

Husbandry Manual for



Siamang

Hylobates syndactylus

(Mammalia: Hylobatidae)

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DISCLAIMER

This husbandry manual was constructed to meet the requirements for completion of Certificate III in Captive Animals, Course number

1068 at TAFE NSW Western Sydney Institute, Richmond College, N.S.W., Australia. Manual information may be subject to interpretation and it is important to keep in mind this is student work, bearing no responsibility for loss or damage as a result of the included information. This manual is offered to the ASZK Husbandry Manuals Register for the benefit of animal welfare and care.

This husbandry manual can be considered a 'work in progress', thus the author welcomes recommendations and improvements.

OCCUPATIONAL HEALTH AND SAFETY RISKS

Warning: This animal is classified as hazardous, as injury to person may occur due to biting, scratching, or grabbing.

- Siamangs must be locked in a secure holding area while servicing the enclosure.
- Physical stress may result from lifting and carrying feed buckets.
- Excessive exposure to heat may occur. Wear appropriate sun protection.
- Island enclosures require use of a boat with small electric motor. Keeper ability to swim is necessary.
- Take precaution when stepping on to island banks or walking near water's edge. Slips, trips and falls may occur.
- Potential exposure to zoonotic diseases. Primates may carry Hepatitis A or B and keepers are required to be vaccinated.
- Avoid direct contact with disinfectants used in cleaning dens.

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1 Introduction

The Siamang, *Hylobates syndactylus*, is the largest of all the gibbon species. Siamangs have all black hair coloration, except in rare cases of facial markings. This species inhabits the Malay Peninsula and the island of Sumatra, preferring habitat above 300m sea level. It has recently been classed as an endangered species, with only about 200,000 individuals remaining in the wild (MacKinnon 1987; A. Mootnick pers comm., as cited in Gron, 2008c). There is a large captive population; yet no known release programs have been found. Siamangs are primarily monogamous in the wild and captivity, and Siamang groups have been the research subjects for many studies on their song production. The Siamang is similar to the other gibbon species and husbandry information can be useful for the other species, and vice versa.

1.1 ASMP Category

- Primate Taxon Advisory Group (TAG)
- Population Management Plan, Level 1a

1.2 IUCN Category

- Endangered (EN)
- CITES listed Appendix I

1.3 Wild Population Management

- The population of wild Siamangs has decreased by at least 50% over the past 40 years. This species is now listed as endangered.
- This species is protected by CITES and designated areas have been assigned to preserve Siamang habitat.
- At least nine protected areas exist: Bukit Barisan National Park, Gunung Leuser National Park, Way Kambas National Park, West Langkat R (Indonesia); Fraser's Hill R, Gunong Besout Forest Reserve, Krau Wildlife Reserve, Ulu Gombak Wildlife Reserve (Malaysia); Hala Bala Wildlife Sanctuary (Thailand) (Nijman & Geissmann, 2008).
- No known direct management practices have taken place at this time.

1.4 Species Coordinator

- ARAZPA Species Coordinator: Tineke Neilsen-Joustra, Orana Wildlife Park, tineke@oranawildlifepark.co.nz Scope of data: Australasia. Data current to: 30/06/2007.
- AZA Species Coordinator: Jay Petersen, CHICAGOBR, japeters@brookfieldzoo.org

1.5 Studbook Holder

- EAZA Studbook keeper: John Ray, TWYXCROSS, John.M.Ray@btinternet.com
- AZA Studbook Keeper: Cynthia Kreider, ERIE, ckreider@eriezoo.org Data current to: 9/08/2007.

2 Taxonomy

2.1 Nomenclature

- Class: Mammalia (Infra-class Eutheria)
- Order: Primates
- Family: Hylobatidae
- Genus: *Hylobates*
- Species: *Hylobates syndