

Husbandry Guidelines For

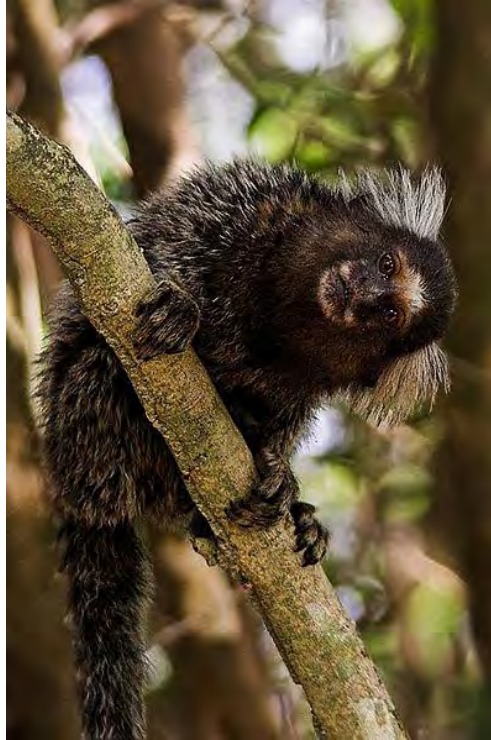


Photo by Carmem A. Busko

Common Marmoset

Callithrix jacchus

Mammalia: Cebidae

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DISCLAIMER

These husbandry guidelines were produced by the compiler/author at TAFE NSW – Western Sydney Institute, Richmond College, N.S.W. Australia as part assessment for completion of Certificate III in Captive Animals, Course number 1068, RUV30204. Since the husbandry guidelines are the result of student project work, care should be taken in the interpretation of information therein, - in effect, all care taken but no responsibility is assumed for any loss or damage that may result from the use of these guidelines. It is offered to the ASZK Husbandry Manuals Register for the benefit of animal welfare and care. Husbandry guidelines are utility documents and are „works in progress“, so enhancements to these guidelines are invited.

Annual Cycle of Maintenance Activities

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BREEDING SEASON				■					■			
ENCLOSURE REPAIRS	■						■					
ENCLOSURE RENOVATIONS		■						■				
FULL ENCLOSURE CLEANING			■			■			■			■
ROUTINE HEALTH CHECKS		■						■				
ANNUAL VET CHECKS	■											

-Common Marmosets are continuous breeders; however they do have two breeding peaks one from April to June and September to November.

-Enclosure repairs should be conducted in January and July so as not to be in the breeding peak; any extensive or high noise repairs should occur when there are no young present under 6 months of age.

- Enclosure renovations should take place when there is an expectant mother or when there are young under 6 months of age, renovations should occur twice yearly outside the breeding peak; the best time to conduct repairs are February and August.

-Full Enclosure Cleaning should occur every three months including a complete substrate overhaul ; if young are present under 6 months of age do not change or clean the nest box.

-Routine Health Checks should take place as needed; with routine treatments such as worming occurring twice yearly in February and August, the reason for this is that they should be wormed just before spring (August) as worms are most prominent at this time, and they need to be wormed every six months.

-Annual Vet Checks should take place in January, as cultures should be done prior to worming so that the correct worming treatment can be used, and while the vet is present other checks should take place.

OCCUPATIONAL HEALTH AND SAFETY RISKS

Common Marmosets are not „dangerous“ in the traditional sense. The main thing to watch out for when working with this species is the zoonotic diseases they can carry; however there are also other areas that persons working with the species should be aware of. These are listed in the 5 main categories below:

Physical:

Common Marmosets are rated innocuous as they can cause no-to-minor harm to human beings. They are able to scratch and bite; however they will rarely pierce the skin.

Prevention:

- The best method of prevention is to wear the following PPE (Personal Protective Equipment): gloves, long pants and long sleeve shirts. (A Titmuss,pers.comm.2007)

Biological:

Common Marmosets, being New World Monkeys, can contract and transmit a wide range of zoonotic diseases; strains of these diseases can be fatal to humans. Common colds, cold sores and measles are common and not serious in humans unless in extreme circumstances, for small primates however they often prove to be fatal. Refer to *8 Health Requirements* for more information about zoonotic diseases in Common Marmosets. (EAPA, Primates Policy, 2000)

Prevention:

- PPE (Personal Protective Equipment) should be worn at all times (gloves, long pants and long sleeve shirts,
- Quarantine periods (usually 40 days) should occur before the species is admitted into the collection, or if they show any symptoms of zoonotic diseases at a latter date (blood tests observations should be conducted in this time to make sure the animals have no zoonotic diseases).
- Good hygiene is a crucial point; many diseases can be avoided when good levels of husbandry and hygiene are maintained (A Titmuss,pers.comm.2007)
- Inoculations and regular testing are extremely helpful forms of prevention (Hepatitis A inoculations and regular testing for Tuberculosis is recommended for all staff). (J Salkeld, pers.comm.2007)

Psychological:

Whilst it is less common amongst New World primates, excessive attachment between keepers and Common Marmosets still frequently occurs due to the relative similarities between human and non-human primates. While becoming attached is a normal healthy part of keeping, associating primates as “people” is not; this can lead to stress on the part of the keeper for a variety of reasons (including, but not limited to, excessive empathy, depression, or a clouding of judgement due to attachment to the animal). (J Salkeld, pers.comm. 2007)

Prevention:

- Professionalism in the workplace and maintaining a healthy detachment from the primates (as would be observed with other animals) is necessary for certain keepers.
- In extreme circumstance an effected keeper should be isolated from any situation which will exacerbate the stress or other negative psychological issues arising from close contact with the Common Marmosets.

Chemical:

There are several chemicals that will be used in the general cleaning of working with Common Marmosets. For every chemical that is used within the institution there should be a MSDS (Material Safety Data Sheet) on site. The three main facts to look out for is the correct concentration that the chemical should be used in, how it should and can be used and what should be done in the case of an emergency (*please refer to Appencies B and C for MSDS's*). The two main chemicals that are used in institutions are;

- F10
- Bleach

Prevention:

- Abiding by good work place practices (MSDS, OH&S practices and correct training)
- Each chemical should be used in the recommended concentration, and great care should be taken to ensure that all chemicals are used in a correct and safe manner so that accidents can be avoided.
- All keepers should be trained in appropriate first aid, and aware of what containment is necessary should a chemical spill occur.
- Correct storage should always be maintained, as compounds within the chemicals can break down.
(A Titmuss, pers.comm.2007)

Radiation:

Common Marmosets have a high Vitamin D3 requirement, the main source of which is direct sunlight. As such, almost all enclosures are located primarily in the sun; thus any keepers working with this species may be exposed to excessive amounts of ultra-violet rays.

Prevention:

- Basic sun-care rules should be followed they include;
 - Sunscreen should be reapplied every two hours
 - A broad brimmed hat should be worn
 - Long sleeve shirts and pants
 - Sunglasses
- Time spent exposed to direct sunlight should be kept to a minimum.
(A Titmuss, pers.comm.2007)

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1 Introduction

Common Marmosets are one of the smallest species of primates in the world. Originating in Brazil, they are one of the most interesting and unique of the New World Primates. Adult males weigh in at 256 grams, while females are a mere 236 grams (Lang, 2005), the species is easily distinguished by their white ear tufts and grey and brown mottled coats. They are extremely active arboreal creatures, and as such make great exhibit animals, especially considering the extremely close relationships within the family group which makes them quite unique amongst primates; the Common Marmosets do not form „cliques“ as such within the larger group, instead working closely together to forage and raise young communally (Lang, 2005).

Common Marmosets are sought all over the world as a part of the international pet trade; this is definitely not a positive thing, as Common Marmosets (like all primates) require a complex family group, diet, and environment to remain healthy and „happy“ in captivity. Common Marmosets are also used extensively in scientific research due to their neurological and reproductive similarities to humans, as well as the ease with which they may be bred.

There is currently no species management (level 3) being conducted for Common Marmosets in the region; if this was present, the species has the potential to be successfully sustained while also maintaining genetic diversity. This is rare in the region due to numbers, limited programs being conducted, and the strict importation laws in place. (REGASP, 2008)

Common Marmosets are rated as 2 - *Extreme* by the Australasian Species Management Plan (ASMP). This means that a permit is needed to keep them in this region; they may only be kept in zoos or endorsed collections. In the event that they were to escape, the Common Marmosets could form a formidable population in the wild, and could potentially harm/damage native fauna and flora.

The International Union for Conservation of Nature and Natural Resources (IUCN) states that Common Marmosets are of *Least Concern*; this means that they have an abundant wild population that is presently stable. Similarly, the Convention of International Trade in Endangered Species of Wild Flora and Fauna (CITES) has listed Common Marmosets under their Appendix II; this means that while not threatened with extinction, the trade in Common Marmosets must be controlled in order to avoid utilisation incompatible with their survival.

2 Taxonomy

2.1 Nomenclature

Class: Mammalia

Order: Primates

Family: Cebidae

Genus: *Callithrix*

Species: *jacchus*

2.2 Subspecies

There are no subspecies of *Callithrix jacchus*. (Lang, 2005)

2.3 Recent Synonyms

As shown by the Intergrated Taxonomic Information System; Common Marmosets were originally named as *Simia jacchus* by Carolius Linnaeus. However this was changed in 1977 to *Callithrix jacchus* when Johann Christian Polycarp Erxleben developed several new genuses, making marmosets the sole members of the *Callithrix* genus instead of the *Simia* genus; they remain under this scientific name today.

2.4 Other Common Names

- True Marmoset
- White-tufted-ear Marmoset
(Lang, 2005)

3 Natural History

Common Marmosets are native to the South American country of Brazil, particularly the dry forests of the north-east; however they have also been introduced in limited numbers to neighbouring countries, including Argentina.

The Common Marmosets are diurnal primates. These small mammals are territorial, and uses specially developed throat glands to mark territory with scent markings. In the wild their home range can consist of between .005 to .065 km²; this will depend upon food availability and group size.

Members within the group will help to nurture and raise the young, assisting in duties such as carrying them and supplying them with food. They are active climbers and foragers and as such thrive in complex environments. (Lang, 2005)

Currently Common Marmosets are generally content in captivity, as previous research has led to their natural environment being replicated to a satisfactory standard. One area that would benefit from additional research would be how to accurately determine aging patterns in the species, as currently tagging and scrupulous record keeping are the only truly accurate means of tracking adult age.

3.1 Morphometrics

3.1.1 Mass and Basic Body Measurements

- Males weigh 256 grams, with a body length of 18.8 cm, and a tail length of 27.8 cm (average measurements).
- Females weigh 236 grams, with a body length of 18.5 cm, and a tail length of 25.8 cm (average measurements).(Lang, 2005)

3.1.2 Sexual Dimorphism

- There is very little difference in terms of sexual dimorphism in Common Marmosets. The males are slightly larger, averaging an extra 20 grams in weight and 3mm in body length and 2cm in tail length. All primates also have external genitals which is for most species of New World Monkey the easiest and most certain way of determining gender.

3.1.3 Distinguishing Features

- Common Marmosets have a mottled grey, brown, and yellow colouration. They have white ear tufts and long, banded tails. The skin on their faces is pale in colour, but darkens with sun exposure; they also have a blaze of white on their foreheads. Infants are born with a coat that is brown and yellow in nature, and develop the white ear tufts and forehead blaze as they grow older. (Lang, 2005)

3.2 Distribution and Habitat

Common Marmosets are endemic to Brazil (*see figure 3.2.a below*). They have a large territorial range which extends through the coastal forests of the extreme north-east; the Riverine, Savanna, and Serado forests in central Brazil; or the seasonal, dry, semi-deciduous forests inland from the Atlantic Coast and as far west as the Rio Grande and the states of Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, and Piauí.

Common Marmosets have been introduced to areas outside of their original habitat in Brazil. They can also be found in limited quantities outside of Brazil, including in the cities of Rio de Janeiro and Buenos Aires, Argentina.

This shows that the Common Marmoset can live in fairly diverse habitats, and can relatively easily adapt to life outside of their home range; however on the whole they prefer dry habitats with an average temperature of between 19 to 26 degrees Celsius. (Lang, 2005)

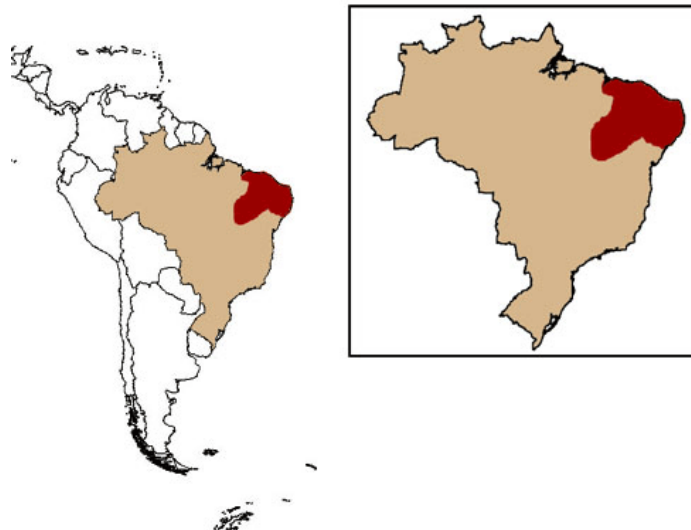


Figure 3.2.a
Map of South America – Brown section is the country of Brazil; Red section is area the Common Marmoset are concentrated in the wild. (Lang, 2005)

3.3 Conservation Status

According to the International Union for Conservation of Nature and Natural Resources (IUCN) the Common Marmoset is rated as „Least Concern“ in regards to their conservational status. Whilst the population in the wild is unknown, the IUCN rating means that the population is stable; this rating was last assessed in 2003. According to the International Species Information System (ISIS) the population of Common Marmosets within Zoos and other Wildlife parks is 614 as of 2006.

3.4 Longevity

3.4.1 In the Wild

- Common Marmosets typically reach 12 years in the wild; however due to their small stature and the difficulty of accurately tracking Marmosets, it is possible that there are individuals that have lived beyond the norm. (Lang, 2005)

3.4.2 In Captivity

- Common Marmosets typically reach 16 years of age in captivity (Lang, 2005); however cases have been recorded of individuals living beyond this. The oldest Common Marmoset recorded lived to be 22.8 years of age (Weigl, 2005).

3.4.3 Techniques Used to Determine Age in Adults

- Accurate record keeping is the primary method used to determine and keep track of adult Common Marmoset age. Another method of determining age is by dentition; tooth developments, as well as decay, are accurate ways of narrowing down the exact age of the Marmoset. Sedation is necessary when using dentition to determine age; using physical restraint would be far too stressful on the individual. (J Salkeld, pers.comm. 2007)

In terms of visual signs, a Common Marmoset has reached maturity when its white ear tufts are fully developed, and also by the completed white blaze on the forehead; these features have fully developed by 18 months, giving an indication of whether the animal has or has not reached maturity. (Lang, 2005)

4 Housing Requirements

4.1 Exhibit/Enclosure Design

A Common Marmoset enclosure should aim to meet both the physical and psychological needs of both the individual and the group as a whole. An enclosure should provide both a complex and stimulating environment with as many enrichment programs in place as possible, so as to promote normal behaviour and prevent boredom (Please refer to 9.7 *Behavioural Enrichment*). This is especially important with Common Marmosets as social interaction is highly important to normal development; therefore family groups or larger social groups should be aimed for. However an enclosure should have areas where individual monkeys can be alone or escape from others in the group should it feel the need; this helps to prevent aggression. (Please refer to 4.9 *Enclosure Furnishings*)

The legislation will vary depending upon state and local councils it is therefore important to check with both your state and local council legislations before acquiring Common Marmosets. In New South Wales an application must be made for a permit to keep and display Common Marmosets; this application must include an escape and recapture plan. Also it must be shown that the monkeys will not be exhibited singularly (unless in special circumstances where one is particularly anti-social or is not accepted by the group; in this case special approval may be given by the Director General of NSW Agriculture) and that steps will be taken to prevent abnormal behaviour patterns from developing. (*Please see 9.6 Signs of Stress for more details*)

Common Marmosets must be exhibited in an enclosure which resembles their natural habitat as closely as possible (including living/fresh vegetation that is not toxic to the animal please see Appendices A), both for the enrichment of the species and the education of the public. The natural habit of Common Marmosets is the tree tops of South America; thus they are an arboreal species that require climbing structure as far off the ground as possible and vegetation resembling the natural growth of South America, or at the very least of tropical rainforests. The majority of the enclosure must be out of sight range of any nearby exhibits that contain potential predators or other territorial primate species; however portions of the exhibit may be in visual range of predators and other primates so as to stimulate natural behaviour and will also in fact provide environmental enrichment.

Common Marmoset enclosures must allow the animals to be situated above the eye level of the public; Monkey pits are therefore not acceptable housing under any circumstances.

Lighting conditions within the enclosure must match as closely as possible the conditions found in their natural habitat; this includes ample direct sunlight. It should be noted that ultra violet (UV) lights are not a permanent solution to natural sunlight, as several essential vitamins in sunlight are not present in UV globes.

(EAPA Primate Policy, 2000)

Please refer to the entirety of section 4 *Housing Requirements* for specific enclosure requirements.

4.2 Holding Area Design

Generally speaking Common Marmosets can be housed solely in their exhibited enclosure (provided there is a nest box or other area where they can be confined if needed) as they are innocuous to keepers, and most activities can be carried out within the enclosure while the species is present.

Off-exhibit holding areas where Common Marmosets are held for longer than six weeks, or if they are regularly spending more than half of any 24 hour period, must meet the minimum enrichment, furniture and space requirements for exhibits as stated under NSW law; however naturalism is not required, but is preferred for the well being of the species. Any surplus animals unable to be exhibited must be placed at other institutions; individual Common Marmosets must not be housed in isolation for extended periods of time.

An exhibited area must be connected to any routine management holding areas so that the Common Marmosets can move easily between them. These connections must be designed so that the risk of the monkeys escaping and/ or being cornered and attacked is minimised (e.g. a circular raceway system); these connections must also allow the animal to use their normal methods of movement i.e. arboreal raceways.

All exhibits must have an area such as a nest box, raceway or night den suitable for physically isolating individuals for close examination or veterinary treatment. (EAPA Primate Policy, 2000)

4.3 Spatial Requirements

The minimum dimensions of a Common Marmoset enclosure, as stated in the *Exhibited Animals Protection Act*, for up to three adults, or two adults plus dependent offspring, is 2.5 meters width X 3.0 meters length X 3.0 meters height.

For each additional animal add at least 50 X 21cm (the maximum body length of the Common Marmoset) to the floor area; the minimum height of roofed enclosures is independent of the number of animals.

All Common Marmoset enclosures must contain a minimum of two climbing structures with a minimum of the indicated height. If staff routinely enter the enclosure, it must be possible for all the animals within to climb simultaneously to the minimum height indicated.

The enclosure must contain sufficient space (horizontally and vertically) so that natural locomotion can take place ; to protect them from undue dominance or conflict; to provide adequate nesting and feeding stations; and to meet the social, behavioural and breeding needs of the group both presently and through predicted growth. (EAPA Primate Policy, 2000)

4.4 Position of Enclosures

Common Marmoset enclosures must be constructed so that the animals can rest a minimum of two body lengths above the eye level of members of the viewing public; the exception to this rule is in the case of an enclosed public viewing area within a building; in this case the animals must be able to rest at least the eye level of any member of the viewing public.

It is preferable that the enclosure is positioned so as to receive morning sunlight, as Common Marmosets require high levels of Vitamin D3. (EAPA Primate Policy, 2000)

4.5 Weather Protection

Common Marmoset enclosures may be open, semi-enclosed or totally enclosed; an enclosure may also consist of islands surrounded by water. Sufficient shelter must be provided to allow protection from rain, wind and extreme temperature. There must be sufficient shade and sunlight for the animals; Common Marmosets require 500 International Units per day of Vitamin D3. (EAPA Primate Policy, 2000)

4.6 Temperature Requirements

Common Marmosets prefer a temperature range of 19 to 26 degrees Celsius, with low levels of humidity. Shelters within the enclosure should fall within this range to maintain the health of the species. A heat lamp must always be available at night or if the outside temperature is going to fall below 19 degrees Celsius during the day.

If the animals are housed indoors there must be sufficient air changes per hour to provide ample fresh air and to prevent an over abundance of odours and noxious gases. (EAPA Primate Policy, 2000)

4.7 Substrate

All natural substrate, or a mixture of artificial and natural substrate must be provided to allow for normal behaviour; these include scent marking and foraging. (EAPA Primate Policy, 2000)

With Common Marmosets, the preferable forms of substrates are leaf litter or mulch; it is best to use these as deep litter to effectively manage the avoidance of disease and the infestation of parasites (e.g. fleas, intestinal worms); appropriate drainage of the enclosure also helps to prevent these conditions from occurring. As Common Marmosets are extremely arboreal in nature they do not go to the ground very often, thus substrate is usually for the benefit of the public, drainage and to minimise pests. (M Radnidge, pers.comm.2007)

All primate enclosures should be deep meshed to prevent pests; specifically rodents and foxes for entering the exhibit. (M Radnidge, pers.comm.2007)

4.8 Nest boxes and/or Bedding Material

In a Common Marmoset enclosure there must be a raised nest box sitting at least 1 meter above ground; however it is preferable to be above this minimum, with 1.5 – 2 meters being optimal. The size of the nest box is completely dependent the number of individual animals housed, as well as whether breeding is possible. The NSW Exhibited Animals Act states that a nest box must be large enough for the whole family, with an entrance wide enough for an adult carrying young.

