFF. No matter how comfortable a hand tame FF may appear during transit, the animal should always be contained. Apart from the safety aspect for yourself and the animal, if you have a car accident, the rescuer may think twice about opening the car door to offer assistance if there is an anxious FF flapping around inside the car.





8 HEALTH REQUIREMENTS

Before even opening the enclosure door it is easy to get a basic overview of the health of the occupants. As GHFFs usually hang above keeper head height, it is simply a matter of standing below the animals and assessing them visually.



Daily health checks do not necessarily mean physically handling the animals. Some factors to be aware of are listed below in 8.1.

8.1 Daily Health Checks

On approaching the enclosure, be aware of the positioning of the animals, for example, observe whether individuals are:

- within the group or apart from the group;
- whether 'friends' are hanging in their normal grouping or whether their allegiances have shifted to other individuals;
- whether they are hanging near the door (or even on the wire on the back of the door awaiting your arrival);
- underneath shade or hanging out in the light,
- hanging low down on the cage furniture;
- are the wings wrapped around the body or hanging at their sides;
- are the majority of the group asleep or are they awake and alert;
- are the knees bent indicating anxiety or wariness or are they relaxed;
- are they hanging near or above the food bowls, and if so, are the food bowls empty and licked clean, or is there food remaining,
- basic body condition – are they dry, well groomed or wet with poor fur condition (nb: they may have just taken a urine bath so be aware of associated odours as wet fur does not necessarily indicate illness)
- any unusual vocalisations/sounds;
- consistency of the droppings on the cage floor – are they well formed or runny – what's the colour. For example, this animal ate (left to right)

apple, paw-paw and banana. An overall orange/ocre colour may indicate an animal is only eating the soft fruit and not touching the staple fruit (eg: apples, pears) and so may develop dietary deficiencies and/or rotten teeth.



Often, as soon as you open the enclosure door, the individuals move to the rear of the enclosure and you have lost this opportunity for non-intrusive observation.





8.2 Detailed Physical Examination

GHFF are inquisitive by nature and as a result may inflict minor damage on themselves by flying, flapping and generally crawling around the enclosure. The most common injuries will be thumb hook or wing damage. (refer to 3.1.4 – Anatomy and Physiology, and Annexure 8)

8.2.1 Chemical Restraint

INHALATION

Isoflurane (with oxygen) is recommended for short term restraint and anaesthesia as it provides rapid induction and recovery. Isoflurane is administered 5% by mask with maintenance of 2% to 2.5% (Heard-D, p322).



Isoflurane (Aerrane [ICI Australia], Forthane [Abbott], Isoflurane Inhalation Anesthetic [Fauldine Pharmaceuticals]. Analgesia and muscle relaxation are excellent, induction and recovery are rapid and smooth ... it is expelled virtually unchanged from the lungs, is safe to use in all species, is not hepatotoxic or carcinogenic" (Vogelnest-L, p128)

Halothane can be used but recovery is more prolonged (T. Bellamy) Anaesthesia is usually induced with 2.5-5% and maintained with 1-1.5% halothane and 1-2 l/m oxygen (Vogelnest-L, p128)

Halothane (Halothane M&B, [Merial], VCA Halothane [Veterinary Companies of Australia], Fluothane [ICI Australia]. "Halothane gives fast induction ... however there is a close interval between respiratory and cardiac arrest so it is essential that animals ... are closely monitored during anaesthesia. Recovery takes 3-15 minutes". (Vogelnest-L, p128)

Bats of over 150gms are intubated with a 2-mm or less internal diameter endotracheal tube. **Glycopyrrolate** (0.01mg/kg IM) administered before induction reduces the profuse pharyngeal secretions.

SEDATION:

Ketamine (30 to 37.5mg/kg intramuscularly produces short term chemical restraint but poor muscle relaxation and struggling during recovery.

Ketamine HCl is available in Australia as a 100mg/ml aqueous solution and marketed as Ketapex [Apex], Ketamav 100, [Mavlab], Ketamil [Ilium], Ketamine Injection [Parnell] and Ketavet 100 [Delvet].

Ketamine is short acting. It is metabolised in the liver and excreted by the kidneys. It can be administered intermuscularly, or orally by squirting into the mouth. (Vogelnest-L, p120).





“**Xylazine** and **ketamine** (2mg/kg and 10mg/kg [IM]) and **medatomidine** and **ketamine** (50 µg/kg and 5mg/kg [IM]) combinations produce short-term immobilisation (30 minutes) with good muscle relaxation and quiet recovery.

The recommendation when using these combinations is that neither Xylazine nor Medetomidine be reversed, except in an emergency, because the adverse effects of Ketamine (wing flapping and struggling associated hyperthermia) will be unmasked during recovery” (Heard-D, p322).

Xylazine HCl (Anased Injection [Heriot], Bomazine [Hoest Roussel], Romazine [Jurox], Rompun [Bayer], Thiazine [RWR] Xylaze [Parnell], Xylazil [Ilium]. Xylazine is metabolised in the liver and excreted in the urine.

Medatomidine HCl (Domitor [Novartis] Zalopine [Farmos, Finland] is highly lipophilic, rapid acting and quickly eliminated. It produces excellent, reliable sedation, muscle relaxation and analgesia ... due to desaturation of blood and vasoconstriction in the periphery, mucous membrane colour and periphery pulse are poor. Medatomidine is metabolised in the liver and excreted in urine. (Vogelnest-L, p131)

Tiletamine HCl (Zoletil). Tiletamine HCl is only available in combination with zolazepam HCl as Zoletil [Virbac]. Tiletamine is a congener of phencyclidine HCl and ketamine HCl. This combination of cyclohexamine dissociative anaesthetic agent (tiletamine) and a benzodiazepine (zolazepam) is now one of the most commonly used agents for the anaesthesia of many wildlife species.

Zoletil is centrally acting, rapid acting and repeat doses can be safely given to increase depth and duration of anaesthesia. It can be give IV or orally by spraying into the mouth. It is primarily metabolised and excreted by the kidneys. (Vogelnest-L, p128)

Diazepam (Valium [Rochel], Pamlin Injection [Parnell]. Diazepam is the most widely used benzodiazepine in both wild and domestic animals. It has very good muscle relaxant, anxiolytic and anticonvulsant activity Dose rates range from 0.5-10.0mg/kg depending on species and desired effect. It can be administered orally, IV or IM. It can be used on its own or combined with ketamine. It is fast acting with onset of effects in 1-2 minutes following IV injection and 5-20 minutes following IM injection. Duration of action is normally 1-2 hours. (Refer Annexure 9)





8.3 Physical Examination

Flying foxes are generally reasonably easy to handle by one person, providing the animal is wrapped correctly prior to starting the inspection. This wild adult male (right) was easily distracted by the prospect of consuming vast quantities of figs during inspection. However, inspection of an anxious animal should be carried out by two people, or with the animal sedated (as described above).



Before catch up, visually assess the animal's condition (as described in 8.1 above). Your sense of smell can also play a part in determining a FF's state of health. If the animal appears to be generally in good health, then begin the inspection in a methodical order.

- With your fingertips, gently feel along the spine, from the head, neck down to the legs and feet. Feel for punctures, lumps, damaged toes, missing nails, foreign bodies and heat spots (which may indicate an infection). Check the grip of the feet;
- Determine fur condition - alopecia, ectoparasites, fungal infections, trauma; lack of grooming, dull and listless or shiny and lustrous;
- Feel along the chest and stomach and gently palpate muscles to determine general condition – is the animal eating enough, is it overweight; etc.
- Inspect the wings (refer handling technique below). Check for any holes, breaks, dislocations, inflammation or abrasions; similarly check the thumbs. Be aware of the feel of the wings – they should feel supple and soft – a dry papery feel can indicate dehydration.
- Oral cavity – are the teeth clean and all present; colour of mucous membrane; tongue;

Mouth Inspection



Note:

- * The FF's body is confined within the towel, wings are tucked against the FF's side;
- * Feet are confined within the towel (or secure along the handler's body);
- * The handler's left hand holds the FF body securely;
- * Slight pressure is applied at the corner of the jaw, whilst tilting the head back so the jaw opens;
- * The handler's right index finger is free to lift the FF's lip for closer inspection should the need arise.

- Inspect the eyes – are they clear and bright, is there a normal bilateral pupillary light response (difficult to determine if the animal is anaesthetised), normal corneal reflex, no discharges;





- Inspect the ears – are they clean and erect, any discharge or odour;
- Auscultation of lungs; and observe respiratory rate noting any strange noises such as a rattley breath or laboured breathing;
- Check pulse rate (average heart beat rate at 30°C is 130 bpm);
- Take temperature (rectally). Adult GHFF maintain a body temperature between 35°-40°C; with an resting active body temperature averaging 36°C;
- Record weight, with consideration given to time of the year – males gain weight in breeding season (March/April), females gain weight prior to parturition September/October;
- Check genitals – males check testes and penis, female check nipples (some females continue to lactate after weaning a pup and can get mastitis or fungal infections under the wing);
- Check the anus – should be clean and neat – check for diarrhea or unusual discharges.

8.4 Known Health Problems

8.4.1 Ectoparasites


Cause	Protozoan Trypanosoma Pteroi. <i>At least 3 types of sarcoptid mite species occur on FF.</i>
Signs	Scurfy skin, alopecia (hair loss)
Diagnosis	Through clinical signs, or skin scrapings, microscope examination. The mites can be brown, red or yellow.
Treatment	Flea powders, pyrethrum sprays (Pea Beau (tetramethrin/phenthrin/piperoni/N-octylbicycloheptene dicarboxide) or Moretein (bioallethrin/bioresmethrin). If mites are on the wing, sticky tape pressed gently onto the mite when it's on the membrane and then peeled off will bring the mite with it. Ivermectin (sheep strength), 1 drop mixed with 10 drops water. Give 1 drop.

