Husbandry Manual

Mahogany Glider
(*Petaurus gracilis*)

2007

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Contents

1. Taxonomy

1.1 Common Name

Mahogany Glider

Other common names: None.

1.2 Classification

Class: Mammalia

Subclass: Marsupialia

Order: Diprotodontia

Superfamily: Petauroidea

Family: Petauridae

Subfamily: Petaurinae

Genus Species: *Petaurus gracilis* (de Vis, 1883)

pet-or'–us grah-sil-is:

'slender rope-dancer'

Subspecies: None.

Recent Synonyms: *Petaurus norfolcensis gracilis* (Strahan 1995).

1.3 Status

The mahogany glider is listed as 'endangered' under the Queensland *Nature Conservation Act 1992* (NCA) and the Commonwealth *Environment Protection*

and Biodiversity Conservation Act 1999 (EPBC Act) (Parsons & Latch 2006, Goldingay & Jackson 2004).

2. Natural History

2.1 Physical Description

2.1.1 Family Petauridae

The marsupial petaurid family consists of the Striped Possum, Leadbeater's Possum and wrist-winged gliders (Strahan 1995). These small mammals range from 150–450 mm head and body length and 100–2000 grams in weight. All species show a general arboreal adaptation, including feet adapted for grasping and a long prehensile or semi-prehensile tail (McKay 1989). On the hind foot the hallux is opposable and clawless and the second and third digits are syndactylous as in the other phalangeroid families (McKay 1989). All petaurid species have a prominent dark dorsal stripe extending onto the forehead (Strahan 1995, McKay 1989). Petaurids are diprotodont with the lower incisors visible as long, sharp and protuberant, and molars present with low, smooth cusps (Strahan 1995). Petaurid pouches open forward and enclose two or four teats. Some petaurid pouches contain a median septum which roughly divides the area into left and right compartments (Strahan 1995). One of the most significant distinguishing features of petaurids, particularly wrist-winged gliders, is the patagium; a fold of skin with the two skin layers bound together tightly by connective tissue. A number of muscles or individual muscle fibres run through the patagium which allows the membrane to retract while not in use and control altitude while gliding (McKay 1989). Two subfamilies are recognised;

Petaurinae (Leadbeater's Possum and wrist-winged gliders) and Dactylopsilinae (Striped Possum).

2.1.2 Species 'Petaurus gracilis'

The nocturnal mahogany glider can be distinguished from other petaurids by its larger size, long tail and buff to mahogany-brown belly (Van Dyck 1993, Jackson 2000b, Parsons & Latch 2006). The mahogany glider has a head-body length of approximately 250mm and a vent-tail length is generally one and a half times longer than the head-body length, averaging 370mm (Jackson 2000b). In the wild mahogany gliders weigh between 310 and 500 grams, averaging between 365 and 407 grams (Goldingay & Jackson 2004). As with all *Petaurus* gliders, a dark to black stripe extends from the eyes to the rump and there is significant variation in the depth of dorsal and ventral toning. The band of fur along the lateral anterior edge of the mahogany glider's patagium ranges from buff to rich orange to deep mahogany. The lower half of the mahogany glider's tail is black (Van Dyck 1993, Parsons & Latch 2006).

2.1.3 Sexual Dimorphism

Sexual dimorphism is apparent in the mahogany glider, distinguishable in weight, head length and head width variation between the genders (Jackson 2000b). Mahogany glider males are heavier, have a longer and wider head and snout-vent length, while the females exhibit a significantly higher tail length to body ratio (Jackson 2000b). Androgen dependent scent gland on forehead of males, see figure one.

Figure 1: D. Dickson

Male scent gland

2.2 History of Wild Population

The arboreal mahogany glider was first described in 1883 by Charles De Vis; however it was later assumed to be the same species as the squirrel glider. During the relocation of the Queensland Museum in 1985, three glider skins were unearthed and reassessed by Steve Van Dyck. In 1989 Van Dyck launched a search for the species which resulted in observations of the glider on freehold land at Barretts Lagoon (14km south-east of Tully), however the area was cleared soon after for banana plantations. In 1991 Van Dyck fronted another successful search, focussing on Barrett's Lagoon (Van Dyck 1991). The mahogany glider was confirmed as a separate species to the squirrel glider in 1993 (Lindenmayer 2002, Goldingay & Jackson 2004). The wild population has steadily diminished over the past century primarily due to habitat loss and fragmentation (Parsons & Latch 2006, Strahan 1995).

2.3 Current Population

The cryptic and elusive nature of the mahogany glider affects the accuracy of surveys undertaken to estimate total population size as well as the southern, western and northern distribution limits. As a result, records-based modelling and ad hoc surveys currently provide the most up to date estimates on total population and distribution limits (Van Dyck 1995, Parsons & Latch 2006). The Queensland Museum currently estimates between 2000 and 3000 individuals exist in the wild. Due to the lack of accurate knowledge about population structure, information on subpopulations, and dispersal and gene flow obstacles, the extent to which fragmentation has isolated populations remains unknown. However, Jackson (1999) suggests that a minimum of 8000ha is required for a population of 800 individuals to be viable in the long term.

Evidently, smaller fragments of habitat provide a smaller carrying capacity of isolated populations which have a lower chance of long-term survival. Parsons and Latch (2006) identify the following five existing geographic locations which can be tentatively considered large enough to support populations in the long term; Wharps Holding – Paluma Range, Lannercost – Henrietta, Yamanie – Cardwell Range west, Cardwell Range east and the Cardwell coastal region. However the strength of links between these locations and the likelihood of dispersal barriers are unknown. Parsons and Latch (2006) also identify three smaller, heavily fragmented and isolated areas of habitat (Halifax Bay, Hull Heads and the Murray floodplains). It remains to be seen if these three smaller locations can be designated as subpopulations or whether they might support viable populations (Parsons & Latch 2006).

2.4 Habitat

The Mahogany Glider habitat encompasses medium to low woodland on swampy coastal plains, beach ridges and swales, *Melaleuca* swamps and *Xanthorrhoea* woodlands (Strahan 1995). This is corroborated by Jackson's (2000a) field study where the mahogany glider was most commonly found in the presence of Clarkson's bloodwood (*Corymbia clarksoniana*), Red mahogany (*Eucalyptus pellita*), Swamp turpentine (*Lophostemon suaveolens*), Cloudy tea tree (*Melaleuca dealbata*) and a reduced lower and upper canopy. Figure two depicts typical mahogany glider habitat.

Figure 2: M. Parsons

2.4.1 Distribution

The geographic range of the mahogany glider is highly restricted and limited to the southern Wet Tropics of north Queensland, see figure three (Lindenmayer 2002, Parsons & Latch 2006). According to Strahan (1995) the Mahogany Glider is known to occur coastally between Bambaru near Ingham to the Hull River near Tully (approximately 100 kilometres north). The 100km east-west range extends from the coast to the lower Herbert Gorge and foothills of the Mt Fox section of Girringun National Park in the Wet Tropics Bioregion. In this narrow strip of woodland mahogany gliders occur between sea-level and an elevation of 120 metres. Sightings exceeding the 120m level (maximum 200m) are limited to spotlight observations in Lannercost State Forest and the headwaters of the Stone River, Seaview Range (Parsons & Latch 2006). As mentioned in 2.6.1, land clearing has greatly reduced and severely fragmented available habitat to 20 percent (106,669 hectares) of the original extent (Lyon 1993, Van Dyck 1993, Jackson 1998) and approximately 45 percent of essential habitat lies within the protected area estate of Hinchinbrook and Cardwell shires (Kemp, King, Parsons & Morgan 2006). This is greatly affecting the distribution of gliders are they are dependent on continuous open forest or woodland to range freely (Strahan 1995, Parsons & Latch 2006). In 2006, the southern distribution was extended another 9.5 kilometres after researchers confirmed sightings close to Ollera Creek, 40 kilometres north of Townsville (QPWS 2006, QLD Government 2006).