Some preferred types of bedding material for use within the nest box include: straw; refined leaf litter; and large-grade, unprocessed sawdust. Often a combination of these materials is used, both to provide added insulation and to provide material to be used in the event the Common Marmosets wish to build nests.

In addition to the nest box, sitting or sleeping perches at least 2.0 meters above ground and of sufficient number that each animal can be by itself must be provided; these perches must also support more than one animal for the purposes of mutual grooming and socialising. (EAPA Primate Policy, 2000)

4.9 Enclosure Furnishings

In general, enclosures must be furnished with horizontal, vertical and sloping pathways, shelves, and perches above ground level. New enclosures must include animal access doors at a level which allows the Common Marmosets to use their normal method of locomotion. The following are required:

- Sitting/sleeping perches must be at least 2.0 meters above ground. There must be enough for each adult animal to sit by itself. There must be enough room for two animals to sit on the one perch.
- Elevated nest box which fits the entire family. Entrance wide enough for adult carrying young.
- At least 4 horizontal pathways in the upper half of the exhibit. These must be a mixture of flexible and rigid materials (ropes, widely spaced rope netting, bamboo, tree limbs), and large enough to fit Common Marmosets.
- An elevated feeding platform at least 1.5 meters off the ground for each adult in the group. This food must be presented in a manner appropriate to the feeding behaviour of the species and designed to prolong feeding and foraging. Uneaten food must be minimised overnight to prevent rodent and ant infestation.
- At least two climbing structures of a minimum height of 3.0 meters.
- Sharp edges and broken wires must be eliminated.
- Enclosures must be well constructed and in good repair.
- Shelter must be provided to protect from wind, rain and extreme temperature.
- Access to shade and sunlight must be provided.
- Must include living or fresh vegetations.
- Furnishing must be provided to allow the Common Marmosets to sit 2 body lengths above the viewing public.
- Surfaces of resting places and perches must be roughened or otherwise textured so that they are not slippery when wet.

- Walls, floors and ceilings must be impervious and easily cleaned.
- Any ropes must be maintained in good condition. The ends must be sealed against fraying and heavy enough to remain taut when in use.
- There must be an area of the exhibit to which the animals can withdraw, either as individuals or as a group, to hide from an aggressor or the public. This may be provided by visual barriers; these should have escape routes to ensure the animal does not become trapped.
- Furnishings should aim to enrich all 5 senses of the Common Marmosets, and must also meet the behavioural and psychological needs of the group. Examples include replenishable material; manipulative objects; alterations to the substrate or climbing structures; placement of a scented object; or playing recordings of vocalisations from con-specifics.
- Alterations should not be so drastic that no familiar furnishings are left, especially those which are used for scent marking or other routine behaviours.
- Puzzle feeders, such as hollowed-out logs with small holes filled with supplement gum to encourage natural behaviour, are extremely beneficial.
(EAPA Primate Policy, 2000)

4.10 Barrier Requirements

In the event of using mesh or moat walls as a barrier for Common Marmoset enclosures, the following measurements from the *NSW Exhibited Animals Protection Act* must be applied:

- Minimum height of perimeter moat wall above maximum water level (m) = 0.25
- Minimum depth of water at perimeter moat wall (m) = 0.45
- Minimum moat width(m)= 2.0
- Minimum mesh wire diameter (mm)=0.80
- Maximum mesh dimensions (mm)= 12x12

As a general rule heights of moat walls and other fences must be measured from an adjacent ground level to which the animal has access. In the case of wet moats the height refers to the height above the maximum water level. (EAPA Primate Policy, 2000)

5 General Husbandry

5.1 Hygiene and Cleaning

It is important to note that any changing of furnishings within a Common Marmoset enclosure should be staggered so as to avoid removing everything at once; this is due to the fact that they are very scent orientated when establishing territory, and as such this sudden removal may cause distress. (EAPA, Primates Policy, 2000)

Personal Protective Equipment (PPE) and a high level personal hygiene should always be maintained when dealing with Common Marmosets as there are a lot of zoonosis that can pass between them and humans.

The following regime is separated into differing time periods; however take note that this is just a guide, and each step will vary depending on the circumstances of the individual exhibit:

Daily:

- Cleaning should be conducted at least once daily; this should include the removal of as much faeces as possible, paying particular attention to branches, window sills, raceways/crawl ways and other surfaces.
- Feedings platforms should be wiped over with F10 or an equivalent to help maintain good hygiene. *(Please see Appendices B)*
- Leaving food overnight should be avoided, and removed nightly if possible; this is to help prevent rodents, and in particular the diseases which they carry. This also helps to prevent ant infestations.
- Water should be changed on a daily basis; multiple sources of water should be located in the enclosure to provide the Common Marmosets with choice and to also cut down on contamination risks.
- If the enclosure has glass viewing windows these should be cleaned on a daily basis, to ensure easy viewing for the public and hygiene.
- If there are young within the enclosure, bedding should be partly changed daily and the nest box should be disinfected with F10 weekly; this is so that the young do not stress about lack of scent. (EAPA, Primate Policy, 2000)
- Any areas of concrete or other flat surfaces used as flooring should be hosed over at least once daily, and scrubbed with disinfectant regularly.

On demand:

- The nest box should be checked daily, but cleaned on demand; the regularity of this will depend upon what material the nest box is made from, how many individuals are being housed, and whether these are male or female (the ratio thereof).
- Branches need to be changed once they are smooth or once they are unhygienic for the individuals being housed.

Monthly:

- It is preferable to change the top layer of substrate once a month; however this may need to be done more regularly depending upon the amount of individuals being housed, weather conditions, the amount and type of shelter and the type of material used for the substrate. (M Radnidge, pers.comm.2007)

The chemical agents used to maintain hygiene will depend greatly upon the structure of the enclosure; if the chemical will have time to dry sufficiently then there are very few chemicals that cannot be used; however stronger chemicals such as bleach should be avoided if possible as unless they dry completely, the fumes and toxic nature of these chemicals can cause illness in Common Marmosets due to their small stature. A common example of this is chemical toxicity, brought about by inhaling fumes or licking chemicals; Common Marmosets are particularly susceptible to this condition. F10 is one of the most common disinfectants used as it removes most diseases, pathogens and foul smelling odours, and is not harmful to the animals. (J Salkeld, pers.comm. 2007)

Methods of pest control should be inbuilt into the enclosure; examples of this include the use of deep litter, and wire mesh (or other sufficient barriers) that travels underground (preferably a half meter or more) and around the edges of the enclosure. These combined with good hygiene will help to help to prevent rodents, flies, other insects and parasites from infesting the enclosure. (Radnidge, 2008)

5.2 Record Keeping

Records must be kept on any observed changes in behaviour, feeding, excretion, treatments (including veterinary), or changes in husbandry or diet. Wherever possible routine tests (such as body weight, faecal samples, etc) must be completed, and samples taken when an animal is being handled for husbandry or other purposes.

The *NSW Exhibited Animals Protection Act* states that the following must be complied with:

1) Identification

- *Each primate shall be individually and permanently identified by an appropriate method of identification*

2) Records

- *Establishments shall keep records of all primates on an individual basis in a form which can be quickly and easily examined, analysed and compared with those kept by other establishments.*
- *The records shall provide the following information:*
 - i) Identification number, common name, scientific name, any personal name and any distinctive markings;*
 - ii) Origin (details of parents and their origin and of any previous locations);*
 - iii) Dates of acquisition and disposal, with details of circumstances and addresses;*
 - iv) Date of birth;*

- v) *Veterinary records, including results of physical examinations, details and dates of any treatments, results of routine health examinations;*
 - vi) *Breeding (including mating, reproductive and behavioural cycles, parenting ability) and details of any offspring;*
 - vii) *Date of death and cause including results of post mortem reports;*
 - viii) *Normal diet;*
 - ix) *Any other specific details pertaining to the individual such as changes in behaviour or diet.*
- *Where an Australasian or international studbook exists for a primate species held by the exhibitor, records must be provided to the studbook keeper at least yearly or as required by the studbook.*
 - *Holder of surplus primates must actively seek to place their surplus animals into another institution capable of providing appropriate care and housing.*

For information

Surplus lists that include primates should be circulated in industry publications at least every three months.

3) Documents

- *All documents, records and other information pertaining to each animal including those from previous locations must be kept safely and maintained for the life of the primate plus five years.*
- *Animals moving to new locations must be accompanied by copies of all relevant records.*

(EAPA Primate Policy, 2000)

5.3 Methods of Identification

There are three routine methods used for identification purposes with Common Marmosets. These are micro-chipping (inserted via injection into the back of the neck); Ear tags (it is preferable to keep these small so as to remain aesthetically pleasing to the public); and tattooing. (J Salkeld, pers.comm. 2007)

5.4 Routine Data Collection

Please refer to *Section 8.1 Daily Health Checks* for information on Routine Data Collection.

6 Feeding Requirements

6.1 *Diet in the Wild*

Common Marmosets are omnivorous; they eat a varied diet consisting primarily of the gum (e.g. Acacia) or exudates of trees (this exudate provides a food source which is high in energy for when fruit is unavailable), as well as insects, spiders, fruit, flowers and nectar. They have also been observed to eat small lizards, frogs, bird's eggs and nestlings, although this is less frequent.

In the wild the Common Marmoset may spend up to 42% of their time throughout the day engaged in activities based around food; of this up to 30% of their time is spent foraging for food, and between 12% feeding. (Lang, 2005)

6.2 *Captive Diet*

Common Marmosets need to be fed a complex rotating diet to remain healthy in captivity; this is due to them being highly intelligent arboreal feeders. They are among the most omnivorous and opportunistic feeders within the primate family.

In captivity it can be challenging to provide Common Marmosets with an appropriate diet that is both nutritionally sound and complex. To achieve this, their captive diet should include but not be limited to: fruit, vegetables, insects, yogurt, eggs, and primate canned food.

Common Marmosets should be fed at least three times a day with at least one of these feeds being an activity feed. Morning feeds should consist of approximately 100grams of food per animal, midday feeds should consist of approximately 40 grams of food per animal; while night feeds should be small and should not contain fruit. Older Marmosets will need softer food (one method of achieving this is by soaking food in water and or blending food) as they often suffer problems with dentition (such as missing teeth). Pregnant or recently post-natal Marmosets should be offered more high-protein food due to sustaining themselves as well as their young. (A Wright, pers.comm.2007)

Where fruits and vegetables are concerned, diet will vary depending upon season and location; this isn't important and is in fact beneficial so long as correct levels of vitamins are maintained (especially vitamin C).

A Healthy diet should consist of the following daily:

- Acacia gum supplement should be given to primates daily; approximately 10 mLs per animal.
- A range of fruits and vegetables (40:60). A variety of fruits and vegetables should be given (a minimum of 8 different types) particularly those that are high in Vitamin C (A Wright, pers.comm.,2007) which include: Blackcurrants, Guava, Kiwifruit, Broccoli, Brussels Sprouts, Lychees, Papaya, Strawberry, Orange, Rockmelon, Cauliflower, Raspberries, Tangerines, Passionfruit, Spinach, Cabbage, Mango, Honeydew Melon, Tomatoes, Blueberries, Pineapple, Pawpaw, Grapes, Apricots, Plums. (Wikipedia, 2007)
- Good sources of protein and calcium include; cheese, boiled, eggs, crickets, mealworms, cockroaches, cat and dog kibble, and cultured yoghurt.
- Good sources of carbohydrates include; cooked pasta, some cereals and insectivore cake. (Wright, 2007)

It should be noted that onions, garlic and other types of herbs have been found to cause Heinz-body haemolytic anaemia in primates, and should thus not be included in their diet. Food items that are high in cholesterol should be avoided as it can cause similar health concerns as those found in humans. Overfeeding should be avoided as besides unhealthy weight gain, it can encourage selective feeding which in turn will allow the animals to eat only their favourite foods and thus not getting the entire necessary daily vitamin intake. (Wissman, Unknown)

Insectivore Cake Recipe:

Ingredients:

- 375 grams of self raising flour
- 250 grams of cottage cheese
- 125 grams of raw sugar
- 125 grams of cooking margarine
- 1 and a half tablespoons of vegetable oil
- 4 eggs

Method:

- Melt margarine and pour in blender with eggs, sugar and vegetable oil-blend
- Add flour to mix
- Add cottage cheese to mix
- Pour 30cm square cake tins and place in oven at 160 degrees Celsius for 90 minutes. (J Salkeld, pers.comm. 2007)

6.3 Supplements

Common Marmosets require 500 IU (International Units/12.5mcg [micrograms]) per animal per day of Vitamin D3. This can be achieved by allowing the animal ready access to natural sunlight or by given them dietary supplements containing this amount of Vitamin C. (EAPA, Primate Policy, 2000)

6.4 Presentation of Food

The *Exhibited Animals Protection Act - Primates Policy* states that all arboreal species of primates must be fed at least 1.5 metres off the ground so as to accommodate natural feeding behaviour and reduce faecal contamination; the only exception to this is activity feeds.

Besides the benefit of replicating natural behaviour, it also helps to prevent the attraction of rodents especially at night; this is dangerous as rodents carry diseases that can be fatal to Marmosets. To minimise the danger of contamination, over-ripe, liquid, and semi liquid foods should be offered on feeding trays or handed out individually.

Common Marmosets spend 35% of their time in the wild foraging for food, (Lang, 2005) and as such it is preferable that an enrichment schedule that encourages prolonged foraging is in place, as this encourages natural feeding behaviours.

Refer section 9.7.1 - *Dietary Enrichment Calendar* for a monthly enrichment calendar.

7 Handling and Transport

Common Marmosets, like all animals should be handled carefully and humanely, and in a way to designed to minimise the amount of stress possible. Any personnel involved in the capture, handling and restraint and transport of a Common Marmoset should be trained and familiar with all necessary techniques, procedures, protocols and natural behaviour, as well as be vaccinated against Hepatitis A and B. (J Salkeld, pers.comm. 2007)

7.1 Timing of Capture and Handling

The best time to capture and or handle Common Marmosets is first thing in the morning, as they are most likely to be in the nest box at this time of day and thus they will be easier to capture (causing less stress for the animal). Furthermore animals tend to be more docile at this time of day, making handling much easier. (Pers.obs.2007)

When capturing animals cannot occur first thing in the morning, the difficulty and stress on the animals increases dramatically; thus when this is the only option it is vital that the capture is done as quickly and efficiently as possible.

7.2 Catching Bags

The ideal catching bag used should be a fixed hooped fine-mesh net (“butterfly net”) with a diameter of approximately 40 cm, this will allow the Common Marmoset to fit comfortably through the hoop without being unwieldy. The net itself should be approximately 60 cm deep to prevent premature escape of the animal.

Catching bags should only be used for the initial capture; prolonged time in the net will heighten stress levels of the captured individual and the rest of the group. (J Salkeld, pers.comm.2007)

7.3 Capture and Restraint Techniques

Every exhibit should have a nest box, raceway, or night den suitable to allow for the physical isolation and subsequent capture and restraint of the animal, or for close examination and veterinary treatment. Common Marmosets are docile creatures and are not known for violence or aggression towards known keepers; however they will bite and scratch when alarmed, and as such every effort should be made to expose them to the least amount of stress possible.

The ideal and most used method of capture of Common Marmosets is listed in the previous section under the heading *7.2 Catching Bags*; chemical capture is not recommended as injury is more likely due to the Marmosets’ physical size.

Restraint may take the form of chemical or physical restraint or a combination of both, such as catching in a race or nest box, and subsequent sedation. It must be undertaken in the manner least stressful to the Marmoset and should not result in injuries. Restraint must be under the supervision of a senior keeper with extensive primate handling experience, or an experienced veterinarian.

Handlers should wear protective leather gloves. Hold the Marmoset by grasping behind the head and above the tail as this provides the most secure holding position. Most animals will take treats during this restraint, which can serve as a reward and enrichment during handling. If handlers are also keepers, different clothing should be worn during manual restraint procedures to minimise distress for the animals during other routine caretaking activities.

Simple procedures such as physical examinations, blood sample collection, and tuberculin testing can be accomplished with an intramuscular (preferably in the thigh) ketamine hydrochloride injection (5 – 10 mg/kg). Ketamine is the most preferable choice of anaesthesia due to quick onset, a wide margin of safety, little respiratory or cardiovascular depression, and a fairly rapid recovery time.

More prolonged procedures require supplementary anaesthesia, achieved by additional ketamine. This is injected intramuscularly, intravenously, or via an inhalation agent this will usually be ketamine or isoflurane; an inhalation agent is the preferred method for longer procedures. During these longer procedures, care should be taken to monitor and maintain core body temperature as this can drop very quickly in an anaesthetised animal.

Common Marmosets should be isolated in a confined area until all methods of chemical restraint have worn off; this prevents undue injury from occurring. (Murray, 1999)

7.4 Weighing and Examination

The EAPA (Exhibited Animals Protection Act) states that every opportunity must be taken to take samples and carry out routine tests (such as recording body weight, taking faecal samples, etc) when an animal is being handled for husbandry or other purposes, as recommended by a veterinarian with primate experience.

Any examinations that do not occur quickly should occur when the animal is in an anaesthetised state (See 7.3 *Capture and Restraint Techniques*).

The best method of gaining accurate weight readings is by conditioning individual Marmosets to stand on scales, or by conditioning them to remain still in a container which has been placed previous on the scales and zeroed. (Murray, 1999)

Adult Marmosets typically weigh between 230 – 260 grams. Newborns weigh between 25-35 grams; weaning individuals weigh 60 grams at the start of weaning and reach 150 grams by the end; weight gain is approximately 0.83 grams per day. (Zuhlke, Weinbauer, 2003)

7.5 Release

In general, Common Marmosets should be released as close to the centre of the exhibit as possible, and at ground level near a tree that can be climbed rapidly; this applies whether being handled, confined in a transport box. It also applies regardless of whether the animal is being released back into its enclosure, or whether it is being introduced for the first time.

When released, the time of day is an especially important consideration for those Marmosets that are being introduced into a new exhibit; in this case morning is preferable as they will have a full day of sunlight in which to become acclimatized to their new surroundings.

In the case of those animals that are new to the collection, it is very important that the Marmosets are given enough time to adapt to their new environment before interaction with keepers occurs. (Sodaro, 1999)

7.6 Transport Requirements

There are numerous factors that one must consider when transporting Common Marmosets. The Exhibited Animals Protection Act (EAPA) and International Air Transport Association (IATA) rules must be followed at all times. Below are several points quoted from the 25th Edition of IATA Live Animal Regulations that must be complied with when transporting all primates:

- *Monkeys from different continents must not be shipped together nor come in airborne contact with each other in aircraft holds, airport cargo warehouses, animal holding facilities, and during all phases of ground transportation.*
- *There are a number of contagious diseases carried by monkeys communicable to man, consequently, care must be taken to avoid physical contact with the animal and full personal hygiene precautions must always be taken. Monkey container ventilation openings must be covered with muslin or other light material that does not occlude ventilation to prevent possible inhaling of infectious droplets by handlers.*
- *Monkeys from different continents must not be shipped together nor come in airborne contact with each other in aircraft holds, airport cargo warehouses, animal holding facilities, and during all phases of ground transportation.*
- *Adult monkeys must be crated individually or separated by partitions, unless they are used to each other.*
- *Mature males will become upset by the presence of females in heat. Therefore, accepting females in this condition for shipment must be avoided whenever possible. If it is necessary to accept male and female monkeys, each sex must be in its own container and the containers separated from each other as far as possible.*
- *Pregnant females and females with suckling young must not be accepted for air transport.*

- *Young animals must not be separated from one another as this increases stress. They must be in partitioned containers or in separate containers loaded adjacent to each other in the aircraft.*
- *Animals of the same species and size may be shipped together in the same container only if they have previously been contained together. Otherwise, they must be carried completely separately. Care must be taken to prevent any possibility of snapping and disturbing one another.*
- *For monkeys which are obviously disturbed by the shipment, reducing the light within the container and the noise level within its vicinity will usually be sufficient to quieten the animal. They must preferably be held in a darkened area with as little noise as possible nearby.*
- *Because all primates are CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) listed species, it is imperative that all the appropriate CITES documentation be completed before acceptance of the shipment and such documents must accompany the shipment as well as the usual shippers and health certification.*
- *It is a CITES prerequisite that all CITES listed species are packed and shipped in accordance with the IATA Live Animals Regulations. It is also a legal requirement by many governments which have incorporated these regulations into their national legislation bin regards to the shipment of live animals by air. Therefore care must be taken that compliance is evident at the time of live animal shipment acceptance.*
- *It must be noted that the IATA Live Animals Regulations container requirements stipulate the minimum requirements for air shipment. The construction principle of containers described within these regulations are not intended to conform any air worthiness requirements. Structural aircraft containers must comply with the specifications published in the IATA ULD Technical Manual.*
- *The size of the aircraft compartment door and the area of the aircraft hold must be considered when determining the size of the container to be used.*

7.6.1 Box Design

Common Marmosets fall within the IATA Container Requirement 31 standards, and as such any containers built must abide by the following:

- Environmental Considerations/Requirements:
 - These animals are affected by temperature changes and severely affected by temperature extremes. Care must be taken to ensure that they are not subjected to drafts. Most species can withstand reasonable variations in temperature but exposure to the wind or to a draft can be fatal. Therefore, consideration must be given not only to the temperature changes, but also to the chill factors involved.

On the other hand, these animals must not be exposed to direct heat, such as placing them in sunlight or against hot radiators. Monkeys unavoidably subjected to extreme heat must be cooled so as to prevent dehydration or heat prostration. During prolonged transit stops, when the ramp temperature exceeds approximately 20 degrees Celsius, the aircraft compartment doors must be opened and, in extreme temperatures, ground equipment must be used to ventilate the compartments. The different climactic factors prevailing during a journey must always be considered when arranging the routing and carriage of these animals.