Cause	Nycteriibid and Streblids Flies “Wingless flies”
Signs	Symbiotic relationship – no concern. These are small, long-legged brownish insects, from family Nycterbiidae. They feed on dead skin cells and don't pose problem to the FF .
Diagnosis	Visual - Heavy infestations may appear as yellow dots on the wing membrane
Treatment	Parasites can be sponged off by using a swab soaked in canola oil and then applying bird insect powder along the spine (between the scapula – to prevent the animal from grooming it off).





8.4.2 Endoparasites

Cause	Round worm (<i>Ascaridoid Nematode, Toxocara Pteroodis</i> is found in all Australian mainland flying fox species.
Signs	Worm infections develop only in suckling juveniles. Contamination of roost areas over summer months contaminate adults which harbour third stage larvae in their livers. In females, larvae move internally to mammary glands after parturition to infect offspring through the milk. Infected juveniles rarely harbor more than three or four of these large worms, which are expelled spontaneously prior to weaning at about 5 months of age. Juvenile FFs – signs found in hand reared animals are failure to feed, regurgitation and vomiting, nagging cough, bloated, diarrhea, lethargy.
Diagnosis	Clinical signs, faecal flotation
Treatment	<p>Felex paste (pyrantel pamoate 115mg/g Pfizer. The past 1ml/kg is smeared on the fur and the bat licks it off during grooming. Droncit injectable cesticide (praziquantel 56.8mg/ml, Bayer) 0.2ml intramuscularly) can also be given. Panacure 100 (fenbendazole 100mg/ml at 10,g/kg can also be used and appears to be successful with <i>Angiostrongylus cantonensis</i>)</p>  <p><i>Worms expelled from one 6 week old GHFF</i></p>

Cause	<i>Angiostrongylus Cantonensis</i> “Rat Lungworm” Metastrongylid nematode that inhabits the right ventricle and pulmonary arteries of rats. Rats acquire the infection by eating third stage larvae in the tissues of intermediate hosts such as slugs and snails.
Signs	Neurological symptoms, similar to those exhibited by Australian Bat Lyssavirus – hind limb paralysis or tetraparesis, general depression, stiff movements, lack of wing mobility, shivering, tremors, nystagmus, respiratory distress, anorexia over a period of weeks.
Diagnosis	Blood tests, faecal floats.
Treatment	Prognosis poor. Caused fatal encephalitis. Panacure 100 (fenbendazole 10mg/kg PO SID for five days (Rose-K)
Prevention	Routine worming and appropriate husbandry measures to eliminate rodents and slugs from the enclosure.



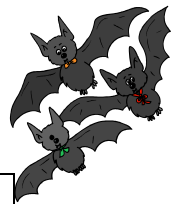


8.4.3 Viruses

Cause	Australian Bat Lyssavirus “ABL”
Signs	<p>The first case was reported in May 1996 when a sick bat came into care in Ballina. It was unable to fly, had mild tremors, paralysis and exhibited aggressive behaviour. Brain pathology showed rabies similar virus. (there are two strains, megachiroptera and microchiroptera).</p> <p>The Virus affects the nervous system. Following introduction into the body the virus travels through the peripheral nervous system to the spinal cord, then to the brain, where it multiplies before moving to the ducts of the salivary glands. In the brain, the virus causes severe neurological problems that result in the animal suffering partial paralysis, tremors, altered metabolism, dysphagia and sudden aggression. Virus combines with saliva and can be transferred to another animal during biting, the virus only lives for a short time outside of the host.</p> <p>The virus cannot be spread through contact with air, guano, urine or blood of infected animals.</p>
Diagnosis	<p>A suspect animal can only be accurately determined by histiopathic analysis on autopsy.</p> <p><i>“When a bat has bitten a person, the bat should be euthanased and its tissues submitted for rabies diagnosis” (Rose K)</i></p> <p>Immunofluorescence and immunoperoxidase antibody tests; viral culture of the brain. Conducted by the Australian Animal Health Laboratories in Geelong.</p>
Treatment	<p>Untreatable. Affected animals to be euthanased.</p> <p>The bitten person undergoes a series of post bite rabies vaccinations. A vaccinated person should seek a post bite booster shot.</p>
Prevention	<p>A course of three injections (Merieux Inactivated Rabies Vaccine) is believed to provide adequate protection, provided suitable titre levels are maintained.</p> <p>Non vaccinated people should not handle bats. However, if an unvaccinated person is bitten:</p> <ol style="list-style-type: none"> 1. Wash the wound with soap and water for no less than FIVE minutes; 2. Report for medical treatment (post exposure immunoglobulin vaccination). <p>Although many factors need to be aligned for a Zoonotic transmission of Lyssavirus, once a person shows symptoms it is too late with death occurring within a few weeks.</p>

(Refer Annexures 11, 12 and 13 for more information)





Cause	Hendra. Equine Mobillivirus (EMV); member of family Paramyxoviridae which was initially called Equine Mobilivirus or EMV.
Signs	First discovered in 1996 when the Department of Primary Industries was researching a virus that killed two humans and a number of horses in 1994. The affected died after contracting an influenza type illness, resulting in pneumonia, respiratory and renal failure. It is not considered to be highly contagious. No gross pathology or history of attributable illness has been detected in FFs. GHFF do not appear ill with this virus.
Diagnosis	Flying Fox to Horse to Human. Only confirmed by histological examination after death using indirect immunofluourescence test.
Treatment	None known.
Prevention	Regular testing of captive population – segregate from wild population.

Cause	Menangle – Paramyxovirus – first observed in stillborn piglets.
Signs	Symptoms similar to severe influenza – not known how it affects FFs.
Diagnosis	Blood tests for antibodies.
Treatment	Not known at this time.
Prevention	Not known at this time.

Wing Damage Inspection Technique

Damage to the wing membrane is generally repairable with time, however, GHFFs have a tendency to self-mutilate whenever the wing membrane is damaged so an Elizabethan collar may be need to be applied in cases of severe wing membrane damage (Bellamy-T and pers obs). (Refer Annexure 13 for template). Any tear to the leading edge of the Propatagium may render the GHFF unable to fly, and as this controls the ability of their ability to close the wing properly, euthanasia may need to be considered.



Turner-B discusses the complex nature of the FF wing when he notes:

“The bone is thin and highly fragmented, the humerus has a decided curve to it, the integrity of which is important to maintain for functional flight.

The radius is difficult to pin. The radial nerve is highly vulnerable to damage from attempting a retrograde pinning, that is, introducing the pin into the fracture site, pushing it out through the elbow and then pushing it back into the other side of the bone”. (p1)





Major bones need to be pinned whilst finger bones can be strapped. Young animals can recover from broken bones as they are more tolerant of treatment. Providing the break to a major bone is mid-shaft, it can be pinned and the animal can successfully fly again after an appropriate period of rehabilitation.

Wing Inspection Technique



Note:

- * the FF's head is contained within the towel;
- * the handler's left arm holds the FF firmly against the body, preventing the FF from struggling. This protects the handler from being bitten, and the FF from twisting and damaging the wing.
- * The handler's left index finger pushes on the FF's elbow to extend the wing. The wing is NEVER extended by pulling on the finger bones. Slight pressure is retained on the FF's elbow to keep the wing extended during inspection;
- * Once the elbow is extended, the handler's right hand opens up the wing fingers to inspect the membrane.



This non-releasable female has the tip of her leftwing missing making her incapable of flight.





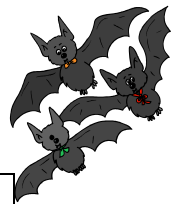
Cause	Ringworm
Signs	Patchy hair loss – patches don't have to be round.
Diagnosis	Skin scrape, microscope analysis
Treatment	Isolate. ORAL: Grisovin tablets (available in 125mg tablets). Give 2mgs or 1/6 a day for one month (based on FF of 700gms, or 2.5mgs per 87 gms of FF.. TOPICAL: Conofite cream.

Cause	Wing Membrane – ‘Slimy Wing’. Generally occur when FFs are not exposed to sun; fungal (candida).
Signs	Creamy white patches on the wings with a slimy feel and bad odour. Can cause permanent and serious wing damage.
Diagnosis	Visual signs and microscopic examination of fungus/yeast.
Treatment	Sponge the area with one part Malaseb to 30 parts water and then thoroughly dry wings with soft towel. TOPICAL: Iovone, Conofite, Panalog. Neotopic-H can be used on inflamed skin where an infection is suspected. ORAL: Anti-microbial drugs may be required, such as Nilstat, Fungallin.
Prevention	Allow access to sun, fresh air and adequate space to fully flap wings.



Cause	Bloat (infants)
Signs	Vomiting. Flying foxes can get bloated from internal fungal infections that can be treated with over the counter fungacids.
Diagnosis	Visual – bloated stomach, urine analysis
Treatment	Review and change milk formula offered. Offer acidophilus yoghurt (eg: Jalna unsweetened)
Prevention	Improved husbandry techniques – ensuring excess milk is sponged from infant after feed.