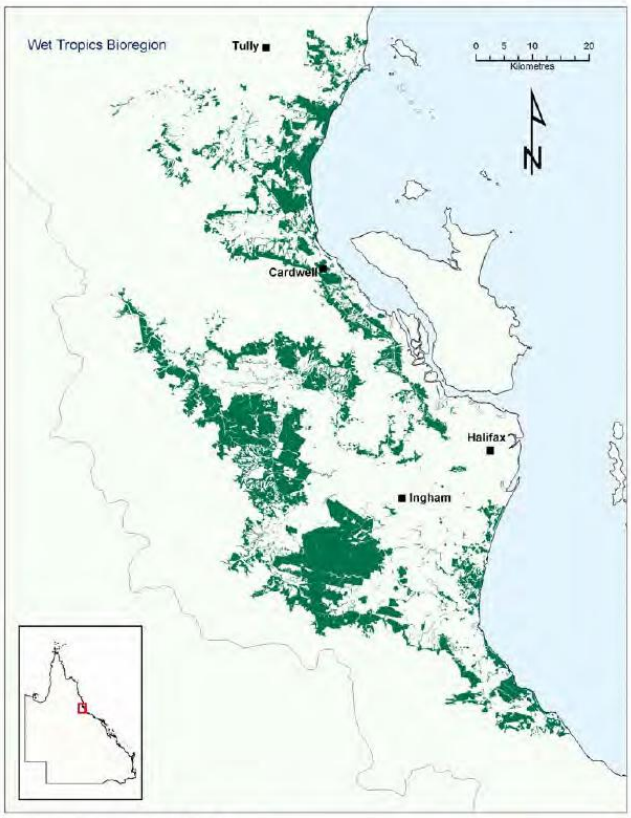


Figure 3: Parsons & Latch 2006

2.4.2 Habitat Use

In areas of continuous habitat, male and female mahogany gliders maintain average territories of 19.25ha and 20.34ha respectively. However in areas of fragmented habitat, territories average 11.06ha and 6.8ha respectively. The territory of mated pairs increases to 23.18ha in continuous habitat and 11.62ha in fragmented habitats (Jackson 2000b). The territorial mahogany glider will likely defend even marginal habitat until suitable resources have been exhausted (Parsons & Latch 2006). Jackson (2000b) found the gliders will actively mark and defend their home ranges by chasing out other mahogany gliders. The mahogany glider nests either singly or in pairs and raises young inside the hollows of both dead and living trees (Strahan 1995, Jackson 2000a).

Up to ten eucalypt lined dens may be utilised throughout a single season by an individual glider (Van Dyck 1993, Jackson 2000a). In comparison, paired gliders use between six and 13 dens, sharing them with offspring of the previous breeding season (Jackson 2000a). Den site favouritism has been recorded, however, each den throughout the home range is regularly utilised (Van Dyck 1993). Jackson (2000a) found den-tree species to include the Poplar gym (*Eucalyptus platyphylla*), Blue gum (*Eucalyptus tereticornis*), Pink bloodwood (*Corymbia intermedia*) and Clarkson's bloodwood (*Corymbia clarksoniana*). According to Parsons and Latch (2006) home ranges of paired males and females overlap approximately 86 percent and only 12 percent between pairs and other individual mahogany gliders.

2.5 Wild Diet

Although principally nectarivorous, the mahogany glider consumes many food sources such as sap, nectar, pollen, mistletoe, insects, wattle exudates and honeydew (Jackson 2001). The glider's diet includes more than 20 tree and shrub species, including eucalypts, bloodwoods, melaleucas, acacia, *Albizia procera*, and *Xanthorrhoea* flower spikes which provide nectar, pollen and sap (Van Dyck 1993, Jackson 2001). Pollen is a major source of protein for mahogany gliders and, like nectar, is an abundant food source throughout the majority of the year (Jackson 2001). However, as the availability of blossom and nectar decreases in summer, intake of food sources such as acacia arils, lerps, honeydew and insects augment the glider diet. *Albizia procera* sap is a particularly important food source in summer as few other tree species are in flower (Jackson 2001). Below is an adapted table of all known and potential food trees within the range of the mahogany glider where N = nectar and pollen,

P = pollen only, F = fruit, S = sap, A = acacia arils, H = honeydew and lerps and

* = observed utilising this species (Jackson 1998).

Family	Species	Common Name
Anacardiaceae	*Euroschinus falcata* (N)(F)	Ribbon wood
Ariliaceae	*Scheffera actinophylla* (N)	Octopus tree
Bignoniaceae	*Deplanchea tetraphylla* (N)*	Golden bouquet tree
Burseraceae	*Canarium australianum* (N)	Mango bark
Combretaceae	*Terminalia muelleri* (N)(F)	Muellers damson
	Terminalia sericocarpa (N)(F)	Damson
Dilleniaceae	*Dillenia alata* (N)(F)	Red beech
Elaeocarpaceae	*Elaeocarpus angustifolius* (N)(F)	Silver quandong
Fabaceae	*Erythrina vespertilio* (N)	Bat's wing coral tree
Lecythidaceae	*Planchonia careya* (N)(F)	Cocky apple
Lorathaceae	*Amyema sanguineum* (N)(F)	N/A
	Dendrophthoe glabrescens (N)(F)	Mistletoe
	Dendrophthoe homoplastica (N)(F)	Mistletoe
	Dendrophthoe vitellina (N)(F)	N/A
Mimosaceae	*Acacia aulacocarpa* (P)(A)(S)	Brown salwood
	Acacia crassicarpa (P)*(A)*(S)*	Thick-podded salwood
	Acacia flavescens (P)(A)*(S)	Beach wattle
	Acacia holosericea (P)(A)(S)	Yellow wattle
	Acacia leptocarpa (P)(A)(S)	North coast wattle
	Acacia mangium (P)(A)*(S)*	Hickory wattle
	Albizia procera (S)*	Brown salwood
Moraceae	*Ficus congesta* (F)	Red leaf fig
	Ficus hispida (F)	Daduri
	Ficus opposite (F)	Sandpaper fig
	Ficus racemosa (F)	Cluster fig
	Ficus variegate (F)	Sycamore fig
Myrtaceae	*Callistemon viminalis* (N)	Bottlebrush
	Corymbia clarksoniana (N)*(H)*(S)*	Clarkson's bloodwood
	Corymbia dallachiana (N)(H)(S)	Bloodwood
	Corymbia intermedia (N)*(H)*(S)*	Pink bloodwood
	Corymbia tessellaris (N)*(H)(S)	Moreton Bay ash
	Corymbia toreliana (N)*(H)(S)	Cadagi
	Eucalyptus acemnoides (N)(H)	Yellow stringy bark
	Eucalyptus cloeziana (N)(H)(S)	Cloeziana gum
	Eucalyptus drepanopylla (N)(H)(S)	Narrow-leafed ironbark
	Eucalyptus pellita (N)*(H)*(S)*	Red mahogany
	Eucalyptus platyphylla (N)*(H)*(S)*	Poplar gum
	Eucalyptus tereticornis (N)*(H)(S)	Blue gum
	Lophostemon grandiflora (N)	Northern swamp mahogany
	Lophostemon suaveolens (N)*	Swamp turpentine
	Melaleuca dealbata (N)*	Cloudy tea tree
	Melaleuca leucadendra (N)*	Long leafed paperbark
	Melaleuca nervosa (N)	A paperbark/tea tree
	Melaleuca quinquenervia (N)	Coastal tea tree
	Melaleuca viridiflora (N)*	Broad leaf tea tree
	Syzygium austral (N)(F)	Creek lillypilly
	Syzygium forte (N)(F)	White apple
	Syzygium tierneyanum (N)(F)	Bamaga satinash
	Tristaniopsis exiliflora (N)	N/A
	Xanthostemon chrystanthus (N)(F)	Golden penda
Pittosporaceae	*Bursaria incana* (N)	Mock orange
Proteaceae	*Banksia aquilonia* (N)*	N/A
	Banksia plagiocarpa (N)	N/A
	Grevillea paralella (N)*	Silver oak
	Grevillea pteridifolia (N)*	Fern-leaf grevillea
	Xylomelum scottianum (N)	N/A
Rhizophoraceae	*Carallia brachiata* (N)(F)	N/A
Rubiaceae	*Nauclea orientalis* (N)(F)	Leichardt tree
	Randia fitzalanii (N)(F)	Native gardenia

Rutaceae	*Melicope elleryana* (N)*(F)	Euodia
Sapindaceae	*Diploglottis diphyllostegia* (N)	Northern tamarind
Xanthorrhoeaceae	*Xanthorrhoea johnsonii* (N)*(S)*	Grass tree

2.6 Current Threats to Wild Population

2.6.1 Habitat Loss and Fragmentation

Land clearing is one of the most serious threats to the long-term viability of mahogany glider populations. The 20 percent of remaining mahogany glider habitat is a severely fragmented, modified landscape consisting of various sizes and shapes of land with wide-ranging levels of connectivity and condition, see figure four. Fragmentation disrupts movement paths, segregates feeding and breeding areas of home ranges and most likely affects genetic diversity which may predispose some isolated populations to local extinction. The clearing of remnant mahogany glider habitat is regulated and restricted by the Wet Tropics Vegetation Management Code under the *Vegetation Management Act 1999*. However there remain pressures from urban residential development as small blocks or parts of supporting mahogany glider habitat have been cleared or severely modified. As the fragile mahogany glider habitat is already severely fragmented, further habitat loss or degradation, even small incremental losses over time, may eventually lead to a landscape matrix unable to support local mahogany glider populations (Parsons & Latch 2006).