- Container Requirements:

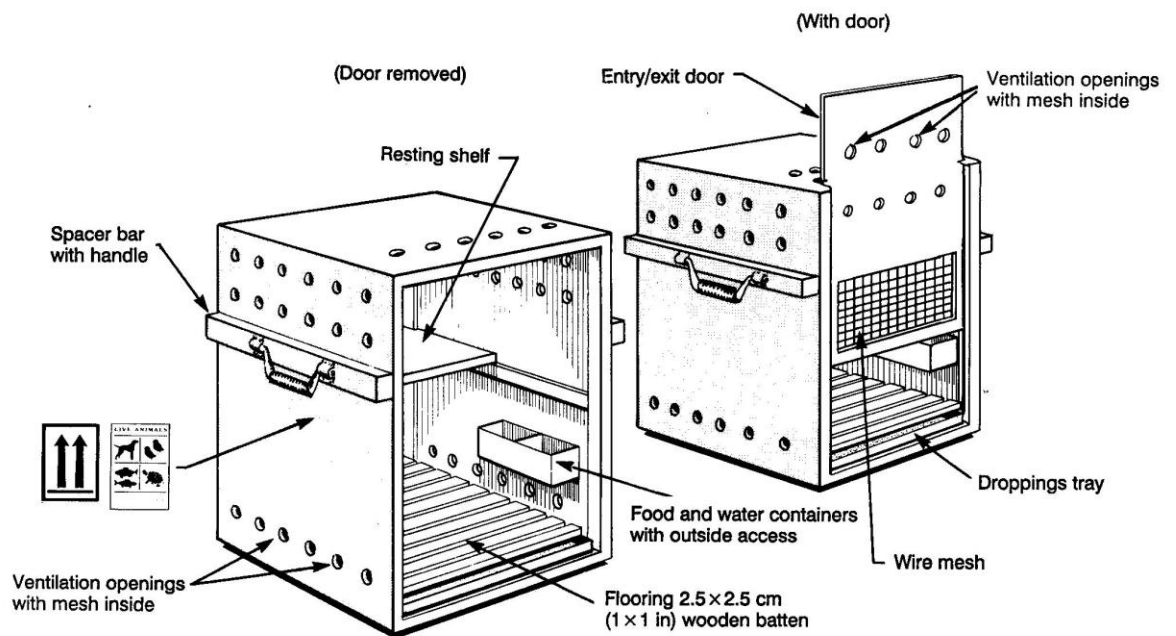


Figure 7.6.1.a-Diagram of Container Requirements 31-compliant transport container

- It is natural for these animals to investigate their surroundings and try to escape. With very few exceptions, these animals do not willingly accept confinement. They become frustrated and will often make determined efforts to escape.

- These animals instinctively fear the strange environment encountered during transportation. Therefore, in transporting these animals, there are a number of basic principles with which the shipper and the carrier must comply as these effect the welfare and comfort of the animal. This, in turn, has a bearing on the animal's behaviour during air transportation as the strain may cause the necessary stimulus for the animal to become difficult. Therefore, the container must be constructed to adequately contain and restrain the animal.
 - The container must be correctly labelled. Labels must not block ventilation holes, especially on small containers. Any labelling, especially on small containers, must not occlude ventilation openings.
 - When animals are carried in SPF (Special Pathogen Free) conditions, the shipper must at least comply in all respects with the specific container requirement in this section. Special measures must be taken to ensure that ventilation rates are maintained within the container.
- Container Design Principles:
 - Primates must be carried in closed containers. The containers must be well constructed. Dimensions, where stated, are length X width X height.
 - The container must be well constructed and able to withstand other freight damaging it or causing the structure to buckle or bend. It must be rigid enough to prevent the animal escaping through gaps at the seams or joints. Certain species require reinforced containers due to size and weight.
 - It must be constructed of non-toxic materials. Chemically impregnated wood may be poisonous, and therefore must not be used.
 - The container must be suitable to keep the animal inside at all times and protect the animal from unauthorised access. The door must be constructed so that accidental opening cannot occur from the inside or outside.
 - The container must not cause the animal to damage itself. All inside edges must be smooth or rounded. There must be no sharp projections, such as nails, upon which the animal can injure itself. Joints of a wooden container must be made so that they cannot be damaged by the animal gnawing or clawing the container from inside.
 - The container must be clean and leak-proof. If the container is to be reused, it must be cleaned thoroughly and then either disinfected or sterilised prior to reuse. Absorbent bedding must be provided by the shipper that is suitable for the species. Straw is unacceptable as many countries prohibit its importation.
 - It must be easy for staff to handle and provide the handlers protection from being clawed or bitten by the animal. Spacer devices must be incorporated into the design as they will provide handles for moving the container as well as preventing the ventilation openings becoming blocked by other freight. Handles may be attached in addition to the spacer bars.

- If forklift spacers are required they must be at least 5 cm thick. Allowance for the extra height must be made when calculating the dimensions of the container.
- Materials:
 - Wood, metal, wire mesh, muslin, other light material.
- Frame:
 - Solid wood, screwed or nailed and glued with non-toxic glue, metal or non-toxic plastic.
- Sides:
 - Wood, metal, or plastic. The front must consist of a 2/3 solid panel with ventilation openings above a 1/3 wire mesh.
- Handling Spacer Bars/Handles:
 - Must be provided as shown in the illustration on three sides of the container.
- Floor:
 - The base of the container must be solid and leak-proof. A slatted floor made of 2.5 X 2.5 cm battens spaced at 0.5 – 1 cm intervals and covered with absorbent bedding must be placed over a droppings tray, with a locking device fitted into the base of the container. If a droppings tray is not provided then there must be sills at both the front and rear of the container to prevent excrement escaping.
- Roof:
 - Solid but with meshed ventilation openings optional
- Door:
 - Either the front of the container can be constructed as a vertical sliding door or a rear hinged or sliding door, extending the whole height of the container, must be provided. In either case the door must be fastened with tamper proof fastenings.
- Interior:
 - For [Common Marmosets] a resting shelf of 1/3 the length of the container must be provided in the rear of the container.

- Ventilation:
 - The container must be adequately ventilated on at least three sides, with the majority of the ventilation being provided on the upper part of the container. The ventilation openings must be small enough so that any part of the animal cannot protrude from the container and they must be covered with a light material such as muslin.
 - Meshed ventilation openings, approximately 2.5 cm in diameter, must be provided along the base of the two long sides and in the upper 1/3 of the sides and front of the container. Whenever openings are covered by mesh, care must be taken that there are no sharp edges present within the container; all edges must be covered with a smooth material that is tamper-proof. A muslin or similar material, curtain must cover all ventilation opening including the front.

7.6.2 Furnishings

As mentioned above, a resting shelf 1/3 the length of the container must be provided at the rear; this should be raised and have absorbent bedding such as sawdust; however straw is not acceptable as in some countries this is classed as importation.

7.6.3 Water and Food

Feeding and watering instructions must be affixed to the container and a copy should be with the documentation. Any water or food given must be recorded on the container instructions with the date and time given. Food will be provided by the shipper, but it must be ensured that this food does not break the transit of importation laws of any country. In the case of sealed containers, feeding is not possible and the shipper must be made aware of this fact. Animals do not usually require additional feeding or watering during the first 24 hours; however should undue delays occur the following points from the IATA 25th Live Animal Regulations must apply:

- *“If feeding or watering is required due to an unforeseen delay, cereal or appropriate primate food, bread and non-citrus fruits, must be provided but care must be taken not to overfeed. After offering water, the water container must be removed as if they are not monkeys will splash themselves and become wet and chilled.”*
- *Separate food and water containers must be provided, either revolving or fixed. If fixed inside the container they must be placed at a height that does not allow the animal to sit upon it and there must be outside access for filling and emptying which does not allow the animal any chance of escape. These containers must have rounded edges and be made of non-toxic material suitable for the species. Shipper’s instructions for feeding and watering must be given in writing at the time of acceptance. Water containers should only be filled to demand and must be emptied after use.”*

7.6.4 Animals per Box

Common Marmosets fall into the category of multiple species per container, and as such there is no limit on the amount of animals provided that the container has enough space for each animal to stand, turn, and lie down in a natural manner.

Animals that have not been transported together previously should be transported in separate containers.

Adult males will become upset by the presence of females which are in heat. Accepting females in this condition for shipment must be avoided whenever possible, but if it is unavoidable to accept male and female monkeys, each sex must be in its own container and the containers separated from each other as far as is possible.

7.7 Timing of Transportation

If possible, the timing should be worked out so that debarkation occurs during daylight (preferably morning) so that the Common Marmosets can have the maximum amount of time to adapt to their new surroundings.

8 Health Requirements

8.1 Daily Health Checks

The following health checks should be carried out at least once daily (note that keepers showing signs of illness, particularly strains of herpes, should not come in contact with Common Marmosets as minor illnesses amongst humans can often prove fatal to them):

- The locomotion of the Common Marmoset should appear normal; all limbs should appear to be moving freely and without causing physical discomfort and the full range of movements should be present (running, climbing, etc).
- Eating and drinking habits should be monitored and assessed to ensure that the Marmoset is eating enough food, is hydrated properly, and is also eating the correct amounts of the different foods available (for example vitamin C rich foods) to ensure that all nutritional needs are met.
- The eyes should be checked to ensure that they are completely open and functional, with no discoloration, swelling, discharge, or any other abnormalities present.
- Ensure that the general appearance of the Common Marmoset falls within the healthy weight range, and that physical signs of malnutrition, injury or illness are not present.
- The condition of the coat should also be observed, both for any visible sign of ectoparasites, as well as any other abnormalities; it should be noted that experience has shown that some Marmosets will naturally release more oil into their coats during the colder months, and this is theorized to be used as an insulator, and is most likely an adaption to a colder climate.
- Any discharge, be it nasal, ocular, genital or anal, should be noted and further investigated as these are (especially in the case of nasal discharge) often the first physical signs of illness.
- Any changes in relative behaviour should be observed, as these are usually the first sign of illness, injury, and many other ailments. Note that the time of year should be taken into account when noting changes in behaviour (e.g. breeding season).
- The consistency of faecal matter should be firm, the colouration should be normal, and it should be without blood or parasites.
- Other physical signs such as cuts, bruises, rashes, etc. should immediately be investigated and treated accordingly.
- Whilst not directly related to the Marmoset's health, any pests (e.g. rodents, insects) should be noted, as these will often carry diseases which are harmful, possibly fatal, to Common Marmosets.

(J Salkeld, pers.comm. 2007)

8.2 Detailed Physical Examination

8.2.1 Chemical Restraint

Simple procedures such as physical examinations, blood sample collection, and tuberculin testing can be accomplished with an intramuscular (preferably in the thigh) ketamine hydrochloride injection (5-10mg/kg). Ketamine is the most preferable choice of anaesthesia due to quick onset, a wide margin of safety, little respiratory or cardiovascular depression, and a fairly rapid recovery time.

More prolonged procedures require supplementary anaesthesia, achieved by additional ketamine. This is injected intramuscularly or intravenously. Inhalation of anaesthesia can also be accomplished via an induction chamber, facemask, or endotracheal tube (in emergency cases, this is done through intubation, which is considered to be fairly difficult due to the small stature of the Common Marmoset); the typical gas used in this case is isoflurane.

During these longer procedures, care should be taken to monitor and maintain core body temperature (thermoregulation) as this can drop very quickly in an anaesthetized animal. Heat loss can be prevented by maintaining the Marmoset on a heated water blanket and, where possible, to use a towel to cover the animal. Rubber gloves, or other similar bladders, can be filled with warm water and placed around the animal to further prevent the loss of heat. Bladders tend to lose heat rapidly; due to this it is vitally important that they are checked and changed regularly, otherwise the animal will lose body heat alongside the bladders. Alcohol and sterile solutions should be used to the maximum effect to both stop infection and minimise heat loss.

If possible, intravenous catheters should be employed to help maintain hydration levels during the procedure. The femoral (thigh), saphenous (back of leg) and antebrachial (along the arm, difficult to locate) veins are all possible locations which can be used for the insertion of a catheter.

Common Marmosets should be isolated in a confined area until all methods of chemical restraint have worn off; this prevents undue injury occurring. (Murray, 1999)

8.2.2 Physical Examination

Complete physical examinations should be performed on the Common Marmosets routinely, and it is recommended that this should happen at least once annually. Regular scheduling is preferable compared to performing exams as opportunity allows.

A complete physical examination should include an evaluation of all bodily systems and functions, blood work, a dental exam, parasites and other diseases, external body condition, reflexes, faecal culture and vital statistics (such as temperature and weight). A tetanus vaccination should also be administered bi-annually during this examination. This examination will most likely require the physical and/or chemical restraint of the animal (see 7.3 *Capture and Restraint Techniques* and 8.2.1 *Chemical Restraint*).

Blood samples should be collected during each physical examination. The femoral vein, cubital vein, jugular vein, cephalic vein and saphenous veins are the best collection sites for this. Blood collection will usually require physical or chemical restraint. ((J Salkeld, pers.comm. 2007) , 2007)

The average body temperature of the Common Marmoset is approximately 37.5 degrees Celsius, and the average adult weight is 236g (female) and 256g (male). (Lang, 2005) A faecal culture should be performed to screen for common pathogens such as *Salmonella*, *Klebsiella*, *Campylobacter*, *Yersinia*, and *Shigella*, as well as worms or other parasites.

The complete physical exam itself should consist of the teeth being examined and cleaned if necessary; tests should be conducted for any common illnesses (especially tuberculosis and hepatitis B, as these are zoonotic), signs of physical injury should be assessed. Reflexes and locomotion should be tested, as should vision, hearing, sense of smell, etc. (J Salkeld, pers.comm. 2007)

8.3 Routine Treatments

Regular de-worming should occur twice yearly (in times of heavy rainfall additional worming may be required). Faecal floats should be conducted a week prior to worming to determine what types of worms are most prevalent; the type of wormer used will be dependent upon the findings of this test. If there is no real burden of worms present, a wormer should be chosen which differs chemically from that last used, so as to prevent immunity from developing within the parasites.

While individual brand names may differ, some of the main different types of active ingredients found in wormers are Ivermectin, Fenbendazole, Praziquantel, Febantel and Pyrantel.

Ivermectin-based medications are typically effective against most types of worms except tapeworms, and are also successful in the treatment of lice and mites.

Fenbendazole is extremely powerful in the treatment of a variety of parasitic infections, and is effective against all types of treatable worms.

Praziquantel, Febantel and Pyrantel are typically used together in the one medication, and are general wormers, but are particularly effective against gastro-intestinal parasites. (M Radnidge, pers.comm.2008)

Whilst it is possible to immunise Common Marmosets against several different zoonotic diseases (e.g. tuberculosis, hepatitis B), this is not general practice in most zoological or wildlife establishments, and is usually restricted to laboratory colonies. This is due to larger amount of exposure within medical testing laboratories, and the generally lacking condition of their immune systems. Furthermore populations within zoological facilities tend to be both larger and better protected due to healthy conditions, isolation from other species, immunised keepers free of zoonosis and good hygiene policies. (M Radnidge, pers.comm.2007)

8.4 Known Health Problems

Below is a list of commonly occurring diseases within the Common Marmoset species. Note that zoonotic diseases are marked as such.

8.4.1 Bacterial Diseases

Salmonellosis (Zoonotic)

Cause: Strains of the *Salmonella spp.* bacterium, particularly the *Salmonella Enterica* strain. This originates primarily in food items, particularly those coming from poultry (such as raw eggs); however the bacteria can infect a variety of carriers, including rodents, birds and insects,(Wikipedia, 2007) and the most common cause of Salmonellosis in Common Marmosets is through eating the faeces of infected carriers. (Unknown, VCM 656)

Signs: Lethargy, diarrhoea (possibly with mucous), gastroenteritis, nausea, vomiting, abdominal cramps, anorexia, fever, dehydration, possible death. (Crab, 1998)

Prevention: Sanitisation of food contact surfaces using a food-contact safe sanitiser (Such as a Quaternary ammonium and alcohol combination). Thorough cooking of food where applicable, particularly food which has been refrigerated. Good husbandry practices, as *Salmonella* thrives in poor hygiene areas such as bedding. Prevention of rodent, insect or bird infestation, and thorough disinfecting and rapid removal of faeces.

Treatment: Infected Marmoset should be quarantined from the group. Fluid and electrolyte replacement therapy should occur primarily, and the Marmoset's immune system should be able to resolve the disease. Antibiotics should be used to treat particularly serious cases. (Unknown-VCM 656)

Campylobacteriosis (Zoonotic)

Cause: Strains of *Campylobacter spp.* Bacterium, particularly *Campylobacter jejuni*. (Rand, 2007) This originates primarily in poultry (such as raw eggs); however the bacteria can infect a variety of carriers, including rodents, birds and insects, (Wikipedia, 2007) and the most common cause of Campylobacteriosis in Common Marmosets is through eating the faeces of infected carriers, and is also present in water supplies unless these are chlorinated. (Rand, 2007)

Signs: Lethargy, diarrhoea, nausea, weight loss. (Rand, 2007)

Prevention: Sanitisation of food contact surfaces using a food-contact safe sanitiser (Such as a Quaternary ammonium and alcohol combination). Thorough cooking of food where applicable, particularly food which has been refrigerated. Good husbandry practices, as *Campylobacter* thrives in poor hygiene areas such as bedding. Prevention of rodent, insect or bird infestation, and thorough disinfecting and rapid removal of faeces. (Wikipedia, 2007)

Treatment: Infected Marmoset should be quarantined from the group. Fluid and electrolyte replacement therapy are very important; after this the Marmoset's immune system should be able to resolve the disease. Oral erythromycin has been successful in treating *Campylobacter*. (Rand, 2007)

Shigellosis (Zoonotic)

Cause: This condition is caused mainly by the *Shigella flexneri* bacterium. This bacterium is typically food borne in raw vegetables, eggs and dairy products which have not been cleaned properly after contact with a contaminated individual; in the case of Common Marmosets, it is most likely that they will be infected through contact with contaminated food, the hands of a contaminated keeper, or through ingestion of contaminated faeces. (Rand, 2007)

Signs: Watery, odd smelling faeces containing blood and mucus, anorexia, lethargy, fever, dehydration, abdominal pain, and death. (Rand, 2007)

Prevention: Sanitisation of food contact surfaces using a food-contact safe sanitiser (Such as a Quaternary ammonium and alcohol combination). Food should be washed thoroughly prior to being fed out. Good husbandry practices, particularly in washing hands after contact with faeces as *Shigella spp.* typically infects through hand-to-hand or hand-to-mouth contact. All faeces should be rapidly removed, particularly if infection is suspected. (Wikipedia, 2007)

Treatment: Infected Marmoset should be quarantined from the group. Fluid and electrolyte replacement therapy are extremely important; enrofloxacin has been successful in treating Shingellosis. (Rand, 2007)

Yersinia (Zoonotic)

Cause: *Yersinia* is a type of bacteria, with the most well known strains being *Yersinia pestis*, *Yersinia enterocolitica*, and *Yersinia pseudotuberculosis*. All strains of *Yersinia spp.* are thought to be carried by birds, rodents and blood-sucking parasites on the rodents.

Signs: Diarrhoea, depression, dehydration and death.

Prevention: *Yersinia spp.* are rare in Australia; however care should still be taken to ensure that rodent infestation are prevented and/or eliminated.

Treatment: Antibiotics should be administered for the bacterial infection itself, although it should be noted that many strains have developed resistance or immunities to certain types of antibiotic. Individual conditions caused by the bacteria should be treated as appropriate; many of the diseases caused by *Yersinia spp.* are often fatal. (Baskin, Unknown)

Tuberculosis (TB) (Zoonotic)

Cause: Mainly caused by *Mycobacterium tuberculosis* bacterium. Transmission is through bodily fluids or short-distance airborne (aerosol effect, i.e. sneezing). Marmosets are resistant to TB, and as such the disease rarely occurs; however when it does it occurs as a slowly progressing respiratory disease.

Signs: Laboured breathing, coughing up blood, prolonged coughing fits, fever, chills, appetite loss, weight loss, and fatigue are common symptoms; however death often occurs before clinical signs occur.

Prevention: TB is usually contracted in captive Marmosets through their keepers; as such all keepers should be immunised against tuberculosis. Other sources of infection are Old World Monkeys; these should be quarantined until it is certain that TB does not exist. While expensive, all Common Marmosets should be vaccinated against tuberculosis if at all possible. Tuberculosis testing should occur regularly and routinely.

Treatment: While it is occasionally possible to treat cases of tuberculosis which are noticed sufficiently early, it is unlikely that the outcome will be anything other than death; as such the most common treatment for TB infection is euthanasia as the disease is highly zoonotic and the Marmoset, assuming it survived, would have to be quarantined for the rest of its life. (Rand, 2007)

Tetanus

Cause: Tetanus is caused by the bacteria *Clostridium tetani* which exists naturally outdoors, and occurs through wound contamination (deep cuts or puncture wounds), and would only usually occur through self-injury or accidentally injury.

Signs: Lockjaw, difficulty swallowing, muscle stiffness, spasms, subsequent infection, fever.

Prevention: Potential causes of injury such as sharp objects, fencing, sharp corners, etc. should be removed or minimised within the enclosure. Where injury does occur, wounds should be disinfected and bound where appropriate. If serious violence occurs within the group, it may be prudent to separate the offending Common Marmosets to prevent injury and possible infection.