Injury/Disease

Cause	Trauma
Signs	One of the wings or legs not moving as freely or evenly as other.
Diagnosis	Radiography or visual signs (compound fractures, etc).
Treatment	<p>Fractures involving joints rarely heal well enough for sustained flight, midshaft fractures of long bones can be treated. Wound should be rinsed twice daily with Betadine or 10% Nolvasan solution, followed by application of antibiotic. Wing checked daily.</p> <p>Breaks to humerus or forearms much more serious, can be pinned - care not to exit bones through joints. Elizabethan collars applied to prevent self mutilation. Valium (diazepam) at 0.5mg/ml or Benadryl cough suppressant ('nighttime' -with antihistamine) 0.1 to 0.4mls orally</p> <p>Teri Bellamy – pers comm) can be given to reduce stress for first few days until bat is accustomed to collar</p>
Prevention	Bat check enclosure, provide appropriate climbing substrate

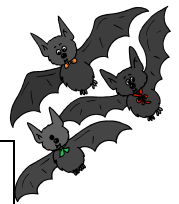


Cause	Wing Membrane Holes/Tears. Caused by fighting, rough surfaces. Can be large and bat can still fly.
Signs	Obvious holes in wing membrane
Diagnosis	Visually
Treatment	<p>Often heal well by themselves. Sponge with weak disinfectant such as diluted Betadine, 10% Nolvasan, Lotage (astringent/antiseptic) or antibiotic solution can be applied twice daily to fresh wounds. Sterile gauze pad to dry off any excess liquid (never leave bat wet). Can take weeks to heal properly with holes healing more rapidly than tears. Tears to the leading edge of the wing membrane are unlikely to heal. Tissue on edges of a tear can be reattached with tissue adhesive such as Vetbond every 1cm (not in a continuous line) along the tear. Sutures are not recommended as they can cause further trauma.</p> <p>“Duoderm” recommended to stabilise wing membrane.</p> <p>A shiny green film associated with laceration (Pseudomonas infection) can be cleaned with Betadine, Lotagen and then application of an antibiotic cream such as Panalog or Neotopic.</p>



Duoderm applied to wing membrane tear. This FF was later euthanased as plagiopatagium turned necrotic (lower edge) subsequent to electrocution.





	<p>A necrotic centre surrounded by inflammation (Staphylococcus aureus) should be treated with peroxide and Lotagen.</p> <p>A hole with thickened edges and a failure to repair can be debrided (little nicks cut all around the hole to removed bits of the ring). Application of macadamia oil to keep membrane supple and stimulate blood flow..</p>
Prevention	'Bat proof' enclosure – remove sharp objects, abrasive surfaces, possibly separate individuals if fighting is occurring.

Cause	Lead Poisoning
Signs	Animals showing signs of lead poisoning have poor body condition, muscle myopathy, dull eyes and diarrhea. They are often unable to fly. They exhibit muscle tremor, uncoordinated movement, severe convulsions, salivation and signs of secondary trauma.
Diagnosis	When tested, such bats show extremely high lead levels in their body tissues and fur. Lead levels of up to 65 ppm in the kidney and 40ppm in the liver have been found in bats. Diagnosis confirmed when blood level concentrations exceed 5 ppm (umolL). Inhibited of serum delta amino levulinic acid and increased blood protoporphyrin concentrations may be used to confirm lead poisoning.
Treatment	<p>Calsenate (calcium disodium edetate 200g/L) diluted to 10mg/ml and administered at 1 dose of 100-200mg/kg subcutaneously daily for seven days. A second course may be required as lead stored in the tissues may be mobilized into the bloodstream, especially under conditions of acidosis or late pregnancy and during lactation. Blood concentrations must be monitored for several weeks after treatment.</p> <p>Calcium disodium versenate tablets (500mg Riker Labs) ½ tablet crushed and mixed with food daily for 14 days also used.</p> <p>Even severe cases have responded but animals may have impaired vision or be blind when recovered.</p> <p>Supportive treatment proper nutrition, fluids to stabilise the patient – Hartmans solution, vitamins, and sedatives such as Valium (diazepam) can be used to control convulsions.</p>
Prevention	Collect browse from areas away from road traffic contamination.





FFs have a very high metabolic rate so injections of long acting antibiotics don't work. Smaller doses of oral antibiotics are effective. Some medications that have been safely used on GHFF are (listed alphabetically):

Aloe Vera	Wing membrane burns. Use straight from the plant, not as a cream or commercially prepared.
Amoxidrops	0.25ml up to 0.5ml for large animals.
Amoxycillin	(Amoxil, Betamox): Dose, 1 drop per 100gms body weight x 3 times a day (nb: Betamox easy to administer orally as FF's like the flavour)
Antirobe	(Recommended for use with bone infections) Mix 1 antirobe capsule (open the yellow and white capsule and pour out contents) with 25 mls of water. Give roughly 0.3 ml per 300 gm of bat. It dissolves easily but shake before drawing up.
Baytril	0.1ml per 500gm or less 2 x day
Benadryl 'Nighttime' with antihistimine	For stress (if Valium isn't available/effective). 0.1ml administered orally. Dextromethorphan hydrobromide, diphenhydramie hydrochloride
Clavulox	1 drop per 100gms of body weight x 3 times a day
Daktarin	(Fungal infections – can use on wing membrane).
Delacin-C	(Recommended for use with bone infections). Dose 1 drop per 100 gms of body weight 3 x times a day
Dequadin	Or "Applicaine" – mouth and throat burns.
Hisoacryl	Like a superglue for skin, works well on wing membrane holes.
Ivermectin	For Parasites (Sheep/Bovine strength). 1 drop to 10 mls of water, then give 1 drop only.
Metacam	Pain killer and anti-inflammatory. Restrict use to 3 days as may cause liver damage. 1 drop per FF twice a day.
Optichlor/Opti cin	Eye injury – refer to vet before use.
Rehydration	Hartmans. Bodyweight, plus 10% of intake weight over 3 days: Day 1 - 10% Day 2 – 5% Day 3 – 5%
Neotopic-H	Used on unbroken inflamed skin where an infection is suspected
Panallog	Used on inflamed skin. Has corticoid in it – so use sparingly on wing membrane, especially on young FFs.
Silvazine	Burns, topical cream for rips/tears.
Ungvita Ointment	Wing membrane burns



Juvenile GHFF taking Betamox
(Qantas in-flight spoon perfect size!)





8.5 Quarantine

Varies on origin and medical history of the animals to be introduced. The incubation period for lyssavirus is unlikely to be greater than six months, but usually three months or less (Fowler-Miller, p333).

Acknowledgement

Materials for this Section were compiled from information gained from personal communication with native wildlife veterinarians, animal care training courses and a composite of papers, some of which are attached as annexures; as listed below:

Annexure	Description	Author
8	Some things that can go wrong and what to do – A Vet's Perspective (pages)	Bill Turner, B.V.Sc
9	Chemical Restraint of Native Fauna, (pages 125-136)	Dr Larry Vogelnest, Taronga Zoo
10	Common Diseases of Megachiroptera(pages 79-82)	Dr Karrie Rose
14	(i) Normal Blood Values for Pteroptus Poliocephalus and P. Scapulatus (ii) Clinical Pathology Records Report – ISIS/In House Reference Values	(i) UNE. UNQ (ii) ISIS (Taronga Zoo)
15	Zoo and Wild Animal Medicine, Section V – Mammals (Chiroptera)	Fowler Miller





9 BEHAVIOUR

9.1 Activity

Although some diurnal camp activity may be observed, just as jostling, vocalisations and short flights to change to another branch within the same tree, the majority of GHFF activity is reserved for night.

Daytime flight is usually avoided due to inconsequential harassment by territorial little birds such as a noisy miner, to more serious threats from larger birds such as crows and raptors.

Around dusk, GHFF can be seen heading out from camps along recognised pathways in search of food. A noticeable exodus is apparent with the majority of FF's leaving the camp simultaneously, returning in smaller groups throughout the night.



9.2 Social Behaviour

Dominance within a flying fox group is depicted by the elevation - the more dominant the animal within the group, the higher up the cage that animal hangs to roost. It is therefore important to consider the installation of several high vantage points within an enclosure to avoid hierarchical struggles for dominance within the group, especially so as captive animals do not have a choice of whom they share a roost with.

A wild colony is comprised of both sexes. Animals often pair up, one particular male favouring a particular female within the colony. As pregnant females approach parturition, the previous year's young may roost on the colony perimeter, acting as sentinels. The colony structure is interlaced and interactive.

Vocalisations

Flying foxes are very vocal in their communication, and their vocalisations have been shown to be situation specific (Strahan, p441). Similarly, Hall & Richards (2002) note:

"...Studies on their acoustic behaviour show that their calls are in the range of 4-6kHz. Vocalisations play an important part in the social behaviour of flying foxes. Over thirty different types of call have been recorded for grey-headed flying foxes". (p65)

A good behavioural enrichment tool may be to play a few minutes of a tape of happy, feeding, friendly bat noises on feeding time/dusk.





Observable Behaviours

Wild GHFF will form a bond with other individuals, but especially so in a captive environment. It is common to see individuals roosting together on a regular basis with some individuals being more tolerant of some than others (pers obs). Hand raised juveniles practice innate play interactions such as thumb hook pokes and punches which in adult life may be aggression or play behaviours. (Refer to Appendix 16 for analysis of GHFF behaviours).

Feeding Behaviours

Feeding time provides an excellent opportunity to view GHFF behaviour at a fundamental level. Large established colonies are set up of individuals who may reside all year (residents) and itinerants (raiders) who visit when food supplies are abundant. Resident FF's jealously guard their traditional food sources against the raiders. This provides a vital role in pollination and seed dispersal as the raiders feed rapidly and randomly as they are discouraged from one feeding location to another. Each time they zig-zag amongst the food sources, they spread pollens on their fur and in their droppings and drop seeds as they take larger fruit away for consumption elsewhere.

9.3 Reproductive Behaviour

GHFF reproductive behaviour is seasonal with offspring production coinciding with the abundance of food sources.

During breeding season, males develop a perceptively stronger odour, with the camp odour increasing due to increased territorial scent marking. Males mark their territory by rubbing their shoulder (where the scapular gland is located) and muzzle along a branch and usually patrol a metre each side of where they hang.