Figure 4: M. Parsons

Pine plantation encroaching mahogany glider habitat

2.6.2 Habitat degradation and alteration

2.6.2.1 Intensive grazing and weed invasion

The impact of cattle grazing (predominantly on the western habitat) remains unknown. However, Parsons and Latch (2006) suggest grazing stock above a tolerance threshold may degrade the understorey species composition and percentage cover, and alter long term canopy maintenance. Both weed invasion and cattle grazing affects fire intensity and the ability of understorey fuel loads to carry fire. Additionally, grazing cattle eat and damage the young flower stalks of Grass trees (*Xanthorrhoea johnsonii*), which are important sources of nectar and pollen that bloom at a time when other food resources are unavailable (Parsons & Latch 2006). Weeds have an aptitude for colonising disturbed sites which can be exacerbated through grazing pressure and if left untreated may diminish mahogany glider habitat integrity; particularly along the highly sensitive Blue gum (*Eucalyptus tereticornis*) and Swamp turpentine (*Lophostemon suaveolens*) districts that often provide habitat linkages. Weed species of particular concern to mahogany glider habitat are Siam Weed (*Chromolaena odorata*) and Sicklepod (*Senna obtusifolia*), and Lantana (*Lantana camara*). *L. camara* is established within most habitats (Parsons & Latch 2006).

2.6.2.2 Open forest and woodland thickening through altered fire regimes

Fire frequency and intensity affect forest structure and species composition in lowland forests of the Wet Tropics bioregion (Parsons & Latch 2006). While there is a degree of natural fluctuation along ecotones maintained by fire, Van Dyck (1993) confirms open forests suitable for mahogany gliders are converting from sclerophyll forest to pioneer rainforest communities because of altered,

reduced fire regimes. Consequently, necessary structural components (for example tree hollows) and food sources required by the mahogany glider are becoming limited (Parsons & Latch 2006).

2.6.3 Transport and easement corridors

Ten mahogany glider road kills were recorded from 1991 to 2005 (Parsons 2005, Parsons & Latch 2006). Almost all road kills were recorded on the Bruce Highway, although Mosquito and Easter Creeks have also had recorded fatalities. Nearly all fatalities recorded on the Bruce Highway appear to be juveniles, suggesting that the road's width is a formidable barrier to dispersal. Sections of highway parallel to the Queensland Rail (QRail) corridor or CSR tram-line can reach 60 metres in width. According to Jackson (2000c) this is the maximum glide distance for mahogany gliders and twice the average glide distance.

2.6.4 Fencing

Many glider species become entangled in barbed-wire fences, see figures five and six. From May 1994 to August 2005, eight mahogany glider barbed-wire entanglements were recorded, five of which were fatal. The patagium generally catches on the top strand of wire with damage ensuing as the entangled glider attempts to break free.

Figure 5: R. Booth

Figure 6: R. Booth

With all known incidents occurring over late spring/summer, Parsons and Latch (2006) state both shock and dehydration are likely consequences. The areas which pose the greatest threat are sections of fencing dissecting sparsely distributed tall trees, and where glides are likely to be longer than 20 metres (Parsons & Latch 2006).

2.6.5 Feral predators

Dog and cat attacks on mahogany gliders are seldom reported, with only one cat and one dog attack recorded (Lyon 1993, Parsons 2005). However, cat attacks on the closely related sugar glider and squirrel glider are reported frequently (Parsons & Latch 2006) which may indicate people do not observe mahogany glider attacks. Therefore predation may occur more often than is known. Van Dyck (1993) and Jackson (1998) include the rufous owl (*Ninox rufa*) and masked owl (*Tyto novaehollandiae*) as mahogany glider predators. Parsons and Latch (2006) suggest feral predation on mahogany gliders may be opportunistic attacks, as a consequence of factors such as habitat fragmentation. With the threats and obstacles (outlined in 2.6) fewer Australian mammals are more in need of immediate attention than the mahogany glider (Strahan 1995).

2.7 Reproduction

2.7.1 Reproductive Biology

According to Jackson (2000b) wild mahogany gliders exhibit a distinct breeding season, with births recorded between April and October. In captivity, births are seasonal with a peak in July. There is currently no published data on oestrous

cycle length or reproductive endocrinology. Gestation had been estimated by Booth, Ensabella and Whiteford (unpublished) as 16 days, n=2.

Male squirrel glider reproductive status can be distinguished by scent gland activity (Millis & Bradley 2001): (1) little or no activity where there is no staining of surrounding hair; little or no hair loss over gland area or no obvious gland product; (2) medium level activity with some staining of hair, some hair loss and waxy glandular products visible and (3) high activity with staining of the surrounding hair, total loss over gland area and a waxy glandular product prominent.

Trapping studies carried out by Jackson (2000a) suggest that the socially monogamous mahogany gliders first breed at around 12–18 months and wean their young after 4–5 months. Pairs are generally unable to raise more than one litter per breeding season, though they have been known to produce another if the first is lost (Jackson 2000a, 2000b, Van Dyck 1993, Parsons & Latch 2006). During the peak breeding season of April to October the average litter size is 1.55 young. During a study conducted by Van Dyck (1993), hairless pouch young were discovered at Barrett's Lagoon in February, which suggests that birth and weaning times might vary with food availability (Jackson 2000a, Parsons & Latch 2006). Following weaning, juveniles of both sexes disperse from the parental home range before the weaning of next year's young (Jackson 2000a).

3. Captive Population

3.1 Overview

David Fleay Wildlife Park currently holds the only captive population of mahogany gliders, with six animals obtained from the wild and 24 animals being bred in captivity since 2001. The captive colony was founded from hand raised and rescued gliders. Presently, the six wild founders have produced 24 joeys from 14 births with three single births and 11 sets of twins. There are currently 26 adult mahogany gliders in the captive population (Booth 2007, pers. comm., 1 Oct).

3.2 Studbook and Genetic Management

The captive colony of mahogany gliders are managed using a SPARKS studbook. Currently 30 animals are recorded in the studbook, including four deceased animals.

The genetics of the captive population of mahogany gliders is managed by the Principal Conservation Officer and mahogany glider keeper at David Fleay Wildlife Park. With careful use of the studbook, the captive population is currently bred to maintain the best genetic representation of the founding animals as a safeguard against the extinction of the wild populations (Booth 2007, pers. comm., 1 Oct). As the David Fleay Wildlife population is the only captive colony in existence, liaison with other zoo communities is unnecessary, however contact is maintained with carers in North Queensland where the founder animals were rescued (Booth 2007, pers. comm., 1 Oct).

3.2.1 Original locations of founder population

Milo was rescued as a 10g pouch young from her deceased mother's pouch at Meunga Creek Caravan Park, Kennedy Valley. Blossom was rescued as an immature female from a barbed wire fence in Murray Valley, west of the Bruce Highway on the Bilyana Road. Vic came into care of a resident after being rescued from a barbed wire fence on a private property on Lily Creek Road in Kennedy Valley. Ollie was found in a banana bag in very poor condition, showing signs of dehydration, a broken tail and an injured eye. Ollie was found at a banana farm, Bluff Road, Bilyana. Hogany was found as a young, just furred glider in the middle of a road adjacent to the intersection of Stoney Creek Road and the Bruce Highway, approximately 2km south of Cardwell. Dale was an emerging den young when she was rescued from a cattle feeding trough on the northern corner of Kennedy Creek Road and the Bruce Highway (Booth 2007, pers. comm., 1 Oct).