Treatment: The anti-infective drug Metronidazole is typically used to treat tetanus, and is successful in most cases. (Whilst this drug is most commonly used in humans, medications in most cases will cross over and be useable in primates)(Wikipedia, 2007)

8.4.2 Fungal Diseases

Candidiasis (Zoonotic)

Cause: A yeast-based fungal infection, the most common strain which causes this is *Candida albicans*. This fungal disease typically occurs in Common Marmosets which are already ill, particularly those individuals already on long-term antibiotics as many types of these will eliminate other competing microorganisms within the body, helping to spread the fungal infection. (Baskin, unknown)

Signs: Itchiness, swelling of the affected area (usually a moist area such as the mouth or genitals), sores, rashes, white discharge from the vulva (in females). (Wikipedia, 2007)

Prevention: The primary means of preventing candidiasis is through maintaining good nutrition and health levels for the Common Marmosets in the collection, as this infection typically presents in individuals already ill; furthermore in the case of antibiotic treatment for an existing illness, long-term treatments should be avoided unless absolutely necessary.

Treatment: Most antibiotics have the effect of accelerating the spread of this disease; however antifungal treatments will quickly eliminate the disease. (Wikipedia, 2007)

Pneumocystis Pneumonia (PCP) (Zoonotic)

Cause: The *Pneumocystis jirovecii* is a yeast-like fungus is the cause of PCP; this was once thought to be a protozoan titled *P. carinii*. Infection occurs in Common Marmosets whose immune system has already been compromised, most typically by other illnesses. The disease is spread by aerosol (e.g. sneezing, coughing), and will typically quickly spread to other Marmosets within the collection.

Signs: Fever, cough, lung lesions, laboured breathing, possible death.

Prevention: The primary means of preventing PCP is through maintaining good health and nutrition levels for the Marmosets in the collection; where infection is suspected, the Marmoset should be immediately quarantined so as to avoid the spreading of the disease. (Baskin, unknown)

Treatment: Antipneumocystic medications and steroids are the typical means of treating PCP; however, like most forms of pneumonia, the usual outcome of this disease is death and as such, especially due to the infectious nature of the disease, euthanasia is often recommended. (Wikipedia, 2007)

Ringworm (Tinea) (Zoonotic)

Cause: Ringworm, despite the name, is actually a form of fungal infection, and is a very common condition which often occurs on moist, damp skin, particularly within skin folds. The disease is highly contagious, and can spread easily through skin-to-skin contact, or through contaminated items.

Signs: One or more inflamed, itchy patches of skin with defined edges, scaling of the skin, hair will fall out of affected areas, affected nails or claws can discolour, deform, crumble, and eventually fall off.

Prevention: Where possible, efforts should be made to prevent the Marmosets from being exposed to prolonged moisture or damp; this includes the removal of non-drinking water, and wet substrate (if possible). Infected individuals should be isolated so as to prevent the transmission of the infection; bedding and any items they may have touched should also be disinfected.

Treatment: In severe cases oral-fungicide should be given for at least a week to guarantee the removal of this strain of fungus; while this is difficult to accomplish with Common Marmosets, this disease will continuously reoccur unless completely wiped out. Also, efforts must be maintained to keep the affected animal dry during this time. (Unknown, 2007)

8.4.3 Protozoal Diseases

Cryptosporidiosis (Zoonotic)

Cause: Caused primarily by the protozoal parasite *Cryptosporidium parvum*, and infects the Common Marmoset through ingestion of contaminated material, most typically fresh or rain water or wet soil, or faeces belonging to an infected host (most mammals are susceptible to the disease).

Signs: Diarrhoea and dehydration, some infected individuals will show no signs of the disease while still being infected.

Prevention: Drinking water should be tap-water, as all water supplies in New South Wales are chemically treated to prevent cryptosporidiosis; other water supplies should be boiled before use, and pools of rainwater should be removed as soon as possible from the enclosure, as should mud caused by rain or faeces belonging to wild or possibly infected animals; keepers should also observe good husbandry and hygiene practices before contact with the Marmosets.

Treatment: Common Marmosets which are otherwise healthy should be quarantined and hydrated until the disease runs its course (usually 1-2 weeks); Marmosets which are already immune-compromised through other illness, however, may require intravenous hydration and anti-diarrhoeal medication. (Rand, 2007)

***Entamoeba histolytica* (Zoonotic)**

Cause: *Entamoeba histolytica* is typically transmitted to Common Marmosets through the ingestion of infected faeces (e.g. from rodents), or through the ingestion of contaminated food, water or insects

Signs: Diarrhoea with blood and mucus present, vomiting, severe ulcerative enterocolitis.

Prevention: Good nutrition and health are primary methods of preventing and limiting the spread of this infection. It is important to prevent infestation of rodents or insects within the enclosure, and to remove any faeces rapidly. Good husbandry and hygiene practices should be observed when in contact with the Marmosets or their food/water. Infected animals should be quarantined, and anything that they have touched (e.g. bedding, food bowls, etc) should be decontaminated.

Treatment: These protozoa can only be diagnosed through examination of a fresh stool sample. Once diagnosed, the Marmoset must be quarantined, kept well hydrated (intravenously if necessary). (Rand, 2007)

Toxoplasmosis (Zoonotic)

Cause: Caused by the protozoa *Toxoplasma gondii*, this disease occurs in Common Marmosets mainly through the ingestion of infected insects, infected faeces, raw meat, rodents, contaminated water, contaminated food or transplacental transmission (mother to unborn child/ren).

Signs: Decreased appetite, anorexia, weakness, lethargy, crouching, fever, coughing, nasal and ocular discharge, abortion, coma, and eventual death.
(Baskin, Unknown)

Prevention: Good husbandry and hygiene practices are the primary means of preventing this disease from occurring; water supplies should be from a certified source (e.g. tap-water) and/or boiled, and food preparation areas should be consistently cleaned and disinfected, as one of the primary sources of this disease is through food contact with infected raw meat. Insect and rodent infestation should be prevented, and faeces should be removed as quickly as possible. Females suspected of being infected should be quarantined and prevented from falling pregnant until diagnosed and cured if possible. (A Titmuss, pers.comm.2007)

Treatment: The disease is diagnosed through examination of a faecal sample. If diagnosed early the disease can be treated with a combination of anti-infection medication such as Metronidazole, and some antibiotics. However in cases, in which the disease is not diagnosed early, it will cause irreversible damage and euthanasia may be preferable. (J Salkeld, pers.comm. 2007)

8.4.4 Endoparasites

***Enterobius vermicularis* (Pinworm) (Zoonotic)**

Cause: Eggs containing pinworms are transferrable through skin contact, or contact with contaminated items, and the most likely cause of this parasite occurring in Marmosets is through a contaminated keeper.

Signs: Itchiness of the peri-anal area; tape may be used against the anus area to discover egg infestation. (J Salkeld, pers.comm. 2007)

Prevention: Good husbandry and hygiene practices are the primary means of avoiding infection; keepers should always thoroughly wash their hands before and after contact with the Marmosets themselves, as well as food stuffs, water, and any other object which will come into contact with them. Marmosets which show signs of infection should be quarantined and treated.

Treatment: This parasite should have no ill-effect beyond the general itchiness caused to the anus area except in rare circumstances. Pyrantel painoate and Fenbendazole are effective medications in the treating of pinworms. (Wikipedia, 2007)

***Trichospirura leptostoma* (Pancreatic Worms) (Zoonotic)**

Cause: This is a common parasite in Common Marmosets, and is mainly carried by host insects (e.g. cockroaches). This parasite occurs within the pancreas, and is considered to be harmless in small amounts; however large amounts of the parasite can cause chronic pancreatitis, and it is theorized that pancreatic worms may also be responsible for marmoset wasting disease.

Signs: Diarrhea, weight loss, alopecia of the tail base and hind-leg paralysis may eventually progress to death.

Prevention: Insect infestation should be prevented within the enclosure, and any insects found should immediately be removed. When feeding out insects to the Marmosets, it must be ensured that these are taken from a non-contaminated source.

Treatment: Fenbendazole has been effective against infestations of this parasite if detected in time. (Wissman, 2006)

***Cestodes* (Tapeworm) (Zoonotic)**

Cause: This parasite occurs in Common Marmosets, it rarely causes any ill effects, and is mainly caused by poor hygiene conditions within the food preparation area of the institute where they are kept.

Signs: There are usually no symptoms.

Prevention: Good husbandry and hygiene are the primary means of preventing tapeworm from occurring within Common Marmosets, as the main way for tapeworms to enter a host is through infecting food in poorly sanitised food preparation areas. (A Titmuss, pers.comm.2007)

Treatment: *Cestodes* are cured with Piperamizine, Fenbendazole, or any other commercial de-wormer available for humans or animals; surgery may occasionally be required for tapeworms that grow particularly large. (Wikipedia, 2007)

***Prosthenorchis elegans* (Thorny-headed Worms) (Zoonotic)**

Cause: This parasite occurs primarily in insects (particularly cockroaches and beetles); primates contract these worms by eating the hosts. (Baskin, Unknown)

Signs: Diarrhoea, anorexia, pain, debilitation; if worms succeed in burrowing through the intestinal wall, abscesses, sepsis and necrosis can occur, often resulting in death. (Wikipedia, 2007)

Prevention: Insect infestation must be prevented from occurring; any insects being fed out to the Marmosets should come from a known uninfected source.

Treatment: Otherwise healthy infested animals can be maintained through good nutrition levels and the application of antibiotics to subsequent illness. Antibiotics are ineffective in the treatment of the parasite itself however, and surgery is required to totally remove the thorny-headed worms. (J Salkeld, pers.comm. 2007)

8.4.5 Ectoparasites

Cutaneous Mites (Skin Mites) (Zoonotic)

Cause: There are a variety of different skin mites (some of the most common include the *Sarcoptes spp*, *Demodex spp* and *Psorergates spp.*); all of these are, however, are very similar in effect, and are transferred through contact with an infected host (mainly humans or other primates) or contact with a contaminated item (such as bedding).

Signs: Generally no symptoms occur unless there is a particularly large infestation, in which case itchiness and irritation of the skin will occur; self-mutilation due to this is also possible. (Baskin, Unknown)

Prevention: Good hygiene and husbandry practices are essential for the prevention of mite infestation; any infected keepers or Marmosets should be immediately treated, and all bedding, food bowls, etc disinfected. Infected Marmosets should be quarantined.

Treatment: Insecticides are the general treatment for mites; some anti-inflammatory creams may also be appropriate in extreme cases. (J Salkeld and A Titmuss, pers.comm. 2007)

Lice (Zoonotic)

Cause: There are numerous different types of lice (small, wingless insects); while it is rare for infestation to actually occur in Common Marmosets, they are susceptible to a variety of types (including head and pubic). Lice are generally contracted through contact with an infected host (mainly humans, other primates or wild birds) or a contaminated item (such as bedding).

Signs: Severe itchiness and irritation of the skin will occur; self-mutilation due to this is also possible. Many kinds of lice are visible to the naked eye, as are their eggs.

Prevention: Good hygiene and husbandry practices are essential for the prevention of lice infestation; any infected keepers or Marmosets should be immediately treated, and all bedding, food bowls and surfaces should be disinfected. Infected Marmosets should be quarantined. Also wild birds should be prevented from entering the enclosure if possible, as these are one of the primary carriers of lice.

Treatment: Insecticides are the general treatment for lice; some anti-inflammatory creams may also be appropriate in extreme cases. (J Salkeld and A Titmuss, pers.comm.2007)

Ticks (Zoonotic)

Cause: There are three different categories of ticks; the most common type found in Australia are members of the *Ixodidae spp* (hard tick). Ticks are small arachnids which are typically found in areas of tall grass and shrubs, and must make physical contact (ticks cannot jump or fly) with a host to begin feeding on their blood.

Signs: Almost all species of tick will be visible to the naked eye; they most often attach to warm, moist areas of the body (such as the groin, behind the ears, armpits, etc) and will grow larger the more blood they ingest. Though uncommon, prolonged exposure to ticks can cause illness, including anaemia, typhus, paralysis, and possible death.

Prevention: Long grass and shrubbery should be kept to the barest minimum within and in close proximity to the enclosure. The Marmosets should also be checked regularly for ticks to ensure that none are present.

Treatment: Ticks can be physically removed using tweezers, a sharp knife or fishing wire; effort must be made not to irritate the tick, as this can cause it to regurgitate the contents of its stomach into the wound, increasing the chance of infection. Some insecticides can also kill ticks while they are still attached to the host. Tick-borne diseases can be treated individually once the tick itself is removed. (J Salkeld and A Titmuss, pers.comm.2007)

Fleas (*Siphonaptera*) (Zoonotic)

Cause: Fleas are a type of small, flightless insect which feed on the blood of hosts. They typically breed in dark areas such as sand, long grass, bedding, cracks, crevices, and on host animals (almost all mammals and birds can host fleas).

Signs: Whilst small, fleas and their eggs are visible to the naked eye, and will mainly be located within the furred areas of the Marmoset. Mild itchiness is usually the only symptom; however some individuals may be allergic to fleas, in which case they will exhibit rashes, inflammation and swelling. Fleas can also carry diseases, some of which (such as *Yersinia spp.* and tapeworm) affect Marmosets, and are also zoonotic.

Prevention: Long grass, shrubbery and sand should be kept to the barest minimum within and in close proximity to the enclosure. Contact should be minimised with wild birds, and good husbandry and hygiene practices should be observed by keepers at all times. Bedding should also be changed regularly, and the Marmosets should be checked often to ensure that an infestation is not present. Infected individuals should be quarantined, and have their bedding cleaned and changed. (J Salkeld, pers.comm. 2007)

Treatment: Due to the grooming nature of primates treatment can prove to be difficult however infested bedding can be removed and sanitised.

8.4.6 Viral Diseases

Herpes

There are numerous different types of *Herpes spp.*; however whilst most of these are in fact universally fatal to Marmosets, most of these do not occur naturally in Australia, and should be caught by quarantine procedures within the country of origin of the carrier species. Some forms of the *Herpes* virus carried by primates which are deadly to Marmosets if contracted include Epstein-Barr virus (EBV), *Herpes samiri* and *Herpesvirus ateles*.

The following have been found to occur in Australia:

***Herpesvirus hominis* (Zoonotic)**

Cause: Contact with infected humans or primates through contact with infected areas or fluid exchange.

Signs: Swelling, pain, encephalitis, conjunctivitis, death. (Crab, 1998)

Prevention: Good husbandry and hygiene will prevent *Herpesvirus hominis* infection from occurring; keepers suffering from this condition should not have any contact with the Marmosets. Any Marmosets thought to be infected should immediately be quarantined.

Treatment: There is no cure for any form of herpes virus; however analgesics can help to reduce swelling and pain when an outbreak initially occurs. (J Salkeld, pers.comm. 2007)

***Herpes simplex* (Zoonotic)**

Cause: Skin to skin or fluid to skin contact with host humans or infected primates. Infection in humans generally manifests as cold sores; however no physical signs need be present for the condition to still be infectious.

Signs: Anorexia, dermatitis, pruritis, depression, ulcerations in the oral cavity and the gastrointestinal tract.

Prevention: Keepers infected with *Herpes simplex*, regardless of whether the disease is in its active or latent form should not come into contact with Marmosets regardless of their age. Marmosets believed to have contracted the infection should be quarantined and euthanized if necessary, as adults who are immune to the effects of the disease can still act as host organisms.

Treatment: There is no cure for any form of herpes virus; due to the rapidly fatal nature of this disease and the resulting encephalitis in young Marmosets, euthanasia may be warranted. (Rand, 2007)

Herpesvirus simiae (B virus) (Monkey B Virus) (Zoonotic)

Cause: This strain of *Herpes* occurs primarily in Macaques, and is difficult to detect when in latent form. Whilst not usually harmful to the host organism, when contracted by other primates or humans the monkey B virus is highly fatal.

Signs: Skin lesions, swelling, pain, encephalitis, death.

Prevention: The most likely way for a Common Marmoset to acquire this disease would be through contact with a keeper who has been infected by a Macaque within the collection. Keepers should wear protective clothing and use F10 before and after contact with any primates, as the main method of transmission of the disease is through the Macaque biting or scratching, or throwing faeces into the face or open wounds of the keeper. If Macaques are present within the collection, they should be kept isolated from the Marmosets.

Treatment: There is no cure for any form of the herpes virus; this particular condition is highly fatal to both humans and primates, and as such any infected primate, regardless of species, should immediately be quarantined and euthanized. (Unknown, VCM 656)

Encephalomyocarditis Virus

Cause: This virus is hosted primarily by rodents and insects (mainly cockroaches), and acquired by Marmosets through faecal contact or through ingestion of the insect. (EAPA Primate Policy, 2000)

Signs: Influenza-like symptoms, encephalitis and myocarditis, death.

Prevention: Prevention of rodent and insect infestation is the primary way of preventing the spread of encephalomyocarditis; all faeces should be removed as quickly as possible, and infected individuals should be quarantined.

Treatment: Encephalomyocarditis Virus is almost undetectable and is usually only detected after death when an autopsy is performed. (Baskin, Unknown)

Rhinovirus (Zoonotic)

Cause: Also known as the “common cold”, rhinovirus is an airborne disease contracted through inhalation into the respiratory system, or through skin or fluid contact with an infected individual.

Signs: Cold-like symptoms such as fever and coughing after early onset. Rhinovirus is often fatal to Marmosets, and leads to severe respiratory dysfunction, and eventually death.

Prevention: It is impossible to prevent airborne rhinovirus from entering an enclosure; however the chance of infection can be minimized through good nutrition (particularly vitamin C and D). The chance of infection can also be reduced by preventing infected keepers from having contact with the Marmosets. Infected individuals should be quarantined.

Treatment: There is no cure for the rhinovirus; however antibiotics can be used to treat subsequent infections caused within the Marmosets, and good nutrition and intakes of vitamins C and D can help to reduce the effects. (Unknown, 2005)

Morbillivirus (Measles) (Zoonotic)

Cause: Measles is a highly contagious virus which is spread through aerosolization (coughing, sneezing, etc), entering the host through the respiratory system or the eyes. This disease is mainly caught from keepers or infected primates, and proves fatal to Marmosets the majority of the time.

Signs: Nasal discharge, conjunctivitis, facial adema, blepharitis, papular skin rashes and pneumonia in severe cases.

Prevention: Marmosets can be vaccinated for measles; however this is not standard practice in zoological parks, being a more common occurrence within laboratory colonies. As such, the most likely method of prevention would be to keep infected keepers away from the Marmosets, and to quarantine any animal which shows any sign of infection.

Treatment: There is no treatment or therapy for measles; and it is 100% fatal in all species of marmoset and owl monkeys. (Rand, 2007)

Callitrichid Hepatitis Virus (CHV)

Cause: CHV results from exposure to infectious blood, body fluids or faeces, and it is believed that rodents act as a host reservoir of this disease. This disease is a relatively recent discovery, and appears to only occur within zoological and wildlife parks. It is highly infectious and rapidly fatal in Common Marmosets.

Signs: Clinical signs may include anorexia, depression, lethargy, difficulty breathing, and all the typical signs of hepatitis B; however death usually occurs before the onset of symptoms.

Prevention: While the exact cause of the disease is still relatively unknown, evidence strongly suggests that rodents are directly responsible for the spread of the disease; as such, rodent infestations must be prevented and/or removed, and all faeces cleaned. Marmosets suspected of being infected should be quarantined immediately, and euthanasia should be considered due to the high morbidity and mortality rates of the disease.

Treatment: There is no treatment for this disease; it is up to the individual immune system of the infected Marmoset. (Stephensen, 1991)

8.4.7 Environmental Diseases

Toxin Exposure

Cause: The most common form of toxin exposure is through the ingestion of lead-based paint; this is rare, however older facilities may be susceptible to this. Other heavy metals or other toxins would generally only occur within a Marmoset enclosure by accident, or through the actions of members of the public.

Signs: Signs will vary depending upon the toxin ingested, but typical signs include lethargy, temperature, vomiting and diarrhoea.

Prevention: Lead-based paint should be removed from any locations within the enclosure; a typical source of this is old fencing and walls. Keepers should be aware of what substances are toxic to the Common Marmoset, and food items, water or other enrichment items containing these should never be provided. Members of the viewing public may throw rubbish or other substances toxic to the Marmosets into the enclosure; in this case efforts should be made to educate the public (e.g. signs), and enclosures should be scanned regularly, with any items that do not belong removed immediately.

Treatment: Treatments will vary depending upon the type of toxin ingested; consult a vet for more details on specific toxins and their treatments.
(J Salkeld, pers.comm.2007)

Vitamin D Deficiency

Cause: Lack of exposure to sunlight and lack of consumption of vitamin D-rich foods (mainly eggs).

Signs: Deficiency results in impaired bone mineralization, and leads to bone softening diseases and dental problems.

Prevention: The enclosure should be designed to allow adequate levels of direct sunlight for the Common Marmosets; high vitamin D-based food such as eggs should be fed out as required, and vitamin D supplements used when necessary.

Treatment: Treatment for this deficiency is much the same as the prevention: direct sunlight, vitamin D-rich foods, and supplements. Marmosets suffering from deficiency should receive supplements until they are back at a normal level.
(Power, et.al, Unknown)

8.4.8 Nutritional Diseases

Hypoglycaemia

Cause: Hypoglycaemia (low blood sugar) is a common condition in Marmosets caused by their high metabolisms and a lack of high-sugar foods (such as fruit).

Signs: Shakiness, anxiety, weakness, ataxia and hypothermia.

Prevention: The feeding out of lots of fresh fruit helps to prevent the onset of hypoglycaemia.