Vocalisations increase with ritualised shows of aggression towards other males and bravado interactions with females. During mating season (March/April) the males gain weight (reaching up to 1 kilo in weight) and display very obvious external genitalia.

Social groupings alter and the camp segregates into pockets of individuals such as family groups, unrelated adult groups; juveniles and guard groups (Jackson-S)



Coital behaviour can be divided into three noticeable behaviours; courtship, coitus and resumption (O'Brien et al, in prep).

Mating season is very noisy with males screaming at females several weeks before copulation (Refer Appendix 17 for details of GHFF breeding behaviors)





Courtship is normally instigated by the male. With an erect penis he approaches the female and sniffs and nuzzles her genitals (Markus 2002).



The male will then try to step behind the female and mount (dorso-ventrally).



The female may permit the male to mount or reject the male by exhibiting a range of behaviours including turning to face the male, attacking the male verbally by screaming or physically or moving away.

This female is attempting to sneak off whilst the male's attention is momentarily diverted.

If the male is unsuccessful in his attempt to mount he may continue attempting to sniff and lick at her genitals whilst she permits it.

If he succeeds in mounting he will grasp the female using his thumbs and attempt intromission (Markus 2002). Coitus is achieved when intromission occurs.

Disengagement is usually initiated by the female who struggles and/or bites the male. Once separated, the male often barks in the female's ear. Both partners then generally lick their own genitals (Markus 2002) which may be followed by the male resuming oro-genital licking of the female again, which may lead to further mounting (Nelson 1965b).

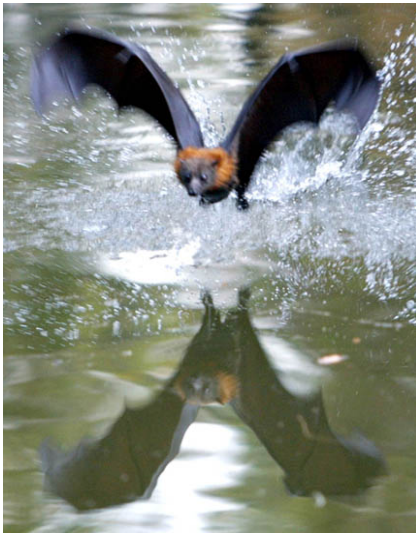




9.4 Bathing

Bathing occurs with individuals hanging in rain showers rather than seeking cover. Wings are spread as the water cleanses the membrane. It is therefore important the GHFF enclosure allows exposure to rain and sun to permit bathing to occur. The installation of roof sprinklers will give bathing opportunities during hot dry weather.

GHFF also participate in regular urine baths, in which they urinate on themselves allowing the urine to cascade down their chest and pool in the wrist. Glands on the back of the head (scapular glands) secrete oils to help in lubricating wing membrane, so they then rub their heads into the urine and spread it around their wings and bodies.



Hall and Richards note the bathing and grooming process maintains the elasticity of the wing membranes:

“.... the muzzle area is pushed into the wing membrane, no doubt transferring sebum from the abundant glands associated with the hair follicles on the muzzle. This behaviour may also rupture the small lipid droplets produced in the wing membrane epidermis and help waterproof the wings” (p64)

In extremely hot weather the wild flying fox may cool themselves by skimming over shallow water. If they alight in the water they use their wrists and thumbs as paddles to swim through. (Refer 6.3 - Feeding)

9.5 Behavioural Problems

If not properly socialised with other GHFFs, some hand raised individuals may exhibit a strong bond with humans. A GHFF held at Taronga Zoo (Ralph) was kept as a solitary animal for a short period of time after his cage companion (Clinger) died. Ralph historically dominated any keeper/GHFF interaction by aggressively chasing Clinger any time a Keeper attempted to share attention between the two animals.

After Clinger's death, Ralph's fixation on humans increased, with an almost instantaneous sexual excitement to any attention he was paid. This behaviour may have been Ralph's adaptation to living firstly in a dyadic male environment, then to his isolation as the only GHFF:

“... Captivity ... imposes schedules that are not self determined, thus creating an environment that provides little stimulation ... captive animals then attempt to control these artificial environments by adapting to their surroundings ... this adaptation could result in developing abnormal behaviours ...” (Cocoran-K, 2003)

The subsequent introduction of two female GHFF initially upset the equilibrium with Ralph attacking the more submissive of the two females any time a Keeper entered the enclosure. Once normality to the new situation had been established, Ralph appeared less aggressive towards the female and did not immediately race to the enclosure door any time a human visited.





9.6 Signs of Stress

Lack of appetite and weight loss are good indicators of stress. Behavioural indicators of stress are usually passive and observed by the animal presenting:

- facing you (or the perceived threat)
- huddling together or in the corner of the enclosure;
- legs bent at the knees,
- wings tucked in at the sides instead of wrapped (ready for rapid withdrawal without the need to unwrap sticky wings),
- wide eyes,
- urination (often appears as urine dripping off wrist as the urine dribbles along the body under the wing)
- lip licking with exaggerated movements (tongue rolling); gaped mouth or pinched lips;



Signs of defensive aggression are more obvious

- Vocalisations in the form of single barks or shrieks,
- Wing extensions, flicks and alert stance
- Thumb hook punches;
- Stepping away from perceived threat;
- urination

9.7 Behavioural Enrichment

GHFF is a social animal with a complex social order. Wherever possible, GHFF should be housed in a group environment, made up of both sexes, to provide the animals with a 'normal' captive colony life.

Behavioural enrichment should aim to be multisensory, ie:



Visual

New cage furniture and/or relocation of existing furniture. In considering GHFF roosting patterns, the introduction of new cage furniture (and relocation of existing furniture within the enclosure) should be carefully considered to avoid undue stress to the occupants. At the same time, enhancing their environment with variants – additional branches, fragrances, etc to simulate the inconsistencies they may encounter in a natural environment.





Kinesthetic

Unusual non-abrasive surfaces such as climbing poles, ropes, cage structure coverings, cloths, etc. Astro turf works well to cover upright struts, providing it is regularly inspected and any frayed or damaged areas removed.



Olfactory

Scents, oils, sprays, non-toxic plants and flowers.

Native plants/blossoms may be lightly sprayed with a leadbeater's mix to extend their 'shelf life' (Refer Section 6 – Feeding)

Auditory

Non-stressing noises – such as gentle music played on a radio, calming bat vocalisations. Be careful to avoid noises which may cause alarm, such as rustling leaves which may sound like a predator attack.

Gustatory

GHFF spends much of its time foraging for food. By presenting food in a variety of different ways to encourage the animal to work for the food, rather than simply take it from a bowl, the feeding experience is prolonged and the animal's activity levels are increased in sourcing food. Food can be offered in 1.25 ltr buckets and suspended from the cage on s-hooks or on cage furniture, such as on a branch



Varied presentation of food is important to discourage boredom as Hall & Richards (2000) note:

“From the large size of the olfactory lobe, it can be deducted that smell plays an important role in social behaviour and navigation, and it is the main sensory system for the location of food.” (p34)



So in essence, a natural group settings which permit normal social interaction assists greatly in enriching behaviour.





9.8 Introductions and Removals

The GHFF colonies consist of many individuals, some residents and some transients, so the normal colony life would consist of many strangers entering and existing the camp. A captive colony is a completely different scenario as the itinerant variant is removed. However, GHFF are sociable and after an initial period of uncertainty, there is rarely aggression resulting in injury or death (Jackson-S).



Newly introduced animals may initially choose to roost away from the main group but they are usually readily accepted. To avoid the resident/raider scenario occurring (where the original group members fiercely protect their food supply), additional food stations should be provided so each animal may maintain guard over its own food station.

9.9 Intraspecific Compatibility

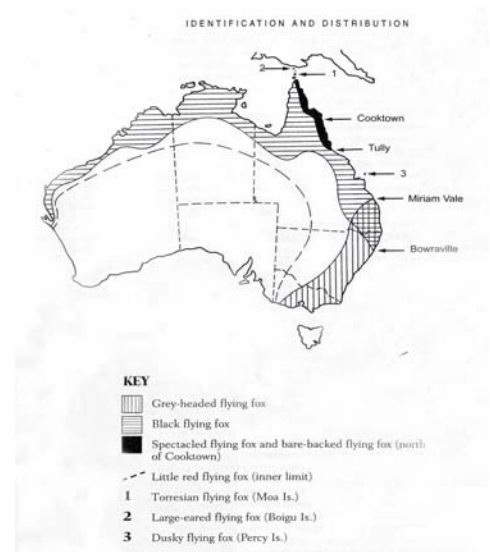
Good, after initial meet and greet which involves a lot of high pressure sniffing, the animals generally settle quickly. Aggressive fighting, even amongst males, is uncommon.

Observation of a small group of ten GHFF held by a wildlife care group, shows the new animal is mobbed and sniffed thoroughly by the group members, with the dominant male becoming very solicitous of an introduced female GHFF. If the new FF is a male, the original male cordons his harem females into the corner of the cage to protect them from the newcomer. Often an older male may 'adopt' a younger male, play fighting and grooming one another (pers obs).

Assuming that the animals are allowed to breed, (flying foxes produce only one baby per year) any offspring surplus to exhibit requirements could easily be crèched with other baby bats from one of the wildlife rescue groups and released within the yearly baby bat release program.

9.10 Interspecific Compatibility

Due to GHFFs nomadic lifestyle it is often found sharing camps with *Alecto* and *Scapulatus*. This map shows the majority of GHFF are restricted to the lower south eastern coast of Australia, with some overlap around Brisbane. Given this, it may possible to maintain an integrated captive colony of GHFF, *Alecto* and *Scapulatus*, providing individuals are selected according to calm temperament and that the captive colony is not merely represented by one individual from each genera (refer Annexure 1).