3.4 David Fleay Wildlife Park Research Facility

Figure 7: J.Whiteford

The research facility at David Fleay Wildlife Park houses the majority of the captive mahogany glider population. Built in December 2004 the facility consists of five enclosures each measuring 4m in height, 3.5m in width and 6.5m in length. Figures seven to ten depict the mahogany glider research facility at David Fleay Wildlife Park. Note the roof of each

Figure 8: J.Whiteford

enclosure roof is three quarters under cover, providing access to shelter and natural light and elements. Zoo mesh, primarily used for aviaries and reptiles (American Steel Builders 2007), has not been used to contain gliders before the mahogany glider research facility was constructed at David Fleay Wildlife Park (Ensabella, 2007, pers. comm., 1 Oct). Zoo mesh is made of durable, woven, stainless steel which boasts an ability to safely contain any terrestrial species in any environment (American Steel Builders 2007). Additionally, Zoo mesh has the advantage of excluding predators such as mice and rodents and is strong and durable.

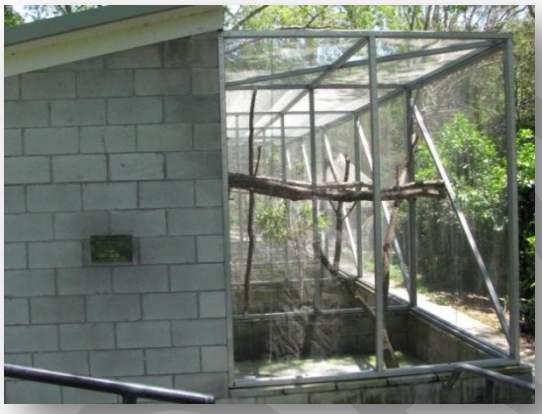


Figure 9: J.Whiteford

Figure 10: J.Whiteford

4. Captive Husbandry

4.1 Individual Identification

The David Fleay Wildlife Park mahogany gliders are microchipped. The microchip is positioned between the shoulder blades of each glider and can be scanned with a Trovan reader, for example a Virbac BackHome V200 (see appendix one for captive population identification numbers). There is a low incidence of microchip associated fibrosarcoma (Booth 2007, pers. comm., 1 Oct), however, this species is unsuitable for other forms of individual

identification. Mahogany glider ear size makes tattooing, ear tagging and puncturing impracticable alternatives to microchipping.

4.2 Housing

Jackson (2003) suggests gliders are best displayed in nocturnal houses, due to their nocturnal behaviour. However, outdoor enclosures (not for display) are sufficient so long as they are well protected from wind and poor weather and the nest box is out of full sunlight. Petaurids require an enclosure area of at least 4m³ with an additional 2x2m in floor area for each additional animal (Jackson, 2003). Heating of enclosures is generally not required for Petaurids unless there are sustained periods (i.e. weeks at a time) of temperatures below five degrees Celsius (Jackson 2003).

4.2.1 Furnishings

4.2.1.1 Nest box and materials

Mahogany gliders show fidelity to multiple nest sites within their home range, therefore their captive environment should replicate this via the provision of multiple nesting sites mimicking tree hollows (Jackson 2000d, 2003). Nest boxes should be positioned under shelter and away from the elements, usually on a platform or hung from a wall (Jackson, 2003). Nest boxes can be natural or manmade as illustrated in figures 11, 12, 13 and 14. It is useful to employ nest boxes as holding areas to allow easy access to the animals for health checks as well as safety for animals and keepers during enclosure cleaning and maintenance. This can be achieved by closing off entry into the enclosure with

Figure 11: J.Whiteford

Natural nest box

a wooden slide, see figures 13 and 14 (Ensabella 2007, pers. comm., 1 Oct). The nest boxes at David Fleay Wildlife Park include a slot at the top of the box which allows a wooden slide to block the entrance of the nest box. Some species are colonial in which case multiple nest boxes should be provided (Jackson 2003). Mahogany gliders are generally housed in pairs with dependent young consistent with the social structure observed in the wild (Jackson 2000b). It is important to ensure the nest box contains no protruding areas and the entrance into the nest box from the enclosure is both smooth and large enough for the glider to safely access their nest, see figure 12 (Jackson 2003).

Figure 12: J.Whiteford

Mahogany glider nesting material consists of eucalypt leaves and dried melaleuca bark. Leaves are 'crunched' and bark is 'ripped up' to assist gliders with lining their nests. Nesting material should cover the base of the nest box and reach a depth of approximately two inches. However, mahogany gliders will rearrange the material to suit their individual needs (Ensabella 2007, pers. comm., 1 Oct). Nesting material should be inspected daily when monitoring gliders in their nest box and changed approximately once a month or earlier if the material becomes damp and/or unclean (Ensabella 2007, pers. comm., 1 Oct).

Figure 13: J.Whiteford

Figure 14: J.Whiteford

4.2.1.2 Browse

All glider enclosures must include good foliage cover, with fresh branches and leaves supplied often (Jackson 2003). Browse not only serve as a natural food source but as a secure area and behavioural enrichment due to the smell, foraging opportunities, climbing structure and chewing source (Jackson 2003). 2.5 lists species which may be included in browse rotation for mahogany gliders, however Acacia, Casuarina, Lophostemon, Grevillia, Callistemon, Eucalypt sp and Melaleuca are commonly rotated at David Fleay Wildlife Park (Ensabella 2005). Figures 15 and 16 illustrate a gum pot/browse holder and the natural climbing and food source respectively.

Figure 15: J.Whiteford

Figure 16: J.Whiteford

4.2.1.3 Climbing structures

Jackson (2003) recommends a network of branches be arranged throughout the enclosures of petaurids to allow jumping and a runway for movement all over the enclosure. Gliding petaurids require fewer branches than the striped possum and Leadbeater's possum as their movement throughout the enclosure is aided by short glides. In fact, purposely creating larger distances between branches can encourage the gliding ability, e.g. five metres (Jackson 2003).

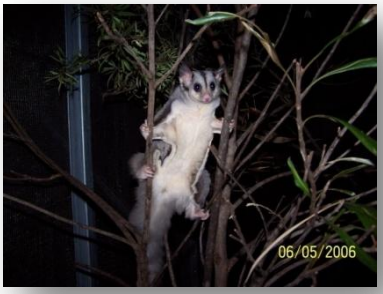


Figure 17: T-J. Ensabella

Browse climbing

Figure 18: T-J. Ensabella

Exhibiting natural behaviour

Figure 19: T-J. Ensabella

Utilising climbing network

4.3 Diet and Food Presentation

4.3.1 Daily Captive Diet

Maintenance diets for adult animals are usually ten to 20 percent of their body weight daily (Booth 2007, pers. comm., 1 Oct). Not all food is ingested as there is some wastage, so the quantities below provide maintenance for a 400 gram adult mahogany glider. An individual mahogany glider should receive 40 grams of fruit and vegetables and 30ml of slurry (nectar mix) per day. The fruit and vegetable component may include; water melon, honey dew melon, rock melon, grapes, red apple, banana, mango, corn, stone fruit, currents, paw paw, pear, avocado and figs. The fruit component should be presented in 1cm cubes in a stainless steel bowl. Five grams of extra protein should be supplied every second day and can include; meal worms, crickets, grass hoppers, fly pupae, moths and egg custard. Stones should be removed from stone fruit, all skins should be removed except apple and paw paw and all seeds should be removed except from apples, grapes and figs. All fruits need to be washed and have any stickers removed. The slurry is a high carbohydrate mix which simulates the sap and nectar components of the natural diet (Ensabella 2005, Booth 2007, pers. comm., 1 Oct).

4.3.1.1 Ingredients and method of making glider slurry

1000ml boiling water

6 tablespoons pure maple syrup

2 teaspoons Sustagen

2 teaspoons glucodin

40 teaspoons Heinz high protein multigrain mix*

Ingredients are combined in a bowl and mixed until porridge coloured paste forms. The slurry is then cooled in the fridge before being measured out and distributed to gliders. The slurry is divided into plastic containers; amounts differ depending on how many animals are housed in each enclosure. For example, three mahogany gliders sharing an enclosure will have a daily intake of 90ml as each animal is allocated 30ml (Ensabella 2005).

4.4.1.2 Special considerations

Breeding and lactating females should be given extra daily food intake. Lactation requires more energy and water than maintenance with greater needs occurring mid to late lactation (Booth 2007, pers comm., 1 Oct). For example, females with pouch young should receive 120g fruit, 30ml slurry and 5g protein daily. This diet should be adjusted as joeys grow and begin feeding on solids (Ensabella 2005).

Wild caught animals may be selective in their choice of fruits and proteins as they adjust to a captive diet. Through close monitoring of body weight and consideration, dietary requirements can be met for wild gliders in captivity (Ensabella 2005).

Weight gain may be necessary for gliders at various stages of captivity, hence a weight gain formulation has been created. Rolled oats and peanut butter balls provide an adequate amount of nutrients to assist weight gain in captive mahogany gliders (Booth 2007, pers. comm., 1 Oct).

4.4.1.3 Feeding enrichment

Slurry is incorporated into environmental enrichment by spraying the browse twice a week to encourage foraging and exploration. Similarly, meal worms are also included in environmental enrichment. Hollowed wood pieces with small holes are filled with the daily provision of meal worms and hung in the enclosure to create a challenge to obtain food and to provide an extra chew toy (Ensabella 2007, pers. comm., 1 Oct).

4.3.2 Water

Ad lib water can be presented in a 200ml capacity stainless steel dish attached to a branch next to the feeding platform (Ensabella 2005).

4.3.3 Presentation

Figure 20: T-J. Ensabella Utilising feeding platform

Mahogany glider food should be prepared daily in hygienic conditions. Captive gliders tend to eat what they need then return to their nest boxes. Therefore food should be spread out in small amounts to encourage activity, which in turn will increase their display time and exercise and reduce the incidence of obesity (Jackson 2003). Feeding at irregular times can also enhance activity and decrease the incidence of stereotypic behaviours (Jackson 2003).

Mahogany gliders are nocturnal, so feeding mid to late afternoon is best. Mahogany gliders housed in a nocturnal house should ideally be fed in the morning when the lights are off (Jackson 2003). Food bowls are placed on previously disinfected, scrubbed and dried feeding platforms. The stainless steel corner platform in the David Fleay Wildlife Park mahogany glider facility allows for good hygiene in feeding areas, see figure 21. Native browse and blossom (a source of natural food and enrichment) should be replaced every second day. Gliders naturally chew branches and gather insects and nectars from blossoms and should therefore be provided with fresh chew logs, eucalyptus, saps and mannas to chew and feed from. Chew logs should be monitored and replaced when required, approximately every 14 days (Ensabella 2005).

Figure 21: J.Whiteford

Feeding platform

Figure 22: J.Whiteford

Stainless steel food and water bowl ring

Fruit, proteins and slurry (nectar mix) are present in two stainless steel bowls. Fruit and proteins are combined in one bowl and slurry is placed in the second bowl, both of which are either in stainless steel feeding platforms or in hanging steel bowl rings. Water should be presented in a 200ml capacity stainless steel bowl in a stainless steel ring close to the feeding platform (Ensabella 2005, Jackson 2003).

Stainless steel food and water bowl ring

4.4 Daily Husbandry

Due to the nature of animal keeping, the following daily husbandry routine is a guideline only. Unforeseeable tasks and new priorities may present difficulties in following a schedule, therefore some set tasks (for example outside enclosure maintenance and browse collection) are able to be prioritised throughout the day or week. The following routine has been developed by Ensabella (2005) for the research round at David Fleay Wildlife Park and adapted for this husbandry manual to focus only on the mahogany glider. These tasks can be spread throughout the day with the first taking place at 8am and the feed out taking place between 3 and 4pm.

- Mahogany Glider Research Facility: ensure computer is running and nest box and enclosure cameras are all operating, gliders in enclosures one to five are present and not displaying abnormal behaviour or presenting with any obvious physical abnormalities (video observation only).
- ABSCO 3, ABSCO 4 and ABSCO 5 enclosures: ensure animals are present and not displaying abnormal behaviour or presenting with any obvious physical abnormalities, record which nest box is being used overnight. Observe enclosure, ensuring there is no damage to the enclosure or foreign objects present then retrieve food bowls. Clean water bowl and remove food scraps, faeces and fallen tree and/or chew log pieces from enclosure. Weigh and record any uneaten food.
- Wash and disinfect (Avicare solution) all ABSCO food and water bowls and allow to air dry.
- Clean mahogany glider research facility: detailed instructions available in 4.5.1

- Empty grates.
- Wash and disinfect (Avicare solution) all research facility food and water bowls and allow to air dry.
- Food preparation for mahogany gliders.
- Maintenance of enclosures, re-fitting enclosures, collection of browse when required.
- Weighing and health check of animals.
- Feed out of animals.

The following tasks can be prioritised throughout the week.

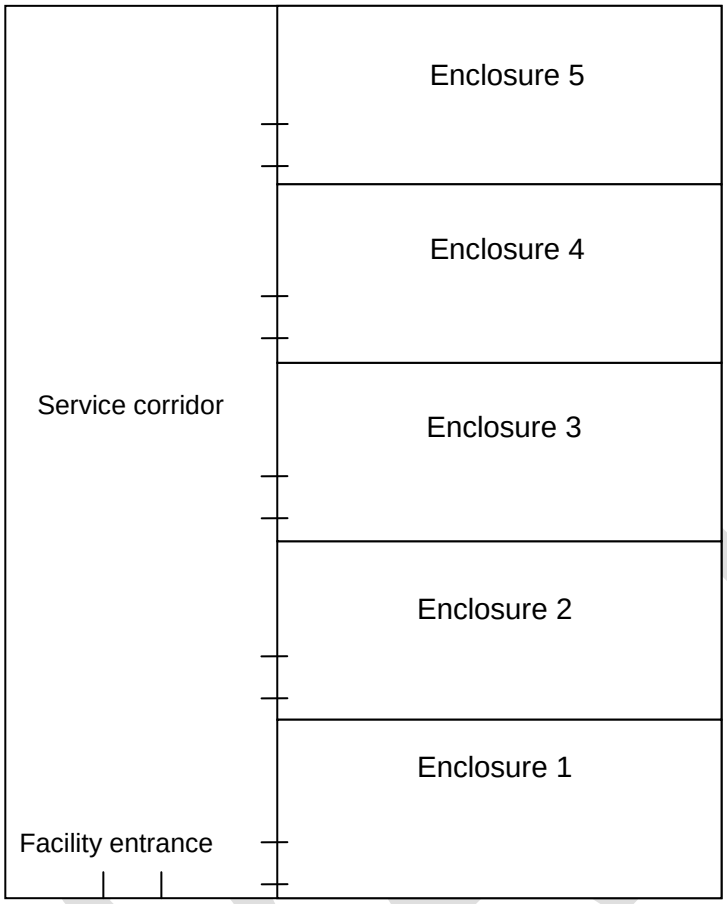
- Organise equipment and staff for capture and restraint of animals for pouch checks weekly (if required, i.e. during breeding season).
- Make enrichment items and place them in enclosures (when required).
- Check and maintain rat bait stations.
- Scrub ibis and bat faeces off enclosures.
- Whipper snipping around enclosures.
- Complete records and paperwork.

4.4.1 Mahogany glider research facility cleaning routine

The mahogany glider facility has five large outdoor enclosures and a service corridor which functions as a keeper look, see figure 23. When the facility requires major cleaning or maintenance (ie: bleaching, re-perching, etc) animals must be contained in nest boxes, so that cleaning and maintenance can occur without danger to animals or keepers. Any enclosure maintenance or modifications are to be recorded in keeper's daily diary, park daily record book and individual animal's specimen record.

Figure 23

Facility floor plan (not to scale)



- Un-lock and enter the research facility, be sure to lock door after entering. Check computer monitor to access where animals are and their health and safety before closing down individual nest box slides to secure animals while cleaning / maintenance (being aware that animals may be in nest boxes out in enclosure). Identification for individuals are attached to individual nest boxes, currently all animals have microchips.
- Gather required cleaning tools ie: towel, broom, bin, dust pan and brush set, cloth, scrubbing brush, hose and diluted disinfectant in container, PPE equipment – safety glasses and mask.