Treatment: When symptoms occur, a food item high in sugar (usually fresh fruit) should be fed to the afflicted Marmoset; this should result in immediate improvement however in some cases dextrose administered via insulin may need to be considered.

(Rand, 2007)

Coprophagy

Cause: This is the act of ingesting faeces (this is not a natural behaviour in Common Marmosets), and generally only occurs in cases of dietary deficiencies or severely limited protein in the diet.

Signs: Ingestion of faeces, possible illness.

Prevention: This condition is easily prevented by both ensuring the dietary needs of the Marmoset, and also by preventing access to faeces by the timely removal of all waste matter from the enclosure.

Treatment: Review the diet of the Marmoset and make necessary changes so as to avoid deficiencies. If bacterial or protozoa disease occurs, the Marmoset should be quarantined and treated as required. (J Salkeld, pers.comm. 2007)

Vitamin C Deficiency

Cause: Lack of consumption of vitamin C-rich foods (mainly fruits and vegetables, see *10.11 Breeding Diet* for examples). Also occurs as a symptom of other illnesses.

Signs: Deficiency results in scurvy (liver spots on the skin, spongy gums, mucus, bleeding, partial paralysis, open, weeping wounds, rotting teeth, and eventual death).

Prevention: The Common Marmoset should have a vitamin C-rich diet which also meets all nutritional needs. If the Common Marmoset is still deficient, or falls ill, additional vitamin C should be administered; this would mainly occur through supplements.

Treatment: Treatment for this deficiency is much the same as the prevention: vitamin C-rich foods, and supplements. Marmosets suffering from deficiency should receive supplements until they are back at a normal level. Individuals suffering severe scurvy can be treated injections of ascorbic acid at 25mg/kg given inter muscularly twice daily for 5 days.

(Rand, 2007)

8.4.9 Miscellaneous Diseases

Wasting Marmoset Syndrome (WMS)

Cause: WMS is a highly infectious disease where the exact cause is unknown; nutritional factors such as protein deficiency or excessive sugars in the diet are suspected of being contributing factors, but the most commonly theorized cause of the disease is the Pancreatic Worm (*Trichospirura leptostoma*, see 8.4.4). The most common method of a Marmoset being infected by pancreatic worms is through the ingestion of infected insects (usually cockroaches)

Signs: Weight loss, anorexia, chronic diarrhoea, chronic colitis, muscle atrophy, anaemia, death; not all infected Marmosets will show all signs, and many will die before all symptoms are present.

Prevention: Insect populations, particularly cockroaches, should be eliminated wherever located, and prevented from repopulating. Good husbandry and a well planned, balanced diet may help to prevent the onset of the disease. Any individuals showing possible signs of the disease should be immediately quarantined, as it is highly contagious, and can affect an entire collection rapidly; appropriate tests should then be performed (e.g. faecal flotation).

Treatment: Appropriate supportive care should be administered to the Common Marmoset, including easily digestible, nutritionally sound diet and constant hydration. (Wissman, 1994) If pancreatic worms are suspected, Fenbendazole should be administered. (M Radnidge, pers.comm.2007)

Diarrhoea

Cause: Diarrhoea is typically a symptom of other illnesses, but can also occur due to overeating of a particular food type, or the administration of certain medications or supplements.

Signs: Watery faeces, dehydration; in extreme or chronic cases, blood may be present in the stool, and weight loss may occur.

Prevention: A nutritionally balanced diet is the main method of preventing diarrhoea from occurring. In the case of this being a symptom of another illness, that particular illness should be prevented if possible, or treated rapidly.

Treatment: Hydration, protein-rich foods and calcium-rich foods, particularly solids should be provided until the condition has ended. If diarrhoea is not treated properly and quickly, the condition can result in permanent illness or death.

Dystocia

Cause: A relatively common condition in Marmosets, dystocia is an abnormal or difficult childbirth, and occurs mainly due to the size, presentation and position of the foetus, as well as maternal pelvic abnormalities.

Signs: Marmoset labour typically lasts between one and four hours; labour which fails to progress during a two hour period, or which goes for more than five hours, is usually a sign of this condition. Marmosets typically give birth in a squatting or upright position; if the mother is found lying down and appears weak, this is typically another sign. Common Marmosets are born headfirst; if limbs are present instead, this is usually another sign.

Prevention: There is no method of prevention of this condition beyond stopping Marmosets known to have suffered from this condition in the past from falling pregnant. Marmosets typically give birth during the night; any that suffer this condition will often have died along with their children by morning, it is therefore imperative that if it is suspected that a Marmoset is soon to give birth, that a keeper watch should take place, a vet should be on standby in case of complications.

Treatment: If the mother can receive plenty of fluids, calcium and vitamin D during the attempted birth, it is possible that the dystocia will end with the successful birth of the infant(s); however this is often not the case, and a caesarean section may have to be attempted in order to save both the mother and unborn babies.

(Rand, 2007)

Traumatic Injuries

Cause: Whilst this is more typical of larger non-human primates, Common Marmosets will occasionally fight; this can lead to scratches, bruises or puncture wounds which will often become contaminated and infected; the most likely targets of injury are the hands, feet, or tail, and infection in these areas can lead to partial or total amputation of digits or portions of the tail. The most likely other cause of these injuries would be accidental environmental injuries.

Signs: Depending on the type of injury, signs may include: cuts, scratches, bleeding, bruising (difficult to detect), weeping puncture wounds, bite marks, deformation of limbs or digits, damage to the tail, Tetanus.

Prevention: At the first sign of conflict between the Marmosets, the offending primates should immediately be separated. Once discovered, the cause of the aggression should be handled appropriately; for example an item that they are fighting over removed, or in the case of continuing dominance issues, they may need to be separated permanently. If the injury occurs through other means (e.g. environmental), the cause should be addressed and appropriate steps taken.

Treatment: All wounds should be disinfected immediately; open wounds should be sutured and bandaged where appropriate. Marmosets suffering from severe bruising should be scanned for further damage, as this can often lead to renal failure. Damaged extremities may need to be amputated where appropriate. Antibiotics should be given in the case of infection. (Rand, 2007)

Behavioural Disorders

Cause: A variety of factors have been proposed as being associated with the development of behavioural disorders, including rearing method, social isolation, and environmental complexity (inappropriate enclosure design). Animals reared in total or partial isolation not only frequently develop a variety of stereotypes, but also may lack the social skills necessary to be pair or group housed as adults.

Signs: Swaying, rocking, pacing, anti-social behaviour, aggression towards other Marmosets and keepers, self-mutilation (e.g. hair pulling). (Rand, 2007)

Prevention: Allowing the Marmosets to be a part of an established social group; if removal from the group is necessary, the Marmoset should be allowed to reach the sub-adult stage (15 months) if at all possible, so as to have experienced and developed the full range of social and parental behaviours. Environment enrichment (especially foraging enrichment) is crucial in preventing behavioural disorders. (Lang, 2007)

Treatment: This will depend on the cause of the behavioural disorder. Marmosets which have been ostracized from the group may need to be transferred to another facility; if the environment is a concern; enrichment or redesign can be undertaken which should reverse stereotypic behaviour. (Rand, 2007)

Hypothermia

Cause: This condition is found everywhere where extreme low temperatures are present; it can also present as a symptom of another illness (the most common cause of this in Marmosets is hypoglycaemia).

Signs: Shaking, lethargy, huddling, pallor.

Prevention: If hypoglycaemia is occurring as a symptom of another illness, all appropriate measures should be taken to treat said illness. If the enclosure is cold, heat lamps should always be present; insulated nest-boxes and warmer bedding may also be appropriate.

Treatment: Core body temperature should be raised using the methods listed in Prevention, as well as through the use of warm saline-filled bladders, towels or heat-packs. In extreme circumstances, an incubator should be used. (Rand, 2007)

8.5 Quarantine Requirements

Quarantine is important as it helps to prevent the introduction of illness and disease into a collection, and also identifies and prevents zoonotic diseases from being transmitted to personnel or visitors; for this reason care should be taken if handling quarantined animals, as bites, scratches, bodily fluids, or airborne agents can all transmit diseases.

The Policy on Exhibiting Primates in New South Wales states the following in chapter 3, and as such must be abided by at all times:

3.3.1 Newly received primates must remain quarantined from resident primates until their health status has been established, in accordance with acceptable veterinary practice and any importation requirements. Any disease in a newly acquired primate must be successfully treated before it is placed with other residents.

3.3.2 Primates which have been acquired in compatible groups must be retained in those groups during quarantine. Introductions to a new group must be undertaken slowly and with care.

3.3.3 The quarantine area and its drainage system must be totally separate from regular holding areas. Staffing and feeding regimes must ensure that there is no contamination of the quarantine area from outside and vice versa. The physical and psychological needs of the animals whilst in quarantine must be provided for.

3.3.4 Newly received primates must be vaccinated in accordance with the vaccination program of the resident animals.

3.3.5 While primates are in quarantine, examination and, where indicated, treatment for internal and external parasites and any other tests or treatments prescribed by the veterinarian must be undertaken.

3.3.6 Keepers' protective outer clothing that has been heavily soiled whilst caring for primates which are in quarantine must be soaked in an appropriate disinfectant prior to being sent for washing.

3.3.7 A footbath containing an effective disinfectant must be used prior to entering all primate quarantine enclosures, or areas containing quarantine enclosures and its use strictly adhered to by all personnel.

In addition to these rules, the following quarantine steps should be followed:

- Adequate pest (insects, rodents, etc) control methods should be instituted, as these are carriers of disease.
- Establish a thorough and complete recordkeeping system; the number and source of animals, the date of shipment, arrival and entry into quarantine, Tuberculosis test dates and results, history of health problems, and diagnostic testing results.
- Any Marmoset which dies during quarantine should have an immediate post-mortem examination performed. Tissue should be submitted for examination, and the results should be determined before releasing any other Marmosets from quarantine.

- Any biological samples (such as faeces and blood) gathered for quarantine testing procedures should be appropriately sealed and labeled before being removed from the quarantine area and disposed of properly.

As mentioned previously, quarantine procedures also help to protect keepers and the public from contracting zoonotic diseases, and thus are useful in observing occupational health and safety requirements.

Staff should have an ongoing, documented training program which addresses potential quarantine hazards such as infectious disease and the spreading of infectious agents; all staff should immediately report any injury received while within the quarantined area (such as bites and scratches) and any unusual illnesses or symptoms.

Some good OH&S steps to follow when dealing with quarantined Common Marmosets include:

- Wear protective clothing such as overalls, lab coats, gowns, gloves and face masks when in direct contact with the animal, their bedding or their secretions. This clothing should be immediately changed if it becomes soiled or damaged, and should be soaked in chemical disinfectant after use.
- Personal hygiene practices must be observed at all times; the face should not be touched, particularly the eyes, mouth and nose. Hands should be washed thoroughly and often, especially before and after handling the animal or their secretions, their bedding, food, or any surface or object in which they have come into contact. Food intended for the Marmosets should be stored separately to any human food.
- Bedding, leftover food, faecal matter, and other items should be removed before being disinfected so as to decrease the potential of releasing airborne infectious material, and to also improve the effectiveness of the disinfectant. (J Salkeld,pers.comm.2007)

9 Behaviour

9.1 Activity

Common Marmosets are diurnal animals, meaning that they are most active during the day and sleep during the night. They do not undergo any hibernation or torpor; however studies conducted into a similar species of Marmoset (the Geoffrey's, or White-headed Marmoset) have shown that they spend a greater portion of their time resting during the wet season each year (32.1% in wet versus 17.85% in dry. This adaption to time spent resting is thought to be due to the decrease in the availability of insects in the dry season, and thus a greater amount of time is needed to be spent foraging. (Passamani, 1998)

Common Marmosets are extremely active primates when they are awake and alert, but otherwise spend a large portion of their day resting and feeding.

Below is table that has been formed using three field studies and one captive study:

	Stevenson & Rylands, 1988	Alonso & Langguth, 1989	Ferrari & Digby, 1996	Current Captive Data by Badihi and Buchanan-Smith
Moving	35% (including foraging)	11%		20%
Foraging		24%		<1%
Feeding	10%	27%		
Stationary (resting)	53%	18%		
Social Activities	10%	15% (grooming)		2%
Resting + Socialising			37%	2%
Interactions with other groups		5%		Inactive alert 68%

Figure 9.1.a – Field and Captive Activity Studies of Common Marmosets

9.2 Social Behaviour

Common Marmosets are extremely social animals. Due to this fact they should not, and are not allowed to be, exhibited singularly (*Policy on Exhibiting Primates in New South Wales*). Social structure of the group revolves around a stable, extended family unit with a few dominant breeding individuals and flexible mating behaviour. Whilst groups of Common Marmosets usually consist of nine animals, groups of three to fifteen animals have been observed. The groups usually encompass one or two breeding females with one breeding male and related adults (usually parents or siblings) and the breeding pairs' offspring. Genetic evidence has shown that the relationships within a group of Common Marmoset females is usually closely related (usually mothers and daughters) while the breeding males within the group are distantly related to the females and each other; this is probably due to them having immigrated from another group.

Social status within the group is interwoven with breeding status; the breeding pair is usually co-dominant, however multiple breeding pairs have been observed. In this instance one female is still dominant over the other breeding group and the rest of the social group. Beyond the breeding pair (or pairs) within the group hierarchy is usually defined by age. As is the case with most animals, dominant individuals will displace others at feeding and watering sites. This displacement (or intimidation) is shown through a variety of postures, including: vocalizations, showing of the teeth, nips, cuffs, lunges, grabs, ear-tuft flicks, genital presenting, chasing, and biting. These individuals are at the centre of the group's social life, and subordinate animals usually favour being in proximity with the more dominant members of the group, showing this by grooming preferentially.

Play is another very important social behaviour that Common Marmosets use to communicate and interact with other members of the group. Playing can also help younger members of the group to develop motor and social skills, which will become important as they reach adulthood. Marmosets exhibit three main types of play: play with an object, solitary playing and social playing.

It is important to be able to distinguish between playing and aggression or fights; during play they will have a relaxed facial expression, whereas during a fight they will be very tense and often bare teeth. (Lang, 2005)

9.2.1 Communication

Common Marmosets use a combination of vocal, visual and physical means to effectively communicate amongst the group. Facial expressions and vocalizations are used to convey a variety of different messages; these messages include social status, emotional state, and intent to other individuals. Due to their small size and the habitat in which they live, visual and physical signals are considered more important when trying to communicate at close range, while vocal communication is more important and effective over long distance.

- Some visual signals that convey specific messages include:
 - Partially open mouthed stare – alarm.
 - Frown – aggression.
 - Slitted-eye stare – submission.
 - Pilo-erection (hair standing on end) - this gives the impression of a larger size and is usually used to intimidate or during sexual display.
 - Tilted head - this is used when the animal is curious about a new object or animal.
 - Ear tuft flattening - submission, fear and sometimes curiosity.
 - Standing on hind legs - usually to get a better look at something just out of view.
 - Cringing - is a submissive gesture.
 - Erect tail – aggressive.
- Vocal signals are usually in response to unexpected movements, threatening situations or simply to convey a message. Some vocal signals that convey specific messages include:
 - Short sharp ascending calls and “tsisks” (usually shake their head when admitting a “tsisks”[pers obs]) - alarm in response to sudden movement.
 - Brief high pitched vocalisations – Alarm or warning to other members.
 - High whistling - these are usually produced in groups and are used to communicate over long distances, attract potential mates, territorial defence and to find lost group members.
 - “Trill” or drawn out whistling calls - are used by all members of the group and is usually used to identify each member by a slight variation in sound or pitch.

Scent marking is very important to New World Monkeys as they have two scent glands which are located on the chest and anal-genital region. These glands produce a chemical which they can then excrete in a focused manner to convey a variety of messages. The main messages that scent marking is used to convey are territorial range, social standing (individuals each have a unique scent) and fertility.

(Lang, 2005)

9.3 Reproductive Behaviour

The mating patterns of wild common marmosets are exceptionally complex and vary over time. Monogamy was long thought to be the only system of mating that took place (due to observations conducted in captivity); however polygynous, polyandrous and polygamous mating systems have been observed in the wild. As mentioned in “9.2 Social Behaviour” only the dominant pair usually reproduces; however when more than one breeding pair is observed in the wild it is usually because the daughter of the dominant female has mated with a male from a neighbouring group. The young produced from this pairing is not usually viable, but on those occasions where viable offspring are conceived, the female will leave the group and join another.

One of the significant defining reproductive features of Common Marmosets is their system of cooperative breeding and infant care. Whilst only the dominant pair usually reproduces, the entire group will care for and raise the new offspring, thus ensuring their survival. To accomplish this social structure the dominant pair must suppress subordinate individuals both behaviourally and physiologically to ensure that they do not breed, thus ensuring that the sole focus is upon the dominant pair’s offspring. Subordinate females (usually unrelated) will in fact cease menstruation while daughters or closely related females may continue to cycle. These females will stay within the group and become essential in successfully raising the young; this choice will in fact benefit the females even if they only choose to remain for a short period of time as, due to the demanding nature of child rearing, their overall health and fitness will increase. Protecting and raising the young also benefits the entire group as the survival of the young will ensure that a new generation of helpers or caregivers are created.

Common Marmosets have an inbuilt system that prevents inbreeding when males are closely related to breeding females; they do not reproduce with them, thus stopping inbreeding. Common Marmosets are unlike many other primate species, as emigration does not occur during adolescence in common marmosets; instead they usually will remain within the social group until they reach adulthood and then the males will leave the group to find unrelated breeding females. The group maintains its size by balancing departures with births, as this helps to keep the group size relatively stable over time; however it is not known why adults leave the group.

Whilst uncommon aggressive behaviour has been observed where the daughter of the dominant female will exhibit aggressive behaviour towards their mother, this is thought to be an attempt at trying to displace them and become the dominant breeding female.

Once the social conditions and the physical conditions are suitable for successful reproduction the female will alert her chosen male by tongue-flicking, pilo-erecting their fur and presenting their gentles to the males. Common marmosets will breed all year round, usually conceiving twice a year; they have two breeding peaks which are between September to November and April to June. (Lang, 2007)

9.4 Bathing

Common Marmosets do not require any bodies of water in their exhibit except for drinking water as they allo- (each other) and auto- (self) groom using saliva, and by removing invertebrates with their hands. This behaviour is exhibited for two purposes: hygiene, as it removes dead skin, debris and parasites living on the host; and social grooming as this helps to strengthen bonds between members of the group and to establish social status. Common marmosets groom often, however each session usually lasts for just a few minutes. (Lascola, 2008)

9.5 Behavioural Problems

Common Marmosets are non aggressive New World Monkeys, and tend to bond well to their keepers and adjust both socially and physically well to captivity; however if their social and/or physical needs are not met, stereotypic behaviour may be observed. An example case of stereotypic behaviour occurring was in a laboratory situation; when isolated, two Common Marmosets began to exhibit stereotypic behaviour in the form of pacing.

Other forms of stereotypic behaviour that have been observed in Non-Human primates (especially in macaques) include the following;

- *Deprivation Stereotypes*- self orality, self clasp, rocking, huddling, crouching, self abuse (both biting and head banging), pressing their eye balls.
- *Repetitive Locomotion Stereotypes*- pacing, bouncing, somersaulting, twirling, spinning, dancing.
- *Other*- head weaving, over grooming, picking at nothing.
(Philbin, Unknown)

Public feedings have not been shown to produce aggressive or undesirable responses; however when dealing with any primate extreme caution should be taken when allowing them to have any contact with the public, as there is such a significant zoonotic risk both to the public and to the Marmosets. (Pers.obs.2007)

9.6 Signs of Stress

There are several signs that a Common Marmoset may exhibit when stressed. Extra care and observation should take place when a stressful situation is occurring (e.g. a physical exam or a serious storm; animal behaviour will vary depending upon time of day, time of year, weather conditions and many other factors). Essentially stressful situations can be anything that is new or invades upon their “safety” zone; the most telling signs are usually:

- Stereotypic behaviour (see “9.5 Behavioural problems”)
- Behavioural changes - behavioural change is usually the first sign that an animal is stressed. Due to this it is vital that keepers know each and every one of their animals,

or at the very least what is normal for the species. The most noticeable changes are withdrawal or abnormal aggression expressed towards their social group and keepers.

- Whilst the previously mentioned factors are the most noticeable, less obvious changes may occur and as such animals should be observed multiple times a day to ensure that nothing is abnormal.
- Self mutilation - whilst this is uncommon in Common Marmosets, it has been observed in other Non-Human primates; self mutilation will normally present in the form of over-grooming.
- Physical signs - Common Marmosets may communicate vocally and or physically to the group or to the keeper that they are stressed (see section “9.2.2 *Communication*”)
- Loss of appetite - this is another common way that any animal will show that it stressed; food intake should always be observed and changes to the amount or types of food consumed should be noted and monitored to ensure that it goes back to normal.
- Illness - animals that are stressed are more susceptible to becoming ill and as such illness may in fact be a symptom of being stressed.

(J Salkeld, pers.comm. 2007)

9.7 *Behavioural Enrichment*

Common Marmosets, like all primates, need to have their physiological and psychological needs met to be successfully exhibited in captivity. For this to be accomplished it is essential to have in place a thorough enrichment strategy which covers exhibit design, complexity and change, foraging and dietary needs, and social grouping. This enrichment strategy, if implemented and maintained correctly, should meet their behavioural needs and stop Common Marmosets from developing behavioural problems.

As an overall goal enrichment of any kind should aim to stimulate the Common Marmoset in a variety of ways so that all behavioural needs are met.

There are two guiding principles that should be followed: natural is usually best; and change in itself can be enrichment. For example, providing a feeding item in the wet and then in the dry will produce two very different responses.

(G Phipps, pers.comm.2007)

- *Foraging and dietary needs* - Please refer to the enrichment calendar below and if extra information is desired please also refer to “6. *Feeding requirements*” ; in particular refer to “6.3 *Presentation of Food*” as this will provide added information on how to meet Common Marmosets foraging needs.
- Exhibit design, complexity and change - Please refer to “4. *Housing Requirements*” for in depth information on design and materials, and to the yearly enrichment calendar below for an example of appropriate periods between changes. If a correct exhibit is designed that replicates their wild environment and a successfully rotating roster is put into place the Common Marmoset’s locomotive and physiological behavioural needs should be met.
- Social grouping - Please refer to “9.2 *Social behaviour and 9.3 Reproductive Behaviour*” these sections will provide in-depth information on how to meet their social and reproductive behavioural needs.

9.7.1 Dietary

Enrichment

Calendar

1. Acacia Gum-SB Fruit mix-DP, SF Insects-IP, CS Yogurt-YP	2. Acacia Gum -GF Fruit mix-WP, SC Insect-INP, EP	3. Insectivore Cake BP Fruit mix-DP, WS Insect-IS, CP	4. Acacia Gum-SE Fruit mix-WP, F Insect-IH, ES Yogurt-YP	5. Acacia Gum-F Fruit mix-DP, FIS Insect-IF, EW	6. Acacia Gum-SB Fruit mix-WP, FIP Insect-IC, CS Yogurt-YS	7. Insectivore Cake W Fruit mix-DP, WN Insect-IFT, EP
8. Insectivore Cake BN Fruit mix-WP, FIS Insect-IC, CP Yogurt-YS	9. Acacia Gum -F Fruit mix-DP, SF Insect-IH, EP	10. Acacia Gum-SE Fruit mix-WP, F Insects-IP, ES Yogurt-YP	11. Acacia Gum-GF Fruit mix-DP, FIP Insect-INP, CS	12. Insectivore Cake BP Fruit mix-WP, SC Insect-IS, EP	13. Acacia Gum-SB Fruit mix-DP, WS Insect-IFT, CP Yogurt-YS	14. Acacia Gum -GF Fruit mix-WP, WN Insect-IF, EP
15. Insectivore Cake W Fruit mix-DP, FIP Insect-IS, EW	16. Insectivore Cake BN Fruit mix-WP, F Insect-IFT, CS Yogurt-YP	17. Acacia Gum-F Fruit mix-DP, WS Insect-INP, EP	18. Acacia Gum-SE Fruit mix-WP, SC Insects-IP, CP	19. Acacia Gum-SB Fruit mix-DP, SF Insect-IF, ES Yogurt-YP	20. Acacia Gum -SE Fruit mix -WP, FIS Insect-IH, EW	21. Acacia Gum- F Fruit mix-DP, WN Insect-IC, CS Yogurt-YS
22. Acacia Gum-GF Fruit mix -WP, SC Insect-IF, EP	23. Acacia Gum-SB Fruit mix-DP, F Insect-IH, ES Yogurt-YS	24. Acacia Gum -GF Fruit mix -WP, FIP Insect-INP, CP	25. Acacia Gum-SE Fruit mix-DP, FIS Insect-IS, CS Yogurt-YP	26. Insectivore Cake BP Fruit mix-WP, SF Insect-IC, EP	27. Insectivore Cake W Fruit mix-DP, WS Insects-IP, ES Yogurt-YS	28. Acacia Gum-F Fruit mix-WP, WN Insect-IFT, EW
29. Acacia Gum-SB Fruit mix-DP, SF Insect-INP, CS	30. Acacia Gum -GF Fruit mix -WP, SC Insects-IP, EP	31. Insectivore Cake BN Fruit mix-DP, FIS Insect-IS, CP Yogurt-YP				

Key:

Acacia Gum- *Needed 5 times a week*

- Spread on browse - SB
- In gum feeder - GF
- Smear around exhibit - SE
- Frozen - F

Fruit mix-*Daily*

Marmosets should get a minimum of two fruit feeds daily for ease of feeding one can be diced on a plate or whole slivers on a plate (easy to prepare and give) and one can be scattered, frozen etc (harder but more enriching)

- Diced served on plate - DP
- Diced scattered - SC
- Diced in fruit feeder - SF
- Whole slivers on plate - WP
- Whole slivers scatter - WS
- Frozen - F
- Frozen/ ice cubes with fruit inside on plate - FIP
- Frozen/ ice cubes with fruit inside scattered - FIS
- Wrapped in news paper - WN

Protein - *Daily*

- Eggs, cat food and insects- Cockroaches, Crickets, Mealworms, Grasshoppers, etc.
- The insects used will depend upon the institutions' insect colonies; however a minimum of two should be used (alternate daily). Cat food/eggs should be given daily also alternating between the two.

Insects-

- On Plate - IP
- Scattered (near animals or will get away) - IS
- Insect feeder constant - IF
- Insect feeder on timer - IFT
- Wrapped in newspaper - INP

- Hidden in bran in bowl - IH
- Hidden in Insectivore Cake in bowl - IC

- Cat food on plate
- Cat food scattered - CS
- Cat food on plate - CP

Egg-

- Cut up boiled egg on plate - EP
- Cut up boiled egg scattered - ES
- Whole raw egg with holes - EW

Calcium- *3 times weekly*

- Yogurt on plate - YP
- Yogurt smeared around exhibit - YS

Insectivore Cake- *Occasionally/desired*

- Broken into crumb form on plate - BP
- Left whole - W
- Buried in newspaper - BN

9.7.2 Exhibit Furnishings Enrichment Calendar

1. 1. Browse Branches 2. Browse Ladders 3. Browse 4. Browse Substrate	2. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate	3. 1. Browse 2. Browse Ladders 3. Browse 4. Browse Substrate Overhaul	4. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate
5. 1. Browse 2. Browse Ladders 3. Browse 4. Browse Substrate	6. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate Overhaul	7. 1. Browse 2. Browse Ladders 3. Browse 4. Browse Substrate	8. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate
9. 1. Browse 2. Browse Ladders 3. Browse 4. Browse Substrate Overhaul	10. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate	11. 1. Browse 2. Browse Ladders 3. Browse 4. Browse Substrate	12. 1. Browse Ropes 2. Browse 3. Browse 4. Browse Substrate Overhaul

The above calendar is displayed in monthly format for ease of use.

Key: For appropriate materials for the following please refer to “4 Housing Requirements”

- Ropes and ladders - Reorganised every second month; should be set up within the exhibit as climbing structures. If they are set up on a blunted or crab claw hook system they will be easily moveable and changeable if needed.
- Browse - Changed on a weekly basis; should be in Browse pots so that they are kept fresh longer, and to allow for easy removal
- Branches - Reorganised or removed depending upon absorbency and condition. They should be secure but able to be changed around so that the exhibit remains diverse and new to the animals.
- Substrate - Should be topped up on a monthly basis and completely removed and replaced every three months; this is good hygiene practice and will help stop disease.
- Vegetation - should be added and or replaced as needed.
- Shelves or ledges - Should be changed as needed

9.8 Introductions and Removals

Common Marmosets have an extremely strict social hierarchy, especially when dealing with the female members of the group (these are almost always closely related), and as such successful introductions are highly difficult and extremely uncommon. Studies attempting to accomplish the integration of new adult animals into an established family group has usually, as intruding animals are universally met with aggression and outright hostility. These studies are by no means conclusive; in the wild unrelated males may sometimes join an existing group, although it would be extremely unlikely for this to occur with a female. In fact, some studies have shown that the introduction of younger males into captive groups as a replacement for the male members of the group have proven to be successful, and have in fact led to greater breeding success (although it should be noted that greater aggression between members of the group was also observed). (Sodaro and Saunders, 1999)

The Policy on Exhibiting Primates in New South Wales states in chapter 8 that the following must occur when introducing and or re-introducing primates into a group in regards to both general principles and quarantine:

- **8.1 General**

- 8.1.1 *Introduction or re-introduction of animals into a group must be undertaken with caution.*

- 8.1.2 *Introduction must occur in a stepwise manner, increasing contact from sound and smell to sight and finally to physical.*

For information

This process may take several months. Often the use of a different, neutral cage facilitates introductions/reintroductions. Integration may be manipulated by temporarily using neuroleptic hormonal drugs.

- 8.1.3 *A separate area must be available to allow for introductions to take place which allows for ready separation of individuals and constant monitoring.*

- 8.1.4 *Once given physical contact, the group must be very closely observed for 48 hours with daily monitoring for at least two months.*

- **3.3 Quarantine**

- 3.3.1 *Newly received primates must remain quarantined from resident primates until their health status has been established, in accordance with acceptable veterinary practice and any importation requirements. Any disease in a newly acquired primate must be successfully treated before it is placed with other residents.*

For information

Staff should take appropriate precautions to reduce the risk of transmission of zoonoses (see Section 5.2).

3.3.2 Primates which have been acquired in compatible groups must be retained in those groups during quarantine. Introductions to a new group must be undertaken slowly and with care (see Part 8).

3.3.3 The quarantine area and its drainage system must be totally separate from regular holding areas. Staffing and feeding regimes must ensure that there is no contamination of the quarantine area from outside and vice versa. The physical and psychological needs of the animals whilst in quarantine must be provided for.

3.3.4 Newly received primates must be vaccinated in accordance with the vaccination program of the resident animals.

3.3.5 While primates are in quarantine, examination and, where indicated, treatment for internal and external parasites and any other tests or treatments prescribed by the veterinarian must be undertaken.

For information

Handling, new environments, noise, separation from compatible group members, unfamiliar personnel and routines are all stresses, the effects of which may be cumulative. Acute or prolonged low grade distress can result in decreased resistance to diseases and parasites and/or death from shock (in the case of acute distress). See 3.1.4

3.3.6 Keepers' protective outer clothing that has been heavily soiled whilst caring for primates which are in quarantine must be soaked in an appropriate disinfectant prior to being sent for washing.

3.3.7 A footbath containing an effective disinfectant must be used prior to entering all primate quarantine enclosures, or areas containing quarantine enclosures and its use strictly adhered to by all personnel.

The long-term or permanent removal of members of the group is nowhere near as stressful overall for the animals, and indeed is often quite stable. Where the dominant male or female has been removed, the social hierarchy shifts so that the “next in line” would assume their place. Overall this tends to be stable and the usual behaviours preventing incest will normally still apply; however exceptions have been known to occur, and where this happens contraception may be required. (Unknown)

With short-term removal there tends to be no adverse reactions when reintroduced into the group. It should be noted that any time spent away from the group should not be conducted alone unless it takes place in less than a 24 hour period, as this will be very stressful for the individual.

The removal of young is potentially very stressful on both the young and the other members of the group. If this is necessary, every effort should be made to minimise unnecessary stress and the disruption of group dynamics. It should also be noted that young which are removed before fully learning about eating habits from other members of the group will often become neophobic, and will be frightened of trying any foods with which they are not familiar. For more information on the removal of young from a group, please refer to section “*10.14 Age of Weaning*” (Sodaro and Saunders, 1999)

9.9 Intraspecific Compatibility

Common Marmosets can be successfully housed with other marmoset species, including Pygmy Marmosets, and Goeldi’s Marmosets. If this is to be attempted it is highly recommended that no more than two individuals be kept in the same enclosure, and that these should both be male. Female pairings will very rarely be successful due to dominance issues. It must also be noted that, depending on the species mix, one marmoset will most often be dominant over the other, and care should be taken to observe and ensure that excess aggression does not occur. Indeed all mixed species pairings should be considered to be ever changing, and as such frequent, careful observation will be necessary for the duration of the pairing.

On the very unlikely chance that an opposite sex pairing is successful, contraception should be used and frequent observation is a must, as it is possible that a hybrid birth could occur. (Sodaro, 1999)

9.10 Interspecific Compatibility

Common Marmosets are not highly territorial towards other species, and are rarely aggressive, and as such have been housed with a variety of different animals. This has not only been with different primates (such as Cotton-top Tamarins and Black-handed Spider Monkeys), but also with other animals of different orders (some successful mixes including with Two-toed Sloths, Prehensile-tailed Porcupines and Green Acouchi).

Successfully housing multiple species within the one enclosure will almost always be a matter of trial and error; even in situations where the mix has been successful in the past does not guarantee that it will be successful every time. Furthermore it is imperative that the space requirements set down in law for each species is observed when the enclosure is constructed.

It must also be stated that zoonoses become a far more serious threat when multiple species are housed within the one enclosure, especially with species which are similar; for example a common cold may be easily survivable for a Spider Monkey, but will often be fatal to a Common Marmoset. (Sodaro, 1999)

Therefore before having a multi-species exhibit, extensive research must be conducted into a variety of factors, including exhibit design, species compatibility (for example carnivores will most likely not be appropriate, or will the offspring or eggs of another species be in danger), and the potential dangers of zoonoses (both to other species and humans). (G Phipps, pers.comm.2007)

9.11 Suitability to Captivity

Common Marmosets are extremely suitable to captivity due to being highly social, very active, curious and not aggressive towards each other or humans. To ensure the successful captivity of the animals, the following should be in place:

- Correct and complex exhibit design (See 4. *Housing Requirements*).
- A clean, hygienic environment (See 5. *General Husbandry*).
- Complex and varied feeding strategies (See 6. *Feeding*).
- Correct and timely capture and restraint procedures (See 7. *Handling and Transport*).
- Adequate and preventative health systems in place (See 8. *Health Requirements*).
- All behavioural needs are met and an enrichment schedule is in place (current section).
- Breeding needs are met in accordance with the institutions plans (See 10. *Breeding*).

Once the above are implemented and maintained, Common Marmosets will adjust well to the captive environment.

10 Breeding

10.1 Mating System

The mating systems of Common Marmosets are extremely complex, varying over time, and even between individual family groups. Monogamous mating pairs were considered to be the set mating system for a substantial period of time, and are still the most common; however more recent field studies and observations have shown that polygynous and polyandrous mating systems are also present, particularly within larger family groups. (Digby, 1995)

10.2 Ease of Breeding

Common Marmosets have been shown to be fairly simple to breed in captivity provided that the following is observed:

- Rainfall, and the presence of a complex and abundant food plan are the most successful triggers that encourage mating. (G Phipps,pers.comm.2007)
- Female marmosets which are not related to the dominant female generally will not exhibit ovarian cyclicity regardless of being sexually mature, and as such are unable to breed.
- Females which are closely related to the dominant female may ovulate, but it is rare that they will actually mate; in these cases the females are always either mother and daughter, or sisters. While it is known that this occurs due to behavioural and physiological factors, the reasoning behind this is as yet to be completely understood.
- Studies have shown that young female Common Marmosets will not ovulate or exhibit sexual behaviour in the presence of their fathers; this is believed to be a natural defence mechanism against inbreeding.
- If introduced to a non-related adult male, females will generally begin ovulation rapidly, and will become aggressive towards their mothers; this is most likely an attempt to displace their mothers as the dominant breeding female of the group. (Lang, 2007)

Common Marmosets will reproduce consistently over the course of their adult lives once social conditions that are conducive to breeding have been met. Females gain the attention of males through displays of tongue-flicking, arching of the back, crouching and/or pilo-erecting their fur. Mating will occur throughout the ovarian cycle, but the vast majority occurs during a three or four day period on either side of ovulation. (Lang, 2005)

10.3 Reproductive Condition

Before a reproductive condition can be established, the gender of the individual must be determined. This can be accomplished by visually sexing the animal as the genitalia are external and visible at all times. Also male members of the species tend to be larger than their female counterparts.

10.3.1 Females

Within Common Marmoset social groups, only the dominant female (and in very limited cases a closely-related subordinate female) is capable of breeding as the other subordinate females of the group have suppressed *oestrous* cycles. There is no particular health, fitness or physical size requirements needed for the female to be mated with. It should also be noted that no external signs of *oestrous* or readiness to mate are visible beyond the below mentioned behavioural signs.

The female must indicate to her chosen mate her readiness to breed; this is accomplished through signs such as tongue flicking, arching of the back, crouching and piloerecting their fur. (Lang, 2005)

Female Marmoset lactation consists of dilute milk and as such leads to relatively slow infant growth rates. The physical size of the mother affects the lactate when feeding the typical birth size of twins, with smaller animals having milk containing less milk fat and lower gross energy; the physical size of the mother has little impact when rearing a single offspring.

Due to these differences in lactation performance depending on size, twins belonging to a larger mother will grow more rapidly (although a singleton belonging to a smaller-size mother will grow faster overall when compared to twins). Smaller mothers with twins have to draw more heavily on reserves to support them, often losing weight and becoming ill (and are less likely to be fertile in the year following the birth) during lactation; these reserves are often inadequate, and as such the energy levels of the milk are sub-par. The twins respond to this lack of optimum milk yield by initiating maternal carrying less often. (Tardif, 2001)

10.3.2 Males

A prospective reproductive partner for a female Marmoset must display a degree of fitness and physical “attractiveness” to be considered; a male who does not meet these conditions but attempts to mate anyway will most often be refused, with the female often sitting down, or simply walking away. Research shows that it is generally the females of the species which initiate copulation by inviting the male with behavioural signs showing her readiness to breed (see *10.3.1 Females*).

The physical fitness and size of the male remains important after parturition occurs, as males often provide equal (sometimes more) care for the offspring, and will usually gain weight alongside the pregnant female so as to have enough body mass and energy to care for these young. (Lang, 2005)

10.4 Techniques Used to Control Breeding

The first thing that must be considered when any form of controlled breeding, regardless of type, is to be implemented is the duration required; whether this is temporary (e.g. temporary separation of sexes), semi-permanent (reversible vasectomy) or permanent (castration).

For ease of reference this section will be divided into *Medical* and *Social/Physical* methods of Controlling Breeding.

10.4.1 Medical Techniques Used to Control Breeding

There are a variety of medical/surgical contraceptive methods available for Common Marmosets; the correct method for any given situation will depend on the required duration of contraception, the cost, and the availability, as some procedures are quite rare outside of laboratories.

- **Vasectomy**

The vasectomy is one of the most common medical methods of controlling breeding, and is also one of the most cost effective. The vasectomy operation consists of the vas deferens in the male penis being cut and sealed (either through stitching or cauterization). This prevents sperm from being conducted during ejaculation.

The vasectomy has the advantages of allowing normal hormone production and sexual activity to occur, as well as being close to 100% effective (there are a very few cases of the severed vessel repairing itself, reversing the effects of the operation).

This operation is considered to be semi-permanent, as whilst in most cases it is a permanent method of controlling breeding, it is usually possible to reverse the procedure should the need arise.

This procedure has no impact on the social standing of the individual, nor its health.

- **Castration**

Castration is a surgical method not recommended as it involves the complete removal of the testes. This has a serious impact on both the hormonal development of the male (including interfering in regular growth, altering life expectancy, abnormal weight gain, and more), and their position within the social group due to a lack of exhibiting the typical male behaviour brought about by the production of testosterone within the testes.

Castration immediately ends the production of normal levels of male hormones, and depending on the stage of life of the Marmoset, can have a variety of ill effects; it is therefore recommended that should castration be desired, it be done before the Marmoset reaches sexual maturity.

This procedure is permanent and 100% effective; however due to the factors listed above, it is not desirable; furthermore the Vasectomy procedure is only slightly less effective, and has little-to-no impact on the individual and the group.

- **Tubal Ligation**

This procedure consists of the fallopian tubes within the female being severed and “pinched” shut using clamps. This prevents fertilization.

Tubal Ligation has the advantages of allowing normal hormone production and sexual activity to occur, as well as being close to 100% effective (this procedure is only ineffective in the case of surgical error).

This operation is considered to be semi-permanent, as whilst in most cases it is a permanent method of controlling breeding, it is sometimes possible to reverse the procedure should the need arise.

This procedure has no impact on the social standing of the individual, nor its health.

- **Immunocontraception**

This method is still in the experimental stage, with a wide variety of different compounds being tested for their effectiveness in contraception for both sexes. This procedure consists of implanting the Marmoset with a protein from another species which causes the immune system to reject sperm (in the case of females) or to prevent the production of sperm (in males).

The method currently most successful with primates involves injecting the male with *human chorionic gonadotrophin (HCG)*; this renders the male infertile, is 100% effective and is similar to a vasectomy in that it does not affect hormone production, health, social standing, or sexual activity.

This procedure is completely reversible, with only a very small number of cases being rendered infertile permanently. Due to the experimental nature of this procedure it is not widely available, and where it is available would most likely be very expensive.

- **Contraceptive Implants/Depot Injections**

These methods are used mainly in laboratories, and consist of either implanting a contraceptive rod, or injecting a slow-release contraceptive depot into the female. These both have the effect of steadily releasing the progestagen hormone into the body in amounts large enough to cause temporary infertility. The length of time required for the implant/injection to be rendered ineffective varies depending on the dosage and type of medication.

Progestagen-based contraceptives are effective approximately 98% of the time; however females injected or implanted with these contraceptives will often display side-effects, including weight gain, increased or reduced sexual activity, and behavioural side-effects.

This procedure is completely reversible, however it can take some time before normal fertility is restored; a very small number of cases have occurred where a female has been rendered infertile permanently.

- **Euthanasia**

Whilst this is the least preferable form of controlling breeding available, it is a common method due to its cost effectiveness, as well as allowing the Marmosets within the collection to experience natural patterns of reproduction (including child-rearing) before euthanasia occurs.

When euthanasia is adopted, it is usually used on the young or elderly; this is the most extreme form of population control, as it is completely permanent and allows for the complete control of the makeup of the group.

While this method allows more natural behaviour and interaction when compared to control methods that prevent pregnancy entirely, the removal of young from its parents can cause undue stress.

Where euthanasia is considered to be the best method of group control, it must be suggested that *transfer* (as seen below in 10.4.2) to another facility be considered. (J Salkeld and G Phipps, pers.comm. 2007)

10.4.2 Social/Physical Techniques Used to Control Breeding

- **Presence of the Dominant Female**

The presence of the dominant female will, in most cases, stop all other females within the group ovulating, and thus reproducing. In this instance breeding is controlled as only the one female can breed, leading to a maximum of two litters per year.

Whilst this method will not completely stop breeding, it should help to control numbers drastically and is also a natural occurrence within the social structure of the species.

- **Presence of the Father**

The presence of the father of any females within the group will, in most cases, prevent them from ovulating, and thus reproducing; this is a natural method of preventing inbreeding within the social group, as well as preventing aggression from occurring between females.

Whilst this is a very specific method to control breeding, it should help to control numbers by preventing some females from within the group from asserting dominance or attempting to breed; it also helps to prevent inbreeding. (Lang, 2005)

- **Transfer**

When considering transfer as a method of controlling population, arrangements must first be made so that another enclosure within the facility or another institution willing and able to take on the desired individual(s).

The best and most humane method of transfer is to wait until the young have been raised within the family group and have reached independence from their parents. Once this has occurred, and it is ensured that the individuals to be transferred have learnt the full range of social and physical behaviours; they should be separated from the group and transferred to the desired location.

- **Bachelor Groups**

This is one of the most desired methods of controlling breeding if no breeding is desired for the foreseeable future, as the group consists entirely of males. This method is most commonly used in institutions that which for Marmosets to be used solely for display purposes.

It should be noted that if breeding is desired at a later date, it must be ensured that the desired breeding male was within his social group long enough to learn proper parental care and courtship behaviour. (G Phipps, pers.comm. 2007)

10.5 Occurrence of Hybrids

Common Marmosets are not known to hybridize with any other species or sub-species in the wild; however if they are held together in the same enclosure with other species of Marmosets (most commonly Pygmy Marmosets) hybrids have been known to occur. Generally a situation enabling this to happen is only found in laboratories or within the pet trade overseas, where rare hybrid primates are particularly valuable.

Despite the fact that hybrid young show no tendency towards physical abnormalities or birth defects, hybrid Marmosets should not be encouraged as their genetics will weaken, and health problems will most likely result. (Neusser, *et.al*, 2005)

10.6 Timing of Breeding

Common Marmosets are continuous breeders; generally having breeding peaks between April to June, and September to November. This is so that parturition occurs at the end of the wet and dry seasons so as to ensure the availability of an abundance of food. (Lang, 2005)

10.7 Age at First Breeding and Last Breeding

Common Marmoset females reach sexual maturity at approximately 17 months of age; however it is unlikely that they will reproduce until 20 months or more of age. Males reach sexual maturity at approximately 11 months of age, and can successfully reproduce from this point on ward. (Lang, 2005)

There is officially no last known breeding age for Common Marmosets as current evidence shows that females do not experience menopause, and males do not become infertile with age.

Whilst the average lifespan of the Common Marmoset in captivity is thought to be approximately 16 years, it has been observed in the wild that female marmosets that breed to their full potential upon reaching sexual maturity will often live only 6 years; while it is likely that captive animals will outlive their wild counterparts, these factors should still be taken into consideration when breeding, and steps such as careful monitoring and contraception should be put into place if a longer lifespan is desired. (Tardif, 2003)

10.8 Ability to Breed Every Year

Common Marmosets are extremely active breeders, and are capable of conceiving from 17 months of age. Common Marmosets are capable of giving birth twice each year; See *10.9 Ability to Breed More Than Once Per Year* for details. (Lang, 2005)

10.9 Ability to Breed More than Once Per Year

Common Marmosets are capable of giving birth twice each year, with gestation lasting approximately 5 months (148 days); after parturition a female will begin to cycle within 10 days, and will be able to fall pregnant again soon after.

Seasonal, nutritional, lactation, olfactory, stress and social factors can cause delays in ovulation after parturition, particularly when nursing twins. It has been shown that females which do not ovulate during this post-parturition period are much more likely to have triplets as their next litter. (Lang, 2005)

10.10 Nesting, Hollow or Other Requirements

In the case of neonates extra soft bedding should be added in addition to the normal requirements. (*Please refer to 4.9 Nest Boxes and/or Bedding Material*).

10.11 Breeding Diet

In the wild, rainfall is one of the major influencing factors that trigger breeding of Common Marmosets. This is due to the direct link between rainfall and the availability of an abundance of fresh food. (G Phipps, pers.comm.2007) For this reason Common Marmosets give birth at the end of the dry and rainy seasons respectively, due to the physical exertion and nutritional stress placed upon nursing females in particular, as well as the father and other members of the group (these often assist in the rearing of the infant, and in some cases the father cares for the child more often than the mother does); the large amount of food available minimizes this significantly, and increases the survival chances of both the mother and young.

In captivity their normal dietary requirements still apply (see *6. Feeding Requirements*), however these should be made available in larger amounts, with particular emphasis placed on Vitamins A and C (this aid in growth and development and the creation of an effective immune system) and protein/calcium rich foods.

Some fruits and vegetables that are rich in Vitamin A which are suitable for Common Marmosets include:

- Sweet potatoes
- Carrots
- Cabbage
- Pumpkin
- Spinach
- Squash
- Apricots
- Rock Melon
- Mango
- Eggs
- Broccoli

Some fruits and vegetables that are rich in Vitamin C which are suitable for Common Marmosets include:

- Blackcurrants
- Guava
- Kiwifruit
- Broccoli
- Brussels Sprouts
- Lychee
- Papaya
- Strawberry
- Orange
- Rockmelon
- Cauliflower
- Raspberries
- Tangerines
- Passionfruit
- Spinach
- Cabbage
- Mango
- Honeydew Melon
- Tomatoes
- Blueberries
- Pineapple
- Pawpaw
- Grapes
- Apricots
- Plums

Some types of foods which are rich in protein and/or calcium, and are suitable for Common Marmosets include:

- Boiled Eggs
- Crickets
- Mealworms
- Cockroaches
- Cat and Dog Kibble
- Cheese
- Cultured Yoghurt

10.12 Oestrous Cycle and Gestation Period

Common Marmosets have a continuous Oestrous Cycle throughout the year which lasts between 24-30 days (average of 28).

Gestation lasts approximately five months (143 to 153 days), and typically occurs twice a year. (Lang, 2005)

10.13 Litter Size

Twin births are the most commonly occurring type in both wild and captive Common Marmoset social groups. In captivity triplets are the next most common (but occur very rarely in the wild), followed by the comparatively rare quadruplets, and the rarer still singletons.

Twins generally weigh between 20 to 27% of the mother's total body weight at birth (approximately 47.2g-63.7g). (Lang, 2005)

The sex ratio of births is generally even, with studies of captive Marmosets concluding that male births are slightly more likely to occur (53%).

10.14 Age at Weaning

Common Marmosets wean until approximately three months of age and are capable of feeding themselves, although they are not yet able to create their own holes to feed on acacia gum, instead licking the holes created by other members of the group.

By five months of age the Marmosets are considered to be juveniles and are completely capable of feeding themselves and interacting within the group, and as such are considered to be independent of their parents. During this period another litter will usually have occurred, as the mother becomes fertile again within ten days of parturition, and can reproduce again from then on.(Lang, 2005)

In captivity young Marmosets typically have a 95% survival rate provided that they are not quadruplets (these have a much higher rate of both stillbirths and infant death; there is no exact figure for this occurrence) and that they are a part of a decently sized social group capable of caring successfully for the young; this should consist of the breeding pair and eight helpers to achieve the best survival rate recorded (95.7%). Males and females do not have any noticeable differences in mortality rates.

It should also be noted that while singleton births are as likely to survive as twins, they are much more likely to not survive the duration of the gestation, as singleton mothers have the highest miscarriage rate of all the possible birth types. (Rothe, et.al. 1992)

10.15 Age of Removal from Parents

Whilst Common Marmosets are safe to remove when they have reached juvenile status (approximately 5 months), it can benefit the young if they are left within their societal group until they reach sub-adult stage (approximately 15 months) so that they can be exposed to, and thus learn, the full range of behaviours exhibited by the species. (Lang, 2005)

In many cases it is unnecessary to remove young from their family group, as serious aggression is generally only shown when the dominant female is challenged (usually by a close relative or daughter); otherwise young tend to live harmoniously within the group, and as mentioned in previous sections, natural safeguards against incestuous behaviour exist within the species.

10.16 Growth and Development

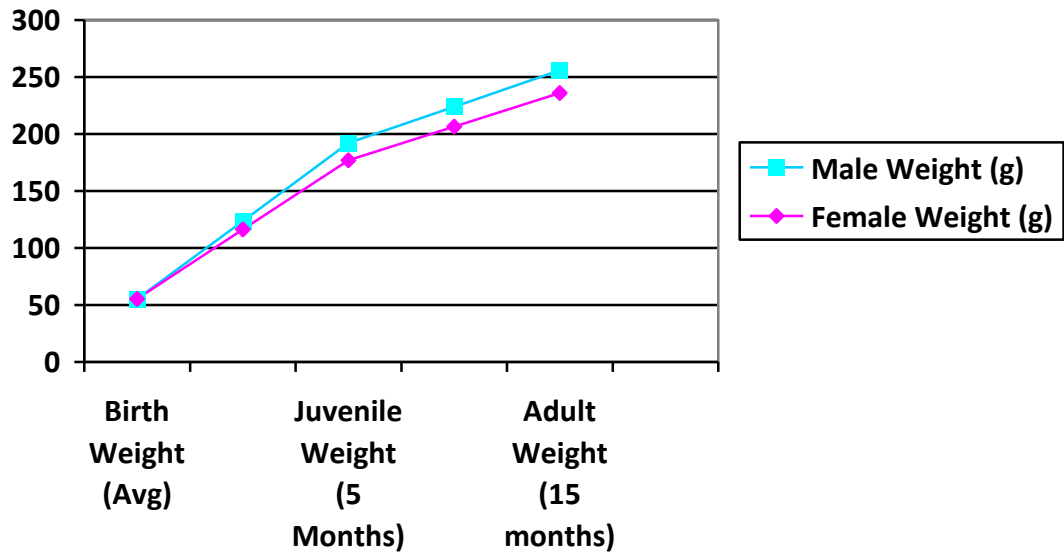
Infant Common Marmosets are born altricial and are unable to thermoregulate until 10 weeks of age. They are generally born with both eyes open, although occasionally one eye may remain closed for up to 3 days after birth. Infants are also born with milk teeth, with baby teeth having completely come in by 27.5 days of age.

Infants have grey fur over the head and neck areas, with less fur over the chest and abdomen so as to better allow for the transfer of body heat from their carrier. They also lack the distinctive ear tufts common to the species. Immediately upon birth they display a very strong cling reflex (they are born with very strong arms and hairs on their fingers to increase their grip), and do not voluntarily leave their carrier's back for the first two weeks of life. Upon reaching their second week, they become highly active, often crawling around on the back of the carrier and investigating the surrounding area.

At four months of age the adult molars will have developed, and by approximately five months of age the Marmoset enters the juvenile period, which lasts a further five to ten months. At the beginning of this period the juvenile reaches around 75% of their adult weight, and interaction with group members besides their parents is encouraged; rough play to determine status also begins at this time. During the juvenile period more infants are usually born; carrying and playing with these new young also makes up an important part of juvenile development.

At between nine and fourteen months of age, the sub-adult stage begins, which is characterized by the full range of adult behaviours, and by the entering of puberty; also during this time (at approximately 12 months of age) the full range of permanent adult teeth should have developed. At 15 months of age the marmoset has reached its adult weight, and is capable of reproducing, although this will not occur unless social conditions become adequate. (Lang, 2005)

Figure 10.16.a Growth Curve



11 Artificial Rearing of Mammals

While not preferable in many situations, there are occasions where the artificial hand rearing of Common Marmoset infants may be necessary. The most common reason for this to occur is that the mother has rejected, neglected, or is otherwise under too much stress (for example, conflict within the group) to properly feed or otherwise care for the newborn. Removal for this reason is especially common when a triple or more birth occurs. In this case the smaller individual in a litter of triplets (or more) is often removed, as otherwise infant mortality usually occurs within the first week.

Medical concerns are another reason for the removal of young for hand rearing, such as mastitis in the mother which would prevent normal feeding. It would also be preferable to remove an infant for hand-raising if the Marmoset is intended to be used as an educational animal in shows, or for the purposes of certain research.
(Sodaro, Crissey, 1999)

11.1 Housing

Newborn Common Marmosets naturally cling to the body of other group members constantly for the first few months of life, as this helps to maintain a healthy body temperature, as well as providing comfort and support. Therefore it is extremely important when hand-raising Marmosets that they are provided with a carrier replacement; some successful surrogates include: towels; plush toys; or a heat pad covered with real or artificial fur.

In terms of housing, a particularly successful method involved a timber box at 25 x 18 x 15cm, lined with marten fur and with a heat pad on the base.
(Voelkl, Huber, 2005)

11.2 Temperature Requirements

Newborn Common Marmosets cling to the bodies of their mothers and other group members and are warmed by the body heat of the carriers. Without these carriers, infant or neonate Marmosets will suffer from hypothermia; if they are being hand reared, the temperature must be stabilised and maintained by an artificial means (for example, an incubator, heat pad, heat lamp, or heated surrogate)

While standard incubators used for human infants are ideal to keep the neonates under optimal conditions, an apparatus such as this may not always be available, especially in smaller zoos and institutions. An appropriate low budget substitute in these situations would be a heat pad.
(Voelkl, Huber, 2005)

The book *Nursery Rearing of Primates in the 21st Century* provides an example of a successful means of thermo regulating Common Marmoset neonates. This involves wrapping heat pad in a towel and placing in a fur-lined box. A digital thermometer with a min-max temperature alarm is then used to monitor surface temperature so that the pad is kept between 35 and 45 degrees Celsius. This temperature is gradually reduced as the neonate's gain the ability to thermo regulate.

11.3 Diet and Feeding Routine

Diet is an extremely important factor for the ongoing health of Common Marmosets, as it allows for normal growth and development, and also helps to build up immunity. An inappropriate diet which lacks in amount, nutrition, vitamins, or other important ways, can cause serious problems in development as well making the infants susceptible to disease (good hygiene is also vital to preventing ill health; see *11.7 Hygiene*).

For the first two weeks of life, the infants should be fed at 2 – 3 hour intervals. From the third week onward, the number of feedings per day can be gradually be decreased to 6 feeds during the day with none at night by week four, and so on until feeds occur three or four times daily as the consumption of solids increases.

When hand-raising, many institutions use a paediatric electrolyte or dextrose solution for the first day. Diluting infant formula with this solution and then gradually decreasing the amount of dilution over several days should eventually allow for the use of full formula; this should still be diluted with boiled water to be suitable for the Marmosets. The formula itself will vary depending on brand and region, and each will have specific instructions in terms of concentration, temperature, and whether the formula will need to be altered depending different stages of development. The amount of formula used should be approximately 10 – 12% of the infant's bodyweight (typically between 25 – 35 grams, depending on litter size and genes); monitoring weight fluctuations daily will allow the determination of how successful the feeding process has been, and whether changes to the formula should be made.

To feed the infant formula, a pipette or syringe with a rubber teat should be used. The infant is held in the hand and fixed between the index finger and thumb. The formula is then slowly dripped into the mouth; if this is done too quickly it may cause the infant to sneeze and refuse to take more for a short period of time.

The formula itself should contain the following:

- Crude Protein g/100mls 3.1-4.0
- Lactose g/100mls 6.8-8.1
- Total lipids g/100mls 5.0-9.5
- Calcium mg/100mls 88.8-95.5

Human formula does not match exactly the basic needs of the infant Marmosets, and as such crude protein, Vitamin D3, and unsaturated fatty acids will need to be added manually. Sustagen (or similar) powder, or Primiliac Commercial Primate Rearing Diet can be added to the formula to increase the protein levels.

Vitamin D3 can be increased by adding supplements (such as Oleovit or Vignatol) in amounts of 600-2100UI/kg body weight/day. To increase the levels of unsaturated fatty acids, cod liver oil should be added at 450-600mg per 100mls of formula. If there is an issue with getting the infant to ingest the formula, a small amount of baby juice can be added to sweeten the taste.

From three weeks of age the infant will begin to consume solids; this will become more regular at five weeks of age. A spoon should be used when initially feeding solids, with a gradual move up to feeding from a bowl. A good starting point is mixing some baby cereal with the formula; soaking bread in the formula also works. After this, a mix of fruit such as apple, melon and banana becomes appropriate. It should be noted that initial consumption of solids will not be regular, and as such formula should be given in addition to this so that the Marmoset is receiving the same amount of nourishment. The initial weight when weaning is begun is approximately 60 grams; by the end of the weaning period the infant should weight approximately 150 grams.

If the infant is intended to be reintroduced to the family group, both the group and the infant should be fed the same fruits, vegetables and insects to make the reintroduction easier; however, it must be ensured that the correct formula is given to make up for any shortfalls of solids in the infants diet. A glucose mix can also be used where necessary to ensure proper hydration.

(Voelkl, Huber, 2005)

11.4 Specific Requirements

Infant Common Marmosets are given D3 supplements in their formula as they are unable to naturally produce this vitamin. Once the transition from formula to solids begins, it is important that they have daily access to natural sunlight, as this is the main (and natural) source of vitamin D3; they require 500 IU of D3 per day. (Voelkl, Huber, 2005)

11.5 Data Recording

Please refer to 5.3 *Record Keeping* for compulsory record keeping that must be kept on all primates exhibited in NSW.

It is important that all stages of hand rearing are accurately documented; not only does this serve as a reference for the institute in question, but it also provides information on the successes and failures experienced to others.

Infant specific information that should be documented includes:

- Weight should be measured every day to ensure that normal weight gain is occurring.
 - Common marmosets are between 25-35 grams at birth
 - They gain an average of 0.83 grams per day.
 - Common Marmosets weigh approximately 60 grams when they start to wean and will be approximately 150 grams once completely weaned (Guerra.et.al, 2003)
 - Individual weights will depend upon litter size and genes
 - Please refer to *Figure 10.16a „Growth Curve“* for a growth chart from birth to adult weight.
- Diet should be recorded at least once daily to determine whether the correct intake is taking place, and that they are weaning at the correct time. The amount of food consumed, when it is consumed, and how it is fed out should be recorded so that successful methods can be referred to in the future.
- Toileting patterns should be recorded; it is very important to maintain a regular toileting schedule to prevent illness or death.
- Abnormalities such as
 - Behavioural
 - Physical
 - Social
 - Discharge from eyes, nose or ears
 - Irregular defecation or urination
- Temperature should be recorded daily and environmental temperatures should be altered as the animal becomes more sufficient

- Socialisation data is important to keep track of; what's being doing to aid it, and what the outcome has been.
- Record any successes and failures other areas of the hand raising process.
- Why was the Common Marmoset hand raised?
- Record identification information for both the institution and for the International Species Information System (ISIS).

11.6 Identification Methods

There are three routine methods used for identification purposes with Common Marmosets. These are micro-chipping (inserted via injection into the back of the neck); ear tags (it is preferable to keep these small so as to remain aesthetically pleasing to the public); and tattooing. However these methods are usually reserved for adults; the most commonly used method of identifying young is marking them on the back or on the ear with a non-toxic marker or paint. It needs to be emphasised that the marking must be clear, thus bright colours are usually best with a large contrast in shades.

If there are multiple litters within the group, it would be wise to have two different systems of markings for each infant so as to identify both the individual and the litter to which they belong.

11.7 Hygiene

Please see *Section 5.1 Hygiene and Cleaning for Common Marmoset* for specific hygiene requirements.

Maintaining good hygiene is even more important with neonates and infants as they are extremely susceptible to illness due to an underdeveloped immune system. Feeding utensils should be boiled and sterilised with a non-toxic chemical before and after use (Milton is an example of a brand that is safe in Australia, and is commonly used with human babies). (G Phipps, pers.comm.2008)

Environmental hygiene is highly important, but it must also be noted that a completely sterile environment (such as what would be found in a research lab) can be counterproductive, as it will stop the immune system from developing the ability to deal with pathogens. Extreme cleanliness of the area in which the infant is staying and is fed is important, but fresh air should still be available. (A Titmuss, pers.comm.2007)

11.8 Behavioural Considerations

Hand raising infant Common Marmosets, by its very nature, creates an abnormal socialisation experience. The individual is unlikely to develop the full range of normal socialising skills, this includes communication and also life and parenting skills needed to be able to have a normal life within the social group; the individual will also often be unable to successfully rear their own young unless they are reintegrated into a group at the appropriate time.

Even after an apparently successful reintegration, problems with socialising will often still occur. The hand raised Marmoset can often display fear of having contact with group members, and may resist attempts to approach or carry them; in the same vein, members of the group may avoid contact with the hand raised individual, and parents completely unfamiliar with their young are likely to reject them, often violently. The hand raised individual can also fail to form attachment to its parents due to having already formed an attachment to a surrogate during the time of isolation.

The first thing that should be considered is the possibility of not having to remove the infant from the group. In some cases assisted feeding (aiding the mother by giving the young additional feeds with formula as necessary) will successfully allow the infant to remain in the enclosure with the group, and thus minimise damage to not only their relationship within the group by also damage their socialisation skills.

Where this is impractical, or where the Marmoset is still not coping even with additional feeds, or in the case of the infant being hand raised for educational or scientific purposes, then one way of reducing the impact of hand rearing is through raising the infant in an incubator within the enclosure itself; being exposed to the group from day one minimises the loss of socialisation skills, and leads to better acceptance of the hand raised individual within the group.

As such, the best hand raising techniques are those which lead to minimal time spent away from the group and for the successful reintroduction of the young to the group, minimising the potential harm to socialisation skills and thus hopefully ensuring that the hand raised individual can also successfully rear young. To accomplish this, the maximum possible contact with the group is extremely helpful, and direct contact with humans should be kept to a minimum; furthermore, using a realistic surrogate for the infant can help the reintegration process. (Sodaro, Crissey, 1999)

11.9 Use of Foster Species

There has been little in the way of published literature describing the possibility of giving Common Marmoset young to another species of primate to raise. While a successful case has been reported in a lab in Brazil, in which a Common Marmoset infant was introduced to and raised by a parental pairing of Black tufted-ear Marmosets (*Callithrix penicillata*). In this situation the fostering was thought to be beneficial due to the infant having been orphaned; the Common Marmoset would not be deprived of social interaction or basic parental interactions by being placed with this pair, as it would have been when hand raised by humans.

In this case there was little in the way of staged introduction; the infant was left on the enclosure floor, and the male of the pair soon interacted with the infant, and carried it to the top of the enclosure. From this moment on the infant was always in the company of one of the pair, and did not exhibit any signs of stress (neither vocalisation nor physical) or being rejected by the foster parents. (Guerra.et.al, 1998)

It should be noted, however, that this was an isolated incident, and furthermore occurred with a species very closely related to Common Marmosets. In the particular circumstances of this case study, there was no inclination to reintroduce the infant to the original family group; if this were to be attempted, it is most likely both the infant and the biological family members would react with hostility due to differing behaviour and smelling of a different species.

Until further research has been conducted into the matter, the attempted use of foster species should be avoided unless the institutions aim is to conduct specific research, or if more literature becomes published that proves that it is more beneficial to the infant in question. Do to the unique communal infant rearing which occurs within a Common Marmoset family group, most species of primate would be extremely unsuitable to correctly foster an infant, and in fact would most likely react with hostility when the infant is introduced.

11.10 Weaning

Common Marmosets will develop their teeth by three weeks of age, and can gradually be weaned off formula and onto solid foods; the consumption of solid foods will gradually become more regular at five weeks of age. A spoon should be used when initially feeding solids, with a gradual move up to feeding from a bowl. A good starting point is mixing some baby cereal with the formula; soaking bread in the formula also works. It should be noted that initial consumption of solids will not be regular, and as such formula should be given in addition to this so that the Marmoset is still receiving the right amount of nourishment.

By one month of age, a large amount of soft foods should be consumed (such as steamed Marmoset canned foods or fruit such as bananas, apples, etc), and little formula should be offered to encourage the consumption of solid foods. Most Common Marmosets should be completely weaned onto solids by approximately three or four months of age. (Voelkl, Huber, 2005)

11.11 Rehabilitation and Release Procedures

Due to the Common Marmoset being a foreign, exotic animal, rehabilitation and release procedures would only ever occur within an institution; they would never be released into the wild.

As stated in *11.6 Behavioural Considerations*, the ultimate goal when removing an infant from its family group and hand raising it should be to successfully reintroduce it at a later date. To accomplish this, it is important to allow the infant to interact with the original group as much as possible (e.g. via placing the incubator within the enclosure) so that they may learn proper behaviours and socialisation skills.

The age of the infant that is to be released back into the enclosure will determine whether an incubator or cage is placed within the enclosure to achieve a gradual reintroduction. This will allow the infant and the family group to have visual, aural, and olfactory contact prior to the actual physical reintroduction taking place; this also allows keepers to observe and assess the reactions of the infant and group members, and whether there will be any issues.

To prevent loss of normal socialisation and rejection by the family group, it is important to reintroduce the infant at as early an age as possible. The age of reintroduction is limited only by the inability of newly born Common Marmoset to thermoregulate (and thus their subsequent dependence on the incubator) and the need to be able to move independently; this is so that the infant is not dependent on being carried by other members of the group, and thus can approach the keepers for bottle feeding without undue stress being placed on the other members of the group.

If the infant is to be reintroduced after a longer period of separation from the group, an interim cage should be used to allow contact between the infant and group members without placing the infant in danger. After initial reintroduction into the group occurs, it can still be prudent to allow the infant to remain in the cage at night or when observers are no longer present, the cage should only be removed once there are no signs of serious aggression present, and the infant has successfully inter-grated back into the group.

Another method has proven successful without the use of interim cages. The infants (at six to seven weeks old) were placed with their surrogates on a warm spot in a well used part of the enclosure; it is imperative that this position is easily observed by the keepers. The infants are initially left in the group enclosure for short periods of time, gradually increased over ten to fifteen days until the infants are only removed at night. When weaning had been completed, and the infants were engaging in positive social interactions with the other group members, they are allowed to remain in the group cage overnight.

The more time that passes between the removal of the infant and its reintroduction to the group, the more likely it becomes that significant aberrations in social behaviour will occur, and thus successful reintroductions become much more difficult to accomplish. While the oldest published successful reintroduction occurred at 63 days old, it is still much more unlikely that infants raised in isolation will be accepted by the group, or indeed will interact correctly with their parents and other group members. (Sodaro, Crissey, 1999)

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14 Glossary

Altricial – "incapable of moving around on its own soon after hatching", and refers to a pattern of growth and development in organisms. The word is derived from the Latin root *alere* meaning "to nourish" and refers to the need for young to be fed and taken care of for a long duration – Wikipedia

Arboreal – animals which inhabit or spend large amounts of time in trees or bushes.

Conspecific – belonging to the same species.

Diurnal – an animal that is the most active during the day.

Exudates – the material that oozes out of a plant including gum, sap, resin, and latex.

Innocuous – unable to cause minor to no harm.

IU – International Unit.

Monogamy – is the custom or condition of having only one mate in a relationship, thus forming a couple.

Neonate – an infant at the youngest stage of life, especially before they can walk, or simply a child before the age of one.

Neophobia – is the fear of new things or experiences.

New World Primates – are the four families of primates that are found in Central and South America: Cebidae, Aotidae, Pitheciidae and Atelidae. – Wikipedia

Parturition – is the process of giving birth.

Polyandrous – a female forming a sexual union with more than one male.

Polygamous – having more than one partner at a time.

Polygynous – a male forming a sexual union with more than one female.

Thermoregulation – is the ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different.

Zoonotic or Zoonosis – is any infectious disease that may be transmitted from other animals, both wild and domestic, to humans or from humans to animals (the latter is sometimes called reverse zoonosis). – Wikipedia

15 Appendices

15.1 Appendix A – Exhibit Horticulture

Plant Fact Sheets:

Common Name: Staghorn Fern

Scientific Name: *Platycerium superbum*

Natural Location: Queensland and Northern New South Wales

Hardiness: High temperatures to minus 3.8 degrees Celcius

Type: Tropical Fern

Height: 2m

Spread: 2.3m and .33 meters deep

Growth rate: Slow if left in natural conditions, will grow rapidly if fertiliser is added

Sunlight requirement: Partial to Full Shade

Drainage if Particular: Average water needed

Toxicity: Nil

Flowers: Nil

Seasonal or Evergreen: Evergreen

Soil Ph: 6.1 to 7.5

Common Name: Common Ground Fern, False Bracken or Rainbow Fern

Scientific Name: *Calochlaena dubia*

Natural Location: Tasmania

Hardiness: Very suitable and hardy; can withstand drought.

Type: Fern

Height: .9m

Spread: Will only spread to available area. Will stunt growth if in a small area can spread 1.2m

Growth rate: Slow

Sunlight requirement: Light Shade

Drainage if Particular: Average water needed

Toxicity: Nil

Flowers: Nil

Seasonal or Evergreen: Evergreen

Soil Ph: Tolerant

Common Name: Japanese Shield Fern or Autumn Fern
Scientific Name: *Dryopteris erythrosora*
Natural Location: Japan
Hardiness: Extremely high temperatures to minus 28.8 degrees Celsius
Type: Fern
Height: .6m
Spread: .9m
Growth rate:
Sunlight requirement: Partial to Full Shade
Drainage if Particular: Average water needed
Toxicity: Nil
Flowers: Nil
Seasonal or Evergreen: Evergreen
Soil Ph: 6.1-7.5

Common Name: Star Vine
Scientific Name: *Schisandra coccinea*
Natural Location: North America
Hardiness: Extremely high temperatures to minus 17.7 degrees Celsius
Type: Vines and Climbers
Height: 2.3-3.7m
Spread: Time determines can span great distances
Growth rate: Fast
Sunlight requirement: Sun to Partial Shade
Drainage if Particular: Average water needed
Toxicity: Nil
Flowers: Nil
Seasonal or Evergreen: Evergreen
Soil Ph: Tolerant

Common Name: Dutch Crocus
Scientific Name: *Crocus vernus*
Natural Location: Holland
Hardiness: Extremely all temperatures to minus 39.9 degrees Celsius
Type: Bulbs
Height: .15m
Spread: .22m
Growth rate: Fast
Sunlight requirement: Sun to Partial Shade
Drainage if Particular: Not particular
Toxicity: Nil
Flowers: White blooms late winter
Seasonal or Evergreen: Evergreen but seasonal blooming
Soil Ph: Tolerant 6.1-7.5

Common Name: Shiroshimah
Scientific Name: *Hibanobambusa tranquillans*
Natural Location: China
Hardiness: Very; high temperatures to minus 12.2 degrees Celsius
Type: Bamboo
Height: 3.6m
Spread: 2.4m; depth will depend upon soil quality and room, in this case there would be limited area around roots to only allow for a small depth.
Growth rate: Fast
Sunlight requirement: Full Sun to Partial Shade
Drainage if Particular: Not
Toxicity: Nil
Flowers: Nil
Seasonal or Evergreen: Evergreen
Soil Ph: Tolerant 6.1-7.5

Common Name: Dwarf Elephant Ear

Scientific Name: *Alocasia gageana*

Natural Location: Malaysian

Hardiness: Fairly low highs to minus 1.1 degrees Celsius

Type: Tropical

Height: .90m

Spread: 1.8m

Growth rate: Fast

Sunlight requirement: Full Sun to Partial Shade

Drainage if Particular:

Toxicity: Toxic if ingested- Have been successfully exhibited with Common Marmosets and no ill signs have been observed, they do not eat foliage and as such this is not a factor to this species.

Flowers: White then Red

Seasonal or Evergreen: Evergreen

Soil Ph: Tolerant 6.1-7.5

Common Name: Osaka or Japanese Bird nest Fern

Scientific Name: *Asplenium nidus*

Natural Location: Japan

Hardiness: Very; high temperatures to minus 6.6 degrees Celsius

Type: Fern

Height: .60m

Spread: 2.25m

Growth rate: Slow

Sunlight requirement: Light to Full Shade

Drainage if Particular: Average watering needed/ moist soil needed

Toxicity: Nil

Flowers: Nil

Seasonal or Evergreen: Evergreen

Soil Ph: Tolerant 6.1-7.5

Common Name: Soft Tree Free or Man Fern
Scientific Name: *Dicksonia antartica*
Natural Location: South Eastern Australia
Hardiness: Very; high temperatures to minus 12.2 degrees Celsius
Type: Fern
Height: 5.5m
Spread: 4.5m
Growth rate: Very Slow
Sunlight requirement: Thrives in shade will grow in sun
Drainage if Particular: Prefers moist soil, so medium to low drainage
Toxicity: Nil
Flowers: Nil
Seasonal or Evergreen: Evergreen
Soil Ph: Tolerant 6.1-7.5

Common Name: None
Scientific Name: *Calyptrocalyx hollrungii*
Natural Location: New Guinea and USA
Hardiness: Fairly; above 4.5 degrees Celsius
Type: Palms
Height: .90m
Spread: 1m
Growth rate: Slow
Sunlight requirement: Tolerant prefers partial shade
Drainage if Particular: Prefers medium drainage but will tolerate all levels so long as soil is wet on a daily basis.
Toxicity: Nil
Flowers: Nil
Seasonal or Evergreen: Evergreen
Soil Ph: Tolerant 6.1-7.5

15.2 Appendix B – F10 Material Data Safety Sheet

MATERIAL SAFETY DATA SHEET

COMPANY DETAILS MANUFACTURER:

AUSTRALIAN DISTRIBUTOR: Health and Hygiene (Pty) Ltd
COMPANY: Chemical Essentials (Pty) Ltd P O Box 347, Sunninghill 2157,
Address: 13 Abelia Str, Doncaster East, South Africa.
Victoria 3111 Tel: +27 11 474-1668
Emergency Telephone number: +03 9841 9901 Fax: +27 11 474-1670
Fax: +03 9841 9909 e-mail: info@healthandhygiene.co.za

IDENTIFICATION

PRODUCT NAME: **F10 SUPER CONCENTRATE DISINFECTANT** UN Number: None

D G Class: None

Hazchem code: None

Poisons Schedule: 5

**HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA IN THE PACK CONCENTRATE ONLY
(eyes and skin irritant)**

USE: Biodegradable multi purpose Disinfectant for all hard surfaces, equipment and airspaces

PHYSICAL DESCRIPTION/PROPERTIES

Appearance: Clear, colourless liquid, with a slight natural odour.

Boiling Point: 110 °C

Vapour Pressure: Not known

Specific Gravity: 1.00

Flash Point: Not flammable

Flammability Limits: Not flammable

Solubility in water: Soluble

INGREDIENTS

CAS Number Quantity (w/w)

Benzalkonium Chloride 68424-85-1 5.4%

Biguanide 27083-27-8 0.4%

Ingredients not determined to be hazardous to 100%

HEALTH HAZARD INFORMATION

HEALTH EFFECTS:

Acute

SWALLOWED: Low. Substantial ingestion may cause irritation to mouth, throat and digestive tract.

EYE: Low. Will cause irritation but not serious damage.

SKIN: Low. Concentrate may act as mild degreasant to sensitive skin.

INHALED: Low. No significant hazard.

Chronic

INHALED: Low. No significant hazard

FIRST AID

SWALLOWED: DO NOT induce vomiting. Give milk or water to drink. Seek medical advice where necessary.

EYE: Rinse eyes with water. Seek medical advice where necessary.

SKIN: Wash affected area with soap and water.

INHALED: Non-toxic. Avoid long term inhalation of neat liquid. Remove to fresh air.

FIRST AID FACILITIES: Contact a doctor or Poison Information Centre (phone 131126)

ADVICE TO DOCTOR: Treat symptomatically

F10 SUPER CONCENTRATE DISINFECTANT

PRECAUTIONS FOR USE

EXPOSURE LIMITS: No data found

Engineering controls: None required

PERSONAL PROTECTION: Not required

FLAMMABILITY: Not Flammable

SAFE HANDLING INFORMATION

Storage and Transport: Store below 30 °C in dry conditions

SPILLS AND DISPOSAL: Soak up on an inert material e.g. dry earth and dispose of in an area approved by local authority by-laws. Flush small spills with copious amounts of water

FIRE/EXPLOSION HAZARD: The product is not flammable or explosive.

OTHER INFORMATION: Ensure good industrial hygiene.

DO NOT mix with soaps or other chemicals.

CONTACT POINT: Managing Director, +03 9841 9901

Chemical Essentials Pty Ltd

15.3 Appendix C – Bleach Material Safety Data Sheet

Material Safety Data Sheet

Bleach

ACC# 91020

Section 1 - Chemical Product and Company Identification

MSDS Name: Bleach

Catalog Numbers: S72823

Synonyms:

Company Identification:

Fisher Scientific

1 Reagent Lane

Fair Lawn, NJ 07410

For information, call: 201-796-7100

Emergency Number: 201-796-7100

For CHEMTREC assistance, call: 800-424-9300

For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7681-52-9	Sodium hypochlorite	5.0	231-668-3
497-19-8	Sodium carbonate anhydrous	<1.0	207-838-8
7732-18-5	Water	Balance	231-791-2

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear pale yellow liquid.

Danger! Corrosive. Causes eye and skin burns. Causes digestive tract burns. Harmful if inhaled. Causes respiratory tract irritation. May cause methemoglobinemia.

Target Organs: Blood.

Potential Health Effects

Eye: May cause irreversible eye injury. Contact with liquid is corrosive to the eyes and causes severe burns.

Skin: Causes skin burns.

Ingestion: May cause methemoglobinemia, cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), convulsions, and death. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death. Methemoglobinemia is characterized by dizziness, drowsiness, headache, shortness of breath, cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), rapid heart rate and chocolate-brown colored blood.

Inhalation: Harmful if inhaled. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May cause pulmonary edema and severe respiratory disturbances.

Chronic: Chronic inhalation and ingestion may cause effects similar to those of acute inhalation and ingestion.

Section 4 - First Aid Measures

Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid immediately. Do NOT allow victim to rub eyes or keep eyes closed.

Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Discard contaminated clothing in a manner which limits further exposure.

Ingestion: Do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation: Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Get medical aid. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated.

Extinguishing Media: Do NOT get water inside containers. For small fires, use dry chemical, carbon dioxide, or water spray. For large fires, use dry chemical, carbon dioxide, alcohol-resistant foam, or water spray. Cool containers with flooding quantities of water until well after fire is out.

Flash Point: Not available.

Autoignition Temperature: Not available.

Explosion Limits, Lower:Not available.

Upper: Not available.

NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks: Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale. Discard contaminated shoes.

Storage: Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Sodium hypochlorite	none listed	none listed	none listed
Sodium carbonate anhydrous	none listed	none listed	none listed
Water	none listed	none listed	none listed

OSHA Vacated PELs: Sodium hypochlorite: No OSHA Vacated PELs are listed for this chemical. Sodium carbonate anhydrous: No OSHA Vacated PELs are listed for this chemical. Water: No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes: Wear chemical splash goggles.

Skin: Wear appropriate protective gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid

Appearance: clear pale yellow

Odor: odor of hypochlorites

pH: Not available.

Vapor Pressure: 14 mm Hg

Vapor Density: 2.58

Evaporation Rate: >1.0

Viscosity: Not available.

Boiling Point: 100 deg C

Freezing/Melting Point: 0 deg C

Decomposition Temperature: Not available.

Solubility: Soluble.

Specific Gravity/Density: 1.07

Molecular Formula: Not available.

Molecular Weight: Not available.

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.

Conditions to Avoid: Incompatible materials, combustible materials.

Incompatibilities with Other Materials: Sodium hypochlorite is incompatible with amines, ammonia, ammonium acetate, ammonium carbonate, ammonium nitrate, ammonium oxalate, ammonium phosphate, cellulose, and ethyleneimine, strong acids, reducing agents, amines, and ammonia salts.

Hazardous Decomposition Products: Hydrogen chloride, chlorine, sodium oxide.

Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:

CAS# 7681-52-9: NH3486300

CAS# 497-19-8: VZ4050000

CAS# 7732-18-5: ZC0110000

LD50/LC50:

CAS# 7681-52-9:

Draize test, rabbit, eye: 10 mg Moderate;

Draize test, rabbit, eye: 1.31 mg Mild;

Oral, mouse: LD50 = 5800 mg/kg;

CAS# 497-19-8:

Draize test, rabbit, eye: 100 mg/24H Moderate;

Draize test, rabbit, eye: 50 mg Severe;

Draize test, rabbit, skin: 500 mg/24H Mild;

Inhalation, mouse: LC50 = 1200 mg/m³/2H;

Inhalation, rat: LC50 = 2300 mg/m³/2H;

Oral, mouse: LD50 = 6600 mg/kg;

Oral, mouse: LD50 = 6600 mg/kg;

Oral, rat: LD50 = 4090 mg/kg;

CAS# 7732-18-5:

Oral, rat: LD50 = >90 mL/kg;

Carcinogenicity:

CAS# 7681-52-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

CAS# 497-19-8: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

CAS# 7732-18-5: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No data available.

Teratogenicity: No data available.

Reproductive Effects: No data available.

Mutagenicity: No data available.

Neurotoxicity: No data available.

Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

RCRA P-Series: None listed.

RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	HYPOCHLORITE SOLUTIONS	No information available.
Hazard Class:	8	
UN Number:	UN1791	
Packing Group:	III	

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 7681-52-9 is listed on the TSCA inventory.

CAS# 497-19-8 is listed on the TSCA inventory.

CAS# 7732-18-5 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 7681-52-9: 100 lb final RQ; 45.4 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 7681-52-9: immediate.

CAS # 497-19-8: immediate.

Section 313 No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depletors.

This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 7681-52-9 is listed as a Hazardous Substance under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7681-52-9 can be found on the following state right to know lists:

California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 497-19-8 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations**European Labeling in Accordance with EC Directives****Hazard Symbols:**

C

Risk Phrases:

R 31 Contact with acids liberates toxic gas.

R 34 Causes burns.

Safety Phrases:

S 28 After contact with skin, wash immediately with...

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

S 50 Do not mix with ... (to be specified by the manufacturer).

S 61 Avoid release to the environment. Refer to special instructions /safety data sheets.

WGK (Water Danger/Protection)

CAS# 7681-52-9: 2

CAS# 497-19-8: 1

CAS# 7732-18-5: No information available.

Canada - DSL/NDSL

CAS# 7681-52-9 is listed on Canada's DSL List.

CAS# 497-19-8 is listed on Canada's DSL List.

CAS# 7732-18-5 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of E.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 7681-52-9 is listed on the Canadian Ingredient Disclosure List.

CAS# 497-19-8 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 9/28/1998

Revision #4 Date: 3/22/2006

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.