9.11 Suitability to Captivity

Good, breeds well in captivity





10 BREEDING

10.1 Mating System

A wild colony is comprised of both sexes with most matings instigated by the dominant male within his colony territory. Multiple matings occur over a day or several days. There is also evidence that some females may mate with a number of males over a period of days, so GHFF's appear to be polygynous (Jackson-S).



Notwithstanding that, animals often pair up, with one particular male favouring a particular female within the colony. The favoured female's status is then elevated to that of matriarch. (Condor-P) (*Refer 9.3 Reproductive Behaviour*)

10.2 Ease of Breeding

GHFF housed outside breed freely in captivity providing a good diet, mental stimulation and an absence of negative stressors are provided.

Indoor enclosures with artificial light sources appear to affect some FF breeding cycles as breeding patterns are to an extent determined by light cycles. For breeding to occur, it is best to mimic natural light cycles. (Jackson-S)

10.3 Reproductive Condition

Subtle changes in sexual organs may give an indication as to reproductive condition.

Males

Studies by McGuckin and Blackshaw (1987) showed that the size and weight of the males' testes varies throughout the year. The period of maximum size is between February and April. The significance of the change in testis size was linked to an increase in plasma testosterone levels as well as sperm production (Boland-B, 2004). Male GHFF produce some sperm all year around with peak fertility occurring in February to April (McGuckin & Blackshaw 1987).

Females

Hall and Richards comment that with a gestation period of around 5 months, a lactation and weaning process for up to 5 months, a large portion of the adult female's year is invested in some portion of the reproductive cycle.





Obvious signs, such as a distended belly, will indicate the female is pregnant.

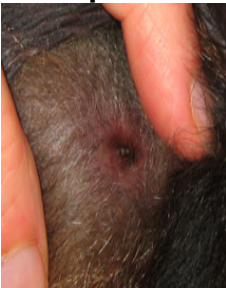




Palpation of the female's abdomen will give a reasonable indication of the stage of the pregnancy.

However palpation of a full stomach after feeding may give a false impression.



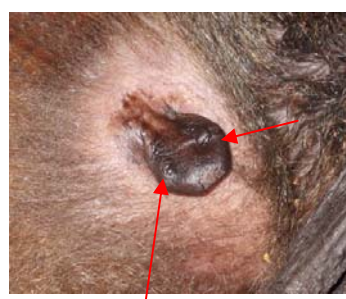
As can be seen from these radiographs (foetus nearly full term), the baby lies across the female's abdomen

Another indication is by review of the status of the female's nipple. There are five phases within the reproductive cycle, each phase manifests in changes to the nipple shape:

1	2	3	4	5
Nulliparous	Pregnant	Lactating	Post Lactating	Regressed
				
Nipple is small and dome like, surrounded by dense fur*	Nipple swelling, 'alive', milk glands beginning to fill.	Nipple larger, subcutaneous white milk glands visible.	Nipple pendulous, surrounded by circular patch of wrinkled skin.	Nipple smaller, flattened. Skin pigmentation often darker.



*note: there may be some exceptions to the norm. This female (pictured above) is held within a captive colony in a ratio of 1:4:0. At eight months of age she began to spontaneously lactate (lactating coinciding with the start of baby season and continuing for a number of months). Similarly the other three females lactated, without the presence of a pregnant female and without a productive mating occurring. (pers-obs)



Above, photograph taken of a female with an eleven week old pup (as pictured right, namely, "*Captain Cornelius Spanglebottom*" – now released at the Gordon colony along with his mother).



The nipple is large, and pendulous, with visible calluses caused by the pup's canine teeth. Not surprisingly, GHFF nipples have very few nerves and are therefore equipped to cope with gnashing baby teeth!





Male



Photograph taken in September (non breeding)
"...the seminiferous cycle of FF is about 16 days, similar to that of humans" (Hall and Richards, 2002).



During mating season (March/April) the males gain weight (reaching up to 1 kilo in weight) and display very obvious external genitalia.

Female



Female – sub adult

Attempts to determine time of fertility in females has failed (Martin et al, 1995). However, Hall & Richards (2000) advise:

"There is an unusual arrangement with the ovarian artery, which is only seen in the Megachiroptera. The artery is coiled and enclosed within a venus sinus (an artery inside a vein). The vagina undergoes changes in response to sex hormones and a female's reproductive state can be determined precisely from vaginal smears" (p42).

This may help when considering the reproductive cycle of a captive colony.

Hall and Richards observe:

"Female receptivity is not tightly linked with female sex hormone levels ... [they] become receptive and acquiesce following courtship.... Females ovulate from late February to April, and implantation occurs on the opposite side of uterus from side where the egg was shed" (p42)

10.4 Techniques Used to Control Breeding

Separation of sexes is the easiest technique (Jackson-S) but in a long term captive colony vasectomising the male may be an alternative. Taronga Zoo houses three educational GHFF with the male being vasectomised prior to introduction of the females. Surgery has done little to alter the male's sexual displays.

10.5 Occurrence of Hybrids

Due to the sharing of colony sites, cross breeding between Alecto and GHFF are fairly common. It is not known if the progeny is sterile.





10.6 Timing of Breeding

A change in day length appears to play a part in the breeding cycle. Jackson-S refers to studies undertaken by McGuckin and Blackshow (1992) when he notes:

“Changes in day length appear to play a major role in determining breeding season in flying foxes, as male GHFF that were moved from natural short days to 16L:8D that was progressively decreased over 120 days to 9L:15D resulted in testicular volume peaking during decreasing photo period. In contrast, those animals that were held in long day lengths did not show as much variation in testes volume, suggesting they do not rely on an endogenous rhythm”

There is one breeding season that occurs in late Autumn (March to April) with babies appearing in spring (late September to early December). However, mating can take place at almost any time of year with homosexual matings occurring (Hall and Richards, 2000).

10.7 Age at First Breeding and Last Breeding

As noted in Pamela Condor's studies of the captive colony at Healesville, flying fox breeding is influenced upon hierarchy within the group. Elderly captive females may still breed annually, if they are aligned with the dominant male.

“Female GHFF do not commence to breed until the second breeding season after their birth (24 months).... Similarly, onset of puberty in males begins in the second breeding season, but they do not reach breeding maturity until 30 months of age” (Hall & Richards, p41-42).

10.8 Ability to Breed Every Year

Possible. Breed well in captivity, birth usually occurs during daylight hours.

10.9 Ability to Breed More than Once Per Year

One single offspring is produced each year. The female GHFF reproductive tract has two ovaries and so twins are possible but very rare. It is considered unlikely that twins would survive in the wild.

10.10 Nesting, Hollow or Other Requirements

Not required. However, studies of wild colonies have shown that after breeding, females will move away from the colony and group together when nearing parturition. Therefore it is advisable to provide at least two sleeping areas when housing pregnant females (Refer 4.7 Bedding Materials).

10.11 Breeding Diet

There are no specific diet recommendations for breeding season (Jackson-S).





10.12 Litter Size

One baby per year. Jackson-S records personal communication with Lumsden-L who observes:

“When females are caught [in the wild] with young they may well be moving them between roosts rather than out foraging; lactating females are known to regularly shift young between roosts” (p341)

10.13 Age at Weaning

In a captive environment weaning occurs at five to six months of age. Generally, the amount of gestation time is equal to the amount of time spend milk feeding of the infant. (Collins-L, pers comm).

However, in the wild, females only lactate for up to six weeks (Hall and Richards, p42).

10.14 Age of Removal from Parents

If required, infants can be removed from the mother once weaned. The young may begin to fly at around eleven weeks of age, and still suckle from the mother; so flight is not an indication of weaning (Jackson-S, p341).

As colony life is the norm for the GHFF, the young usually integrate well into the captive colony. Condor (1994) records the previous year’s offspring suckle from the mother, now heavily pregnant with another infant, just prior to parturition. Further, studies of captive animals have shown the mother-offspring bonds remain strong for up to six years (Hall and Richards, p46)

10.15 Growth and Development

Neonates are born almost fully furred (with the exception of the ventral side which allows transference of body heat from mother to baby). Recurvant deciduous milk teeth and well developed claws allow the baby to hang on to mother for the first few weeks of life.

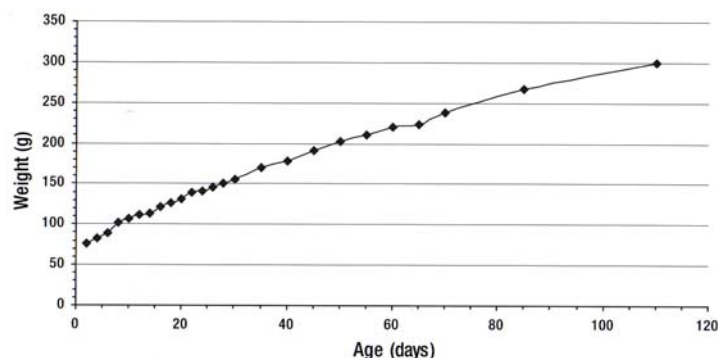


Figure 20. Growth in body weight of the grey-headed flying-fox. Derived from George (1990) and Parry-Jones (2000).

By around 4 weeks of age the baby has reached a stage where mother will leave it in the camp crèche when she goes out to forage.

(Refer to Section 10 ‘Artificial Rearing’ and Annexure 18 for detailed growth charts). (Growth chart from Jackson-S, p342)





11 ARTIFICIAL REARING OF MAMMALS

Minimising stress is a major consideration when rearing an infant GHFF ('pup'). Many pups come into care after mother has been killed, so it will already be compromised, physically, psychologically and/or both. The first consideration should always be to provide an environment with reduced external stimulus and minimal stressors for the pup to begin recovery and development.



Once the pup has been inspected and cleared for injuries (Refer section 8 Health), it should be placed in a quiet environment. Handle the pup as little as possible during the first few hours of its arrival. (SMW/WIRES).

Indicators of stress are biting, crying (especially in older babies), restlessness, poor feeding and baby bat 'tantrums' (where the pup holds its wings rigid against its body and bounces up and down whilst crying out (pers obs).

11.1 Housing

Housing should address the following factors:

- It should be quiet;
- Be free from domestic pets, children and inquisitive adults;
- Be hygienic;
- Be escape proof;
- Be free of hazards, obstacles;
- Be of a moderate temperature;
- Provide adequate shelter from outside elements (rain/sun, etc)
- Be comfortable and secure;
- Not smell of other animals – including other bats;
- Evolve as the animal matures and its' housing requirements change.

Whilst being mindful to ensure the above considerations are made in relation to housing, it is almost equally important to note there is no 100% 'right' or 100% 'wrong' way to house. What works well for one FF pup, may not suit another. Common sense, practicality and individual preferences for each FF must play a part in the husbandry techniques to be adopted for each GHFF pup raised. Routine and establishing a trust bond with the foster carer are key considerations in the successful rearing of the FF pup.

GHFF are placental mammals and therefore do not pouch their young. Do not place infant FF's within pouches/socks/beanies, etc.

Two recognised techniques for providing a secure environment for the FF pup are described below:





Wrapping

This technique is to simulate the secure feeling of the mother's wings wrapped around the FF pup; (it is not intended as a restraint technique).

You will need:

- Man sized handkerchief;
- A tissue/gauze

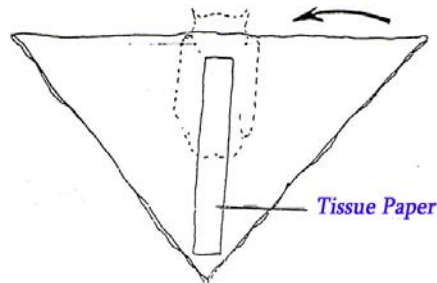


Figure 1

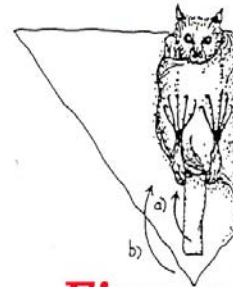


Figure 2



Figure 3



Figure 4

*Diagram from Ku-ringai Bat Colony Committee training notes, 1996,
(as taken from a diagram by Anne-Bowman/Helen George, 1988)*

Figure 1:

- Fold the man-sized handkerchief in half, to form a triangle.
- Place a folded tissue from apex of triangle up towards the flat, folded edge.
- Lay FF pup in the middle (*rear view shown*)

Figure 2

- Fold one corner around pup's body;
- GENTLY place feet so they grip the folded over section of the handkerchief;
- Tuck tissue up between FF's legs;

Figure 3

- Fold bottom corner of handkerchief up over feet.

IMPORTANT: lift bottom corner so feet are still able to stretch out if FF moves.

DO NOT wrap too tightly, this can cause permanent damage both physically and psychologically.

Figure 4

- Fold remaining corner around FF body, ensuring most of the back of the FF's head is covered (and thereby secured).





“Mumma”

This technique not only simulates the feeling of the wings wrapped around the FF pup, but also provides the infant with a simulated ‘mother’ to hold on to.



Figure 1



Figure 2

This mumma method was first introduced by Kerryn Perry Jones and is constructed as follows:

1. Roll a hand towel to dimensions of approximately 20cms in length and 8cms in diameter;
2. Wrap a piece of absorbent material around one half of the mumma (a man sized handkerchief folded in half works well);
3. Fold a piece of flannelette into a triangular shape and place one corner under the mumma (a cotton duster is a good size) (*figure 1*);
4. Place the pup on the mumma; face down. The pup will generally wrap its wings around the mumma with one foot slightly at an angle around the wrap, and the other tucked up underneath it. This is normal sleeping position (*figure 2*);
5. Position a towel/sling at a 45° angle within a cat carry cage, and place the pup and mumma within a carry cage – with the bat’s head facing down. Ensure the head is well supported and the mumma will not roll or slip. Cover the pup with a warm (natural fibre) blanket.

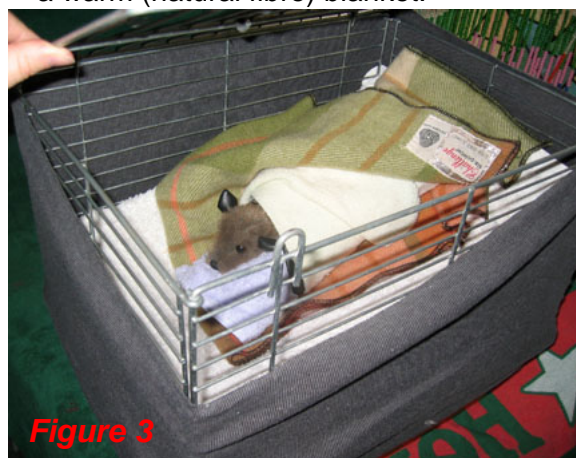


Figure 3

The blankets should be wrapped firmly enough to contain the pup, but not so firmly the pup cannot get free should it soil itself or, when it gets older, desire to hang.

A crepe knitted tube of fabric fits well around the perimeter of the cage (pictured here) and prevents damage to elbows and thumb hooks should the pup accidentally poke them through the bars. It also assists in maintaining a moderate

temperature within the cage and keeps the pup warm (*figure 3*);.





11.2 Temperature Requirements

It is very likely that the FF pup will arrive cold, dehydrated and stressed. It is important to warm the pup slowly. Warming quickly will merely send the blood rushing to skin without warming the vital organs; feeding an infant with warm skin, but cold internal organs must be avoided. In the event of being presented with a very cold pup it is better to rehydrate subcutaneously with a slightly warmed rehydration solution (such as Hartmans) and feed the pup later (Refer s8 – Health).

Neonates are born with a furless underside, which allows the transfer of heat from the mother to the baby. Until the pup is furred (usually by approximately 4 weeks of age) they do not thermoregulate and so require a heat source; usually at **around 28°**. It is important that the heat source is placed in close proximity to the FF pup, but not so close the pup can burn. Overheating has disastrous results with blistered and sloughing wing membranes, dehydration, damaged internal organs, and even death.

When managing the temperature of the FF pup, it is important to monitor the ambient temperature around the animal, not the actual temperature of the FF itself. A variety of thermometers are available with a temperature probe located at the end of a cable, leading to a reader display unit. The probe should be placed within the carry cage, inside the pup's wrappings, but not next to the FF's body. Secure the thermometer cable so there is no possibility of it wrapping around the FF's limbs - as it could cut off blood supply and lead to loss of the limb.

11.3 Diet and Feeding Routine

Unlike marsupials, most GHFF are not lactose intolerant and therefore a variety of milk substitutes can be used for feeding infants. The most commonly used (with documented progress are):



- * **Wombaroo** Flying Fox Milk Replacer

- * **Digestelac/Divetelact**
1 scoop to 40 mls warm water

- * **Nan1**
1 scoop to 25mls warm water

- * **Cow's Milk** (200mls of full cream milk plus 1 tsp Glucodine powder)
Refer Annexure 19 for feeding volumes

The pup's faeces is a good indicator of tolerance to the milk used, for example:

- | | | |
|-----------------------|---|---|
| * Smelly/mucousy | - | incompatible with milk, stress (or worms); |
| * White lumps | - | malabsorption - undigested milk, reduce volume |
| * Black specks | - | the baby has started to groom itself |
| * Diarrhoea | - | incompatible with milk (or poor husbandry techniques; sterilise all feeding utensiles) |
| * Failure to defecate | - | Take off milk and offer warm water, place abdomen under warm running water, refer to Vet if persists for more than 12 hours (could be worms/blocked bowel). |





After approximately four weeks of age, the mother bat will leave the pup within the colony when she goes out at night to forage, returning to the pup afterwards. It is likely then that the majority of pups that come into care from a dead mother will be:

- less than four weeks old; or
- be older than four weeks but be smaller sized pups; or
- be older than four weeks but are being carried by mother as she relocates from one colony site to another.

An exception to this might be instances of heat stress where animals are collected from a colony site due to mass disablement following high temperatures.

With this in mind, you should anticipate feeding the pup five times a day, at four hourly intervals. (Refer to Annexure 20 for detailed feeding guidelines).

Guidelines for Feeding

Ensure the animal is warm before feeding; never feed a cold animal. If the animal is cold; warm slowly – if a cold animal is fed it will inhale the milk; vomit and/or both.



Gently restrain the pup for feeding. An unrestrained pup will attempt to climb up the carer's shirt, twist the teat, push the plunger with its foot (if using a syringe), inhale the milk and generally stress. Placing absorbent material (such as a facecloth) under the head of a bat whilst it is on the mumma, and feeding whilst it is on the mumma appears to stress the bat least.

Always feed the FF whilst it is positioned on its side, with its head facing downwards. Any spilt milk will dribble out of the pup's mouth and not into its lungs.

Toilet the FF before feeding, or after the first couple of mls have been administered. Be aware of the indicators that the FF is self-toiletting, namely the pup tilts its abdomen out from the hips and may momentarily stop sucking on the teat. At the first sign of this, toilet the FF and then continue feeding. Manual stimulation to encourage the pup to toilet is to invert the FF (so its head is up) and using a warm, damp cotton wool ball, rub gently over the genital area. Until skilled at this, it is often advisable to restrain the feet to prevent the faeces covering the feet, as the pup will inevitably immediately place dirty feet onto your clothes.





11.4 Feeding Apparatus



Bottle

Pros

- If the pup inhales the milk it is easy to invert the bottle and immediately empty the teat, to allow the FF to recover.
- Once the pup is familiar with bottle feeding, carer can feed several FF's at one time, providing the FF's are at all times supervised.

Cons

- *Carer can't see how much the FF has taken until after the feed – any remaining milk has to be measured using a syringe*



Syringe

Pros

- Carer can see exactly how much the FF is taking during feed;.
- Carer can moderate the flow of milk a slight squeeze on the plunger to tempt a difficult feeder, or pulling back on the plunger to restrict the flow for a guzzler;

Cons

- *Easy to flood the FF if not careful,*
- *Some plastic syringe plungers get 'sticky' with frequent use;*
- *Plastic is harder to sterilise.*



Teats

Flying Fox teats are available from Wombaroo and come in various sizes. For younger FF's the recommended teat is sometimes too large and a smaller, possum sized marsupial teat works well. Once again, individual preference by the FF determines the size of the teat. The teats are sold without the hole. Pierce the tip of the teat with a hot needle to make a hole about 1 mm in diameter. If the hole is too small, excessive sucking will weaken the tip and the end may blow out. It will also over-tire the FF who may then become a reluctant feeder. The hole should be large enough for milk to drip out slowly when the bottle is inverted, but not so large that it free flows and floods the pup.



Dummy

The pup is normally attached to mother's nipple for the first four to six weeks of its life. The dummy offers a simulated replacement and is a definite aid in calming a stressy pup.

Use a normal FF teat without a hole. Thread the teat through the hole in the middle of an eye dropper lid. Fold the rim (end) of the teat over the outside edges of the lid.

The dummy should be regularly cleaned and sterilised as the pup often drops it when it falls asleep.





You will also need,

- bottle cleaner (pipe cleaner) brushes,
- plastic dripper feeders (like those used for rabbits/rodents,
- a small bowl (to warm up the milk);
- sterilising fluid (like Milton)
- large bowl (preferably with a lid) for sterilising feeding utensils.

11.5 Specific Requirements

Hydration

More often than not, a period of time will have lapsed between the time mother was killed and the FF pup was rescued and brought into care. It is just as likely that the pup will have been hanging in full sunlight on an overhead powerline for a number of days, or lying at the side of the road in a gutter, so it will come into care dehydrated.

If the pup is warm and will accept oral rehydration, offer pre-boiled water at a ratio of 1tsp glucose powder to 100mls of warm water.

Do not offer Lectade (or other electrolyte replacer) to a pup that has been brought down from overhead power cables. The electrolytes exacerbate the effect of the burns. If in doubt, don't offer.

If the pup is excessively cold or has damage to the mouth, rehydrate subcutaneously (Refer 8 – Health). (note: normal body temperature for a FF pup is 35°C).

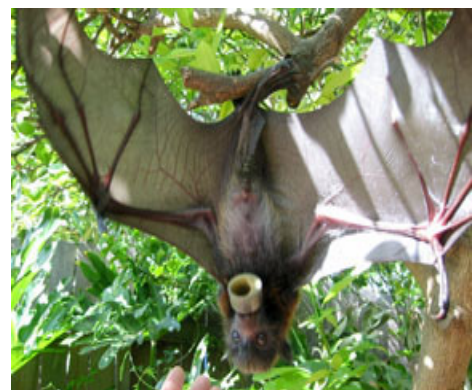
Bathing and Sun



As mother FF feeds the pup, she will also ensure the pup is clean, dry and toiletted. After each feed it is important to clean the pup's mouth and genital area with a warm, damp cloth. At least once a day, the pup should be given a full sponge bath ensuring the crevices within the wings and curls of the wing membrane, the feet, ears, face are all cleansed. This not only reduces odour and prevents spread of bacteria and fungal infections, but it provides the carer with the opportunity to undertake a full inspection for cuts/abrasions/ deformities/ wing

membrane damage and growth landmarks (such as new teeth erupting). Generally FF pups enjoy being bathed and will stretch their wings and flap during the process. Ensure the wing is dried thoroughly (dab dry with a face flannel and if possible, dry in the sun). To avoid fungal infections, never wrap a damp pup.

As pups need sun for health wing membranes, it is a good practice to perform the daily bath in a sunny area and allow the wing membranes to dry naturally.





A good calming mechanism for FF pups is to gently stroke them from the nose up between the eyes and around the ears. Hall and Richards report:

"A considerable amount of the flying fox's cortex is devoted to the hairs of the face"

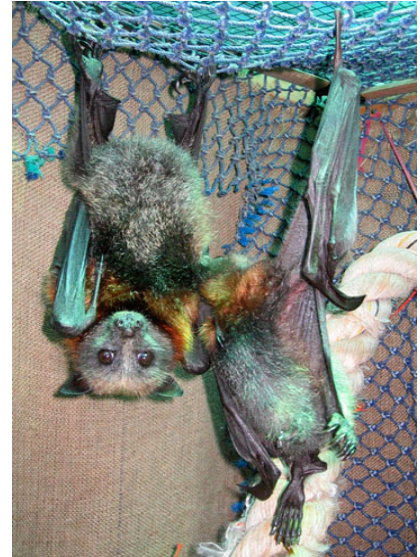
Gentle stroking and calming of the pup assists greatly in encouraging difficult feeders to feed, and truculent pups to settle. (pers obs).

Toiletting

Until approximately four weeks of age, the FF pup will defecate and urinate when manually stimulated.

When toiletting encourage natural 'inversion' by holding the bat wrong side up (with its head up) and allowing the feet to drop. Once the FF pup has the hang of this, it will toilet whenever it is inverted. (Refer 11.3 Guidelines for Feeding)

(Right: pup inverting whilst still hanging on to mother's nipple)



Worming

At five weeks the FF pup should be wormed using a cat wormer such as Felix paste or Panacure. Worms enter the FF pup's gut via the mother's milk and mature, generally being expelled when the pup's diet changes from milk to fruit. Sometimes however, this process needs to be assisted as the pup can lose weight and become difficult to feed. If worms are expelled after the first worming, worm again at six weeks. Do not worm more than twice. (Refer 8- Health)

Teething

At around six weeks of age the pup will begin teething. Signs of teething are a general uneasiness, change in colour or consistency of faeces and a reluctance to feed. The pup may mouth at the teat before settling to feed and roll the teat to the back of the mouth and chew on it.

The pup may also begin to chew on your fingers, as can be seen from this picture, it is during teething that the dummy really comes into its own.





Exercise



After each feed encourage the FF pup to exercise. Often the bathing process will invoke frantic flapping, but a lazy or reluctant flapper can be encouraged to flap by scratching under the wings on either side of its tummy.

As the FF pup grows older, flaps become more pronounced until it gains body lift and becomes horizontal. Encourage the FF pup to fly by placing it on an exercise ailer or within the aviary and calling

it to you, making sure any crash landing hazards are removed. By the age of about seven weeks the pup should be spending the majority of its time on the ailer.



Exercise ailer set up for pup. Food and water readily available and tea-towels extend to floor in case the pup falls and needs to clamber back to the rack.



Also at this time, begin to replace the need for a dummy with a piece of fruit. The dummy gives a false sense of security and may retard the pup's natural progression to hang.



As the FF pup will be beginning to fly, ensure the ailer is placed within a safe environment. Place hangings above the ailer to encourage the baby to climb.

Hall and Richards report:

“A young bat can fly at three months and commences to leave the camp on short forays. It still suckles from its mother, but has lost its milk teeth. The young flies around the camp at dusk, crashing into trees on landing, and then calls to its mother. The mother returns the call and the young flies back to her” (p46)





Note: Occasionally a mother and baby may come into care. This female was thrown from electricity cables and then attacked by currawongs. Her baby was monitored whilst in care, and as it appeared to be deteriorating, it was support fed.

Feed the pup in the presence of the mother taking care not to overly stress mother or pup. Reunite the pup immediately after feeding. If the mother continues to nurture the pup support feed as often as necessary to facilitate desired weight gain (refer to Annexure 20 for age/weight ratios). If the pup appears dirty or unkempt, it may be necessary to remove the pup and hand rear separately, allowing the mother to redirect her energy to her own convalescence.

11.6 Data Recording

On arrival, information such as date, time, body weight, forearm measurement, body condition and general demeanor should be recorded as a benchmark for comparison



during the hand rearing process. In addition, origin of the FF, rescue information, including circumstances found, veterinary attendance and rescuer details should also be recorded. If the pup is handed in by a member of the public, they should be asked whether they were bitten or scratched during the rescue process, as if so, they may require lyssavirus vaccinations. (Refer Annexure 12)

Growth rates are monitored by taking the forearm measurement from the elbow to the wrist using Vernier calipers.
(note the reading is taken where the '0' on the lower right edge meets the ruler line, so this measurement is 103mm)

Weigh the pup on a daily basis at the same time each day; ie, before the first feed of the day. Note that fluctuations in weight do occur, but bear in mind that a weight gain of approximately 20gms per week is desired.

Weight gain alone is not a good indication of a health baby – weight gain, plus increased growth and other indicators such as teething, health coat and anticipated behavioural changes equate to a thriving pup.



Weight gain (or loss), amount of food eaten (solids or milk), defecation and urination, and activity levels should all be recorded on a daily basis. (Refer Annexure 20 for example of daily cage card).





11.7 Identification Methods

If several individuals are being hand raised they can be identified by:

- Individual characteristics such as colour, size, shape, weight, temperament;
- Coloured plastic bird bands applied to the thumb;
- Nail polish on toenails.

Hall and Richards observe:

“Three week old young do not appear to recognise their own mother and will grab any female nearby. Mothers on the other hand, recognise their own young, more than likely through olfactory cues” (p45)



By the same token, the FF pup learns to recognise its foster mother using olfactory cues. If raising more than one pup it is essential that the carer is aware of stresses placed on the pup by carrying the scent of more than one pup. The foster carer should allocate a separate shirt to wear for each individual pup, and ensure that shirt remains with that pup. Wash hands before touching individual pups.

11.8 Hygiene

Hygiene is of critical importance in ensuring the wellbeing of the FF pup. As outlined by Jackson-S, consideration should be made to:

- Providing clean housing, including cage, roost and bedding materials;
- Maintaining high standards of personal hygiene not only to protect the bat, but also the foster carer from zoonotic diseases;
- Use pre-boiled water when mixing up milk formulas (never use boiling water on the milk formula as the boiled water destroys some of the nutrients);
- Fastidiously cleaning the pup of spilt milk, faeces and urine after each feed;
- Thoroughly wash all feeding equipment (including bottles, teats, dummy, food measuring utensils) and then sterilise using a sterilising agent such as Milton (note rinse thoroughly in hot water after sterilisation as the bat may not feed if the teat tastes or smells of bleach);
- Wash all soiled bedding and rinse in Napisan or other such sterilising agent to remove any contaminants/fungus;
- Never reheat milk. Store unused milk in the fridge and heat at each feed, discarding any unused milk – if necessary making up a new milk solution rather than reheat the milk;
- Stimulate the pup to toilet before and after each feed to reduce the instances of the pup lying in soiled bedding;
- Wear specific clothing (a ‘bat shirt’ when handling each specific animal so as not to risk transferring contaminants from one FF to another, or from a domestic pet to the FF pup. (Jackson-S, p349)





11.9 Behavioural Considerations

Until the age of about 12 weeks, GHFF pups are very reliant on their mother for their social needs and therefore require little socialisation. Once they reach this age, they are semi-weaned and begin to spend more time hanging away from mother and exploring the aviary. At this stage, they require interaction with other juveniles of a similar age, forming small juvenile groups. If possible, juveniles should then be buddied up so that normal bat socialisation behaviour can be practiced ready for integration into the colony. (Jackson-S)

11.10 Use of Foster Species

There is no documented evidence to show that GHFF have been fostered to other bats of the same, or different species. (Jackson-S, p349)

11.11 Weaning

Hall and Richards observe a difference in weaning times between wild and captive GHFF's:

"Lactation lasts for about six weeks (or up to several months in captivity)" (p42)

Generally, GHFF are weaned by approximately six months of age. Prior to this stage (at around 12 to 15 weeks of age) they should be buddied up with other juveniles of similar age to allow socialisation (Refer 11.8 Behavioural Considerations)

11.12 Rehabilitation and Release Procedures



Between twelve and fifteen weeks of age, juvenile GHFF are grouped together in a baby crèche situation in readiness for release into the wild. Similarly, wild GHFF move away from their mothers and begin to be socially aware of others of their own age group:

"In January and February young flying foxes form small groups in the camp. They often hang near a large adult and remain as a group until winter. Groups of young bats can be seen flying out of the camp" (Hall and Richards, p45)

This appears to be a natural progression and is age related rather than based on weight or size. FF's who enter crèche earlier than 12 weeks sometimes exhibit behavioural delays, such as submissive behaviour; ie, not accessing communal food dishes, hanging separately from the group, and/or hanging low. They may exhibit an abnormal stress-related weight loss. FFs aged 12-14 weeks old mix well, bond with the group, rather than attempting to retain their individuality, they gain weight and behave happily – vocalising and exercising.





Handraised pups that are raised in groups will have greater social awareness than the pup handraised alone. These pups adjust to crèche life easier as they are used to being part of a collective, rather than an isolated individual.



WIRES (Coffs Harbour) crèche criteria is that the FF pup must be:

- Weaned from milk and be eating solids;
- Weigh a minimum of 286 grams with a forearm of 128mm

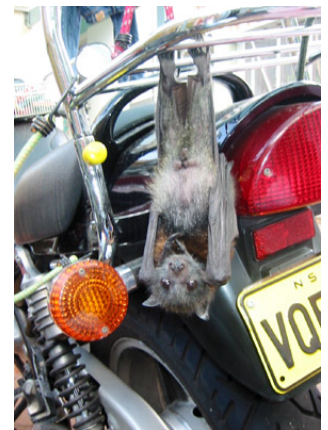
With the aim of releasing the juveniles with a minimum weight of 350 grams, and a forearm measurement of 138mms. (Refer Annexure 21 on suggested protocols to be adopted to prepare FF pups for release).

On integration into the colony by hand-raised infants, Hall and Richards report:

“Observations have been made on the schooling of young flying foxes following the release of orphan young from human carers. It appears that adult males first shepherd groups of recently independent young. These adults warn the young of impending predators and escort them on their initial group foraging expeditions”. (p46)

However, more recent (unpublished) evidence would suggest this theory is unsubstantiated. The young males only appear to guide infants into the colony as it is the males who generally roost on the perimeter of the colony, and therefore are the first to greet newcomers. It is now considered that the infants approach and attach themselves to small groups of individuals and integrate into the colony on an individual basis. (Judi Woods, pers comm).

It is therefore vital the juvenile FF's are socially aware they are FF's on release and not tiny humans with wings.





Radio-tracking studies of hand reared FF pups were undertaken by the Ku-ring-gai Bat Conservation Society (KBCS). These studies lay the foundation for successful release of hand reared FF pups (Refer Annexure 22). However, despite all the best efforts of wildlife rehabilitators, Hall and Richards still caution:

“Winter months can be hard times for flying foxes Mortality of young bats is high at this time, especially if covering long distances is necessary to find reliable food. It appears that experience and learning where to find reliable food are critical for flying fox survival” (p44)

adding:

“It is important for there to be a reliable food supply near the camp for survival of the young” (p46)

It is important that adequate preparation is made prior and during crèche to ensure the hand raised juvenile FFs have the best possible start to a life in the wild.

Something as simple as ensuring the FF's can recognise natural food sources such as native plants and eucalypts and adequate dehumanising from their human carer, may be the make or break for their success in the wild.



Acknowledgement

Materials for this Section were compiled from a composite of training materials produced by:

- Sydney Metropolitan Wildlife Services;
- Wildlife and Information rescue Services (WIRES) (Excerpts - Refer Annexure 23);
- Ku-Ring-Gai Bat Conservation Society Training Manual;
- Training Manual as produced by Linda Collins;
- Personal experience; and
- Word of mouth communications with other FF rehab carers,

In addition to excerpts from:

- Australian Mammals Biology & Captive Management - Jackson-S
- 'Flying Foxes and Fruit Bats' - Hall and Richards





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Annexures

	Description	Source	Refers to
1	Flying Fox distribution within Australia	Australian Geographic	Page 9, Natural History
2	The History of the Grey-Headed Flying Fox in the Royal Botanical Gardens, Sydney, by Alan Leishman	KBCS Website	Page 9, Natural History
3	Flying Fox Wild Diet	P. Eby, KBCS Website www.	Page 10, Natural History
4	Animal Care Card Record Sheet	Self	Page 25, General Husbandry
5	What's in Wombaroo	Wombaroo Website www.wombaroo.com.au	Page 29, Feeding
6	Enrichment Ideas for Old World Fruit Bats	AAZK Enrichment Handbook, prepared by 'The Lube Foundation, Inc' and adapted by Taronga Zoo	Page 30, Feeding
7	IATA Container Requirement (bats)	IATA Handbook	Page 37, Handling & Transport
8	Some things that can go wrong and what to do – A Vet's Perspective (pages)	Bill Turner, B.V.Sc	Page 40, Health Requirements
9	Chemical Restraint of Native Fauna, (pages 125-136)	Dr Larry Vogelnest, Taronga Zoo	Page 41, Health Requirements
10	Common Diseases of Megachiroptera (pages 79-82)	Dr Karrie Rose	Page 43, Health Requirements
11	Managing emerging diseases borne by fruit bats (flying foxes) with particular reference to henipaviruses and Australian bat lyssavirus (pages 61s-69s)	J.S. MacKenzie, H.E. Field, K.J. Guyatt, Journal of Applied Microbiology, 2003.	Page 45, Health Requirements
12	Australian Bat Lyssavirus, Hendra Virus and Menangle Virus – Information for Veterinary Practitioners	Australian Government, Dept of Health & Ageing - Communicable Diseases Australia	Page 45, Health Requirements
13	Template for GHFF Elizabethan Collar	Self	Page 46, Health Requirements
14	(i) Normal Blood Values for Pteropus Poliocephalus and P. Scapulatus (ii) Clinical Pathology Records Report – ISIS/In House Reference Values	(i) School of Biological Sciences, UNE & Dept Physiology & Pharmacology, Uni of Qld. (ii) ISIS - Taronga Zoo	Page 51, Health Requirements
15	Mammal Groups Chiroptera	Fowler Miller (203) 'Zoo and Wild Animal Medicine'	Page 51, Health Requirements
16	Behaviour of Grey Headed Flying Foxes (Pteropus poliocephalus)	Jo Stokes	Page 53, Behaviour
17	Honours Research Project – Literature Review	Ben Boland	Page 53, Behaviour
18	Age Table for the baby Grey Headed Flying Fox	Sydney Metropolitan Wildlife Services	Page 63, Breeding
19	Feeding Requirements – Milk	Various	Page 67, Artificial Rearing
20	Baby Bat Daily Cage Card	Self	Page 68, 73 Artificial Rearing
21	Ku-ring-gai Bat Conservation Society Inc. Release of rehabilitated and hand reared Grey headed flying foxes into Ku-ring-gai Flying fox Reserve Gordon	Kur-ring-gai Bat Conservation Society	
22	Radio-tracking of hand-reared flying-foxes released at Gordon Sydney, Australia	Kur-ring-gai Bat Conservation Society	Page 77, Artificial Rearing