- Un-lock and enter individual enclosures with tools ensuring they are placed in an area that won't impede or obstruct keeper. Close and barrel bolt enclosure door once inside.
- Assess faeces/urine consistency and type, check enclosure for holes or other damage, visual and physical check of enclosure furniture, remove food bowls saving any left overs for weighing and recording, scrub feed station and disinfect (ensuring personal protection equipment is worn for keeper safety), open grate gate (stops access from gliders) to allow access to grate, sweep floor gathering fallen leaves and faeces. Hose floor, besser block edges and debris off roof (being aware of potential slip hazards), access browse, fill gum pots, water trees, empty grate and replace gate. Towel dry feed station ensuring it is clean and dry.
- Exit enclosure locking door upon exit, after removing food and water bowls and tools. Soak, clean and dry food bowls. Clean refill and replace water bowl.
- Open all nest boxes individually and visually check all gliders for health and safety, observing physical appearance and behaviour.
- Open all nest box slides allowing gliders to access enclosures.
- Record any animal's information that will be required for their individual specimen record sheets or if required daily record book and report any problems immediately to the Principal Conservation Officer.

4.4.1.1 Cleaning and maintenance tools

Tools used for the cleaning of the research facility should be stored within the facility. All tools should be used exclusively in the research facility to ensure minimal risk of zoonotic disease transferral and to ensure tools are in good

condition at all times. The chemicals used in the facility are Avi Care (active constituents: 50g/L Benzalkonium Chloride, 25g/L Sulfamic Acid and 25g/L Polyhexamide) and Bleach (active constituents: 45g/L Chlorine present as Sodium Hypochlorite), and are used only in the correct dilution (as per manufacturer directions). These chemicals are stored in clearly labelled original containers. Tools include: dust pan and brush set, scrubbing brush, lint free cloth, cob web brush, bucket, bin, broom, scrubbing broom, Avi Care (disinfectant), bleach, towel, hose and a rake.

4.5 Health

4.5.1 Vaccinations

The captive mahogany glider population is not vaccinated against any disease or infections as no infectious diseases have been detected in this species to date (R Booth 2007, pers. comm., 2 Oct).

4.5.2 Known Health Problems

Good husbandry and preventative medicine programs involve strict hygiene standards and daily observation of the captive animals to check for signs of injury or illness (Jackson 2003). Mahogany gliders are a robust species in captivity and currently show no common health problems (R Booth 2007, pers. comm., 2 Oct). Because the species has only been in captivity since 2001 it is appropriate to review the diseases of other possum and glider species in this manual, particularly the closely related sugar glider, *Petaurus breviceps*.

4.5.2.1 Ectoparasites

A number of ectoparasite species have been found on different gliders and possums. Ectoparasites associated with *Petaurus* include mites of the genera

Guntheria and *Petauralges* and an Atopomelid mite. Ectoparasites can generally be viewed by the naked eye on an affected animal when captured, however excessive grooming, hair loss and inflamed skin may alert keepers to the mites (Booth 2000). The condition can be diagnosed via observation or skin scrapings viewed under a microscope for mite identification. Acaricides and carbaryl powder (50g/kg) can be used topically and in the nest box as a treatment. Alternatively, injectable ivermectin is also successful at controlling a variety of ectoparasites. Preventative measures include good hygiene, routine examination of fur and the quarantining of new arrivals (Booth 2000).

4.5.2.2 Endoparasitic worms

A number of cestodes, trematodes and nematodes have been identified in and on various species of possums and gliders (Jackson 2003). The trematode *Athesmia* sp. has been found in the liver and the nematodes *Parastrongyloides*, *Paraustronstrongyloides* and potentially *Paraustroxyuris* have been found in the gut of sugar gliders (Booth 2000). Booth (2000) notes that while infection with these endoparasitic worms is not obvious, they may cause diarrhoea or ill thift. Prevention can include good hygiene by the removal of faeces from the enclosure and quarantining new arrivals (Booth 2000).

4.5.2.3 Protozoans

Booth (2000) includes the protozoan parasite *Toxoplasma gondii* in the known health problems of possums and gliders. *Toxoplasma gondii* causes toxoplasmosis after the ingestion of felid faecal material containing sporulated oocysts (Booth 2000). However, hand reared young and new arrivals may potentially be infected, and stray cats may contaminate storage areas, therefore the signs, diagnosis and treatments should be known. Infection is often not

obvious and usually occurs in immunosuppressed or hand reared animals. Toxoplasmosis should be suspected in cases with neurological symptoms (Booth 2007, pers. comm., 1 Oct). Antemortem diagnosis of toxoplasmosis is established by serological testing to detect IgG *Toxoplasma gondii* titres and treatment requires pharmacological agents to stop the replication of the parasite such as Clindomycin (Booth 2000). Prevention is best achieved by restricting access to cats and cat faecal matter (Booth 2000).

4.5.2.4 Bacteria

Sugar gliders can be susceptible to infection with common bacteria including *Pasteurella*, staphylococci, streptococci, mycobacteria and *Clostridia* (Booth, 2005). *Yersinia pseudotuberculosis* and a known cause of mortality in captive Leadbeater's possums. Many animals can harbour Yersinia without incident, however it is capable of causing multisystemic illness and clinical sings of the rapid septicaemic form of the disease may include depression, dehydration, diarrhoea and melaena. Treatment in the form of broad spectrum antibiotics is usually recommended. Clinical signs of *Pasteurella*, staphylococci, streptococci, mycobacteria and *Clostridia* include lesions, depression, loss of appetite and weight loss. Antibiotics such as Chloramphenicol palmitate and enrofloxacin compounded into liquid formulas are commonly prescribed and easy to administer (Booth 2005). Prevention methods include; high standards of husbandry and hygiene, protection of food and water from wild birds and minimising stress (Booth 2000).

4.5.2.5 Fungus

While low numbers of *Candida* are normally present in the gastrointestinal tract of many marsupials, poor hygiene and/or stress in hand reared young and

antibiotic therapy can stimulate *Candida albicans*. The *Candida albicans* fungus causes candidiasis and can be identified by yellow-green diarrhoea with a yeast-like smell, sometimes frothy or curdled in appearance. Oral thrush presents with mouth soreness, ulcers and/or white plaques or crusting around the mouth with a rust coloured discharge (Booth 2000). Gram stains of faecal matter or oral cavity can diagnose the fungus, with a positive stain resulting in high numbers of budding yeasts in a blue-purple stain (Booth 2000). Nilstat® Oral Drops or Mycostatin® Oral Drops given orally at 0.1-0.5 ml/kg three times per day over 3-5 days can treat *Candida albicans*. The fungus can be prevented by maintaining high levels of hygiene, paying particular attention to any milk and urine build up, and minimising stress (Booth 2000).

4.5.2.6 Nutritional osteodystrophy

Nutritional osteodystrophy (hind limb paralysis) commonly affects pet sugar gliders overseas, however has not been reported in zoo collections (Booth 2000). Booth (2000) states the condition may be due to a calcium deficiency and can be detected via sudden onset of hind limb weakness or paralysis. Nutritional osteodystrophy can be diagnosed by radiography of vertebral, pelvic and long bones demonstrating osteoporosis. Early identification and subsequent alteration of diet to include higher levels of calcium and additional vitamin D3 coupled with rest is the recommended treatment. The best method of prevention is a high calcium diet (Booth 2000).

4.5.2.7 Bloat

Gas build ups in the gastrointestinal tract has been recorded in adult and juvenile common ringtail possums, *Pseudocheirus peregrines*. Without treatment the intestines may twist and strangulate leading to death. Bloat

presents with an extremely tight, distended abdomen and can be diagnosed via palpation and radiography. The condition can be prevented by providing an appropriate diet with variety including plentiful fresh browse (Booth 2000).

4.5.2.8 Neoplasia

Neoplasia is relatively common in captive gliders, with 50% of all reported neoplasms diagnosed as lymphoid neoplasia. Neoplasia can be treated to varying degrees of success via surgical removal of the tumor (Booth 2007, pers. comm., 1 Oct).

4.5.2.9 Obesity

A fatally obese mahogany glider was recorded in 2001 (Booth 2007, pers. comm.) Obesity has also been associated with fatal coronary artherosclerosis in a Leadbeaters possum and abdominal fat necrosis was recorded in an obese sugar glider at death (Booth 2000). Maintenance on appropriate quantities of a balanced diet which resembles the natural diet (see 2.5) can help prevent obesity.

4.5.2.10 Dental problems

Periodontal disease and tartar accumulation is associated with soft, carbohydrate rich diets in captive sugar gliders. Treatment via removal of tartar under general anaesthesia and broad spectrum antibiotics is recommended along with a modified diet (Booth 2000).

4.6 Captive Breeding

4.6.1 Reproductive history

The monogamous mahogany gliders breed well in captivity. From the six wild founders, 24 animals have been bred in captivity since 2001. Of the 24 captive bred joeys there have been three single births and 11 litters of two. There are currently no known reproductive problems related to the mahogany glider and breeding control is maintained by housing males and females separately (Booth 2007, pers. comm., 1 Oct). The Recovery Plan for the Mahogany Glider 2000 – 2004 does not list captive breeding as an objective, however David Fleay Wildlife Park maintains the captive population to provide a genetically managed, self sustaining breeding colony for possible future reintroductions and for the research of breeding biology to support management of the wild population (Booth 2007, pers. comm., 1 Oct).

4.6.2 Gestation period

A study conducted by Booth et al (unpublished) estimated the gestation period of the mahogany glider to be 16 days n=2. This was determined by observing mating and subsequent births using video monitoring of nest boxes in the David Fleay Wildlife Park research facility. Mating occurred on multiple occasions during a single night and birth occurred during the day 16 days later.

4.6.3 Parental Care

Captive mahogany gliders display biparental care (Booth 2007, pers. comm., 1 Oct). Mahogany glider parents provide warmth, safety, supervision as well as grooming their young and each other within the nest box (Greer 2005). Both parents form bonds and play with their young in the nest box and carry them as

back young on their first excursions from the nest at approximately 100 days. Males have been observed rescuing distressed young and are often first to respond to vocalisations of young. Mahogany glider joeys may be left with their sires during mid lactation and are left alone in the nest box when lightly furred but eyes are closed at approximately 74 days of age.

4.6.4 Joey Development

The table and photos below have been adapted from Booth et al (unpublished) to outline the mahogany glider growth and development milestones. Where age is measured in days from birth, HL = head length from nose to occiput.

Figure 23: R. Booth

Measuring head length at 37 days

Figure 24: R. Booth

Measuring tail length at 37 days

Mahogany glider development milestones

Age (weeks)	HL (mm)	Ulna (mm)	Tail (mm)	BWt (g)	Milestones
0-7	8				Blusih ring around eye Ear bud develops Toes conjoined Permanently attached to teat Can be sexed Skin initially translucent becoming more opaque by day 7
8-14	10.86	6.6	10.7		Bluish ring around eye Ear bud like Toes conjoined Permanently attached to teat Skin opaque
15-21	12.11	8.9	12.60		Lid margins visible
22-28	14.2	10.35	17.88		Lid margins faintly pigmented Ear free and erect Toes distinct and claws developed Claws dirty/pigmented Permanently attached to teat Skin shiny smooth
29-35	16.09	11.15	25		Skin textured as hair follicles develop on body Gliding membrane distinct Claw tips pigmented Hair erupted on bridge of nose and chin Mystachial papillae developed Tail curls
36-42	18.97	13.93	32		Blue eye ring has become solid blue circle Lid margins pigmented Ears erect and faintly pigmented Claws pigmented Permanently attached to teat Skin textured Tail curling more pronounced Mystachial and cheek vibrissae erupted
43-49	20.23	15.73	38.8		Ears pigmented, eye dark, lid margin deepening
50-56	22.41	18.08	48.8		
57-63	25.14	20.79	59.4		Lid margins darkly pigmented and separating Ears more pigmented especially margins Claws pigmented Permanently attached to teat Dorsal pigmentation of body happens rapidly between 59 & 63 days
64-70	28.33	23.9	76.8		Short fur on dorsum Underside and distal limbs unfurred Dorsal stripe prominent Eyes closed but lid margins distinct All vibrissae erupted (mystacial, check, brow, ulnar-carpal) Starting to detach from teat intermittently
71-77	31.65	25.28	96	37	Longer and more fur Underside, gliding membrane and digits unfurred Eyes still closed Dorsal tripe very prominent Detach from teat intermittently Left in nest alone for short periods
90-94	37.71	34.29	156.4	69.88	Rapid increase in length and density of fur Toes, underside and gliding membrane furred Eyes open between 90 & 94 days Phallus in both sexes involuting into cloaca Detached from teat more than attached Left alone in nest for longer periods

101	41.86	38.38	179.4	108.25	Fully furred with short fur Leaves nest box with parents (as back young) Eating solids
126	47.66	46.5	240.6	159.5	Fully furred and fluffy Eats long and mobile Leaves next box with parents (as back young) Eating solids

The following pictures coincide with the growth and development milestone table above.

Figure 25: R.Booth

From left to right: 7 days, 14 days, 21 days, 30 days, 44 days, 63 days, 70 days, 77 days, 84 days, 90 days, 101 days, 126 days

4.7 Hand raising

The decision to hand raise any glider should be considered on a case by case basis. It may be necessary to intervene and hand raise young if they are failing to thrive while suckling, are sick or injured, their mother has rejected them, or they have been orphaned (Barnes 2002). Booth (2000) suggests hand raising be carried out by one carer to maximise consistency in technique and fosters bonding between glider and carer.

4.7.1 Record keeping

Detailed, accurate hand raising records should be maintained throughout the raising for future reference. Barnes (2002) recommends initial records should include age, weight, body measurements, sex, distinguishing marks, parentage (if known), formula given (and at what strength) and housing material (pouch, cage, heat source etc). Furthermore, daily tasks and events such as feeding time, quantity of feed given, formula changes, introduction of solids, frequency of urine and faecal matter, consistency of faeces and behavioural notes should be recorded. Appendix two provides an example of a possible record template for hand raising mahogany gliders.

4.7.2 Equipment

All equipment should be acquired and cleaned appropriately before receiving a glider into care. Barnes (2002) recommends the following equipment for hand raising sugar gliders; artificial pouches and bedding made from natural fibres with no loose threads; a thermometer to maintain and monitor temperature; a small and large cage for early and later (weaned) stages respectively; feeding aids such as a glider teat, syringe and measuring spoons; an electrolyte/glucose supplement such as Lectade; small feeding bottles to suit

food quantities; bottle brush for cleaning; boiling water for steralisation of feeding equipment; food (milk formula, solid food, supplements, natural food like blossoms, insects and various types of tree branches); a heat source as unfurred pouch young cannot thermoregulate (Booth 2000); food bowls for solids; soft brush for grooming; baby wipes or tissues for toileting and cleaning; and NapiSan or equivalent for sanitising/cleaning pouches and bedding (Barnes 2002).

4.7.3 Initial care and stabilisation

If the pouch young has been rejected by its mother the animal should be physically checked for bleeding, breathing difficulties, broken bones, hyperthermia, hypothermia, parasites, shock and wounds. Veterinary care should be administered as soon as possible (Barnes 2002). Care should be taken to provide sick, injured and orphaned gliders with a stress free environment by placing the animal in a pouch with a heat source in a quiet area. Sick or injured adult sugar gliders are kept at 26 degrees Celcius, furred young sugar gliders are maintained at 28 degrees Celcius and furless young between 30 and 34 degrees Celcius (Barnes 2002, Booth 2000). After 100 days in age, sugar gliders may be left at ambient temperature (Booth 2000). Ideally the heat source should be placed on the outside of the cage or have towels wrapped around the object to prevent direct contact (Barnes 2002). An internal/external thermometer is a stress free way to monitor air temperature for preventing potentially fatal overheating and problematic underheating (Barnes 2002).

4.7.4 Feeding

While there are many low-lactose milk formulas available for hand raising young gliders (i.e. Wombaroo, Biolac, Digestelac, etc) it is essential to maintain consistency when feeding and avoid changing formulas to prevent unnecessary problems such as diarrhoea (Cage 2002). Establishing the age of a glider is important as this will affect the type of food and quantity provided (see 4.2.4 for aging young mahogany gliders). Provision of formula may need to be preceded by high-energy fluids (Lectade or Pedialyte), an electrolyte/glucose replacer or Glucodin for a period of up to 24-28 hours. High-energy fluids aid stabilisation, combats dehydration, maintains body temperature and rests the stomach before new foods are introduced (Barnes 2002). Once the glider has been prepared with high-energy fluids and is warm, milk formula may be introduced, however it is recommended a slightly diluted mix precede full strength to avoid causing diarrhoea as the animals adjusts to the artificial diet. The temperature of formula (ideally tepid) should be checked prior to feeding as some gliders will not feed if the milk is too cold and may burn their mouth if too hot. Unused prepared formula should be discarded after 24 hours. Strict hygiene should always be maintained, including sterilisation of feeding equipment after each use (Barnes 2002).

4.7.4.1 Feeding techniques

Common nursing techniques of gliders include lapping from the end of a syringe, using an appropriately sized bottle and teat, and lapping directly from a measuring spoon. Young gliders can be encouraged to feed by allowing them to lap/lick at a small piece of banana, then smearing banana on the feeding tool which can then provide the formula to the glider as they lick the banana. When

feeding via bottle and teat, gently direct the teat into the side of the gliders mouth; do not try to pry the mouth open (Barnes 2002).

4.7.4.2 Feeding frequency and quantity

The frequency and quantity of feeding depends upon the age of the glider. Unfurred sugar gliders require feeding every one to two hours, just furred gliders every four hours, progressively being reduced to once or twice a day prior to weaning (Booth 2000, Barnes 20002). Overfeeding a young glider can cause diarrhoea (Barnes 2002).

4.7.4.3 Toileting after feeding

Pouch young will need to be stimulated to urinate and defecate after each feed. This can be accomplished by slightly moistening a cotton ball or soft tissue to tickle (no rubbing) around the phallus/cloaca (Barnes 2002).

4.7.4.4 Expected weight gain

For consistency and accuracy it is important to use the same scales each time gliders are weighed. Barnes (2002) recommends weighing new animals daily for the first two weeks, slowly progressing to once every two days, then once a week, and then less frequently. Initially it is to be expected new gliders will not gain weight and perhaps even record a loss. Once hand raised sugar gliders adjust to their new environment, they record a weight gain every one to two days. The introduction of solids will increase weight gain, however avoid overfeeding solids as it can lead to obesity (Barnes 2002, Booth 2007, pers.comm.).

4.7.5 Weaning

Weaning occurs between 94 and 101 days (Booth et al unpublished). Following the diet of solids set out in chapter 4.4 will help to prevent problems such as obesity, viral and bacterial infections, nutritional deficiency diseases and reduced breeding success. To aid the transition between formula and solids it is suggested that a variety of the intended solid diet be left with the glider overnight so that the animal may sample the food at leisure. Initially the size of the food should be small and may even need to be grated or mashed. According to Barnes (2002) most gliders will begin the transition to solids if they are made available to them. Food bowls should be shallow and if the enclosure is home to more than one glider, the food should be separated into multiple bowls to allow equal access (Barnes 2002).

4.7.6 Housing

Housing varies with glider age, however all housing must be kept clean (under strict hygiene standards). Young gliders require a small pouch liner placed inside a thick pouch. The cage should be escape proof, free from sharp edges or protrusions and located in a suitable position away from other animals and noise. Unfurred pouch young do not require a cage as they do not leave the pouch. A heat source should be supplied (28 degrees Celcius for furred young or between 30 and 34 degrees Celsius for unfurred) outside the cage or pouch. As the glider begins to emerge from the pouch, ensure water is available at all times and that there are small branches in the cage for chewing and climbing (Barnes 2002). Weaned and adult gliders should initially be housed in a nest box within a cage. Should more than one glider share the cage, additional nest boxes should be supplied and the size of the cage should increase. Weaning

and adult gliders require plenty of climbing and chewing branches as well as fresh browse. Branches around the edges of the cage will encourage the glider to jump rather than run from one side of the cage to the other (Barnes 2002).

4.7.7 Considerations for reintroduction

Wild gliders live in family groups or colonies, so it is important for young gliders to be socialised appropriately and preferably housed with another glider. Any new introductions of gliders must be done carefully (Barnes 2002). According to Barnes (2002) the soft release method involves placing the new animal inside a smaller holding cage within a larger cage of gliders for several weeks before letting the new glider join the colony. A hard release method involves dusting all animals and bedding with talcum powder and placing them all together immediately. An alternative hard release is to cross scent all the animals that are to be housed together by rubbing their scent glands together or covering them in each other's urine (Barnes 2002). Both the hard and soft release methods require supervision of the animals as fighting will most certainly occur (Barnes 2002).

4.8 Capture and Restraint

Jackson (2003) suggests possums and gliders are best caught during the day while they are asleep in their nest boxes. Mahogany gliders exhibited within a nocturnal house can often be caught early in the morning before the lights are turned off. Gliders may also be netted or trapped within the enclosure (Jackson 2003). The procedure followed at David Fleay Wildlife Park involves securing the glider in its nest box and placing a calico bag over the arm to be used to capture the glider. A calico bag is placed over the arm and pulled up to the shoulder to provide some protection. For the safety of the glider, the seams of

the bag must not face the glider, ensuring any frayed hems and threads do not tangle the glider or hook on claws. After slowly opening the nest box door, the glider can be caught by placing the hand across the glider's shoulders and swiftly closing the calico bag. The bag is quickly twisted and tied with a string as gliders can climb up toward the opening of the bag (Ensabella 2005, Ensabella 2007, pers comm. 1 Oct).

4.9 Transportation

4.9.1 Transportation

According to Jackson (2003) most glider and possum species are easily transported. It is suggested a calico catching bag is sufficient to transport gliders short distances (eg several hours drive away), however it is also recommended the glider, contained within a catching bag, be placed in an enclosed nest box as a precautionary measure in the event of escape from the bag (Jackson, 2003). For longer periods of confinement during travel or during air transportation, a wooden box recommended by the International Air Transport Association with adequate nesting material should be utilised to transfer individual animals (Jackson, 2003). Ideally, animals should be transported overnight or during cooler parts of the day (eg between 10-20 degrees Celsius) (Jackson, 2003). Upon arrival in the new enclosure, the bag and/or box should be opened so that the glider can view its surroundings. The animal should be left to emerge from the bag and/or box in its own time. Once the glider has fully emerged the transportation materials should be removed from the enclosure (Jackson, 2003).

4.9.2 Transportation Box

Not only does the transport box act as a second barrier against potential escapes, it also provides protection against objects which may otherwise harm an unboxed glider. As mentioned in 4.9.1, if air travel is involved the transportation box must meet the International Air Transport Association guidelines. The glider must be provided with clean, soft nesting material so that the animal is secure and does not roll excessively. A water container with no sharp edges should be secured to the side of the transportation box along with a small amount of food which will not spoil quickly (Jackson, 2003). It is not recommended females with young be transported unless the young have only recently been born and are still permanently attached to the teat.

5. Glossary

arils: a fleshy, usually bright coloured cover of a seed, arising from the hilum or funiculus (the stalk of the ovule).

ecotones: a transitional zone between two ecological communities containing the characteristic species of each.

hallux: the innermost digit of a hind foot or lower limb.

honeydew: the sweet material that exudes from the leaves of certain plants in hot weather.

lerps: a structure produced by larvae of psyllid insects as a protective cover.

manna: the hardened sugary exudation of various trees.

sap: the juice of plants of any kind, especially the ascending and descending circulating fluid essential to nutrition.

syndactylous: pertaining of two or more digits that are fused together.

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7. Appendix

Studbook Number	Name	Sex	Identification Number
1	Vic	M	981000300007981
2	Dale	F	981098100138275
3	Ollie	M	981098100136040
4	Hogany (deceased)	M	40103C3956
5	Milo	F	412F472D7C
6	Blossom	F	41301B6B1E
7	Bud	M	412F4E303E
8	Jessie	F	400C695218
9	Cardwell	M	412F6D0609
10	Tully	F	412F7A6660
11	Bambaroo	F	981098100135596
12	Lily	F	000669440A
13	Stoney	M	981000300002347
14	Halifax	M	981000300023599
15	Barrett	M	981000300021760
16	Ingham	M	0006696CAD
17	Kennedy	M	000669434D
18	Unnamed (deceased)	M	981098100136147
19	Shoo Shoo (deceased)	F	
20	Murray	M	
21	Bilyana	F	
22	Meunga	F	
23	Jourama	F	
24	Lumholtz	M	000682EAE0
25	Kirrama	F	000682E38D
26	Hinchinbrook	M	000682E2D5
27	Lannercost	M	000682EE3D
28	Hull	M	000682C31B
29	Mungaru	F	000682D209
30	Echo	F	000682B276
Studbook keepers: Traza-Jade Ensabella, Rosemary Booth (David Fleay Wildlife Park)			

Hand Rasing Template (Barnes 2002)

Hand Raising Record					
Common name:			Scientific name:		
House name:			Sex:		
Age:			Measurements:		
Parents:			Reason:		
Formula given:			Carer:		
Date	**Time Fed**	**Amt Fed**	**Total**	**Weight**	**Comments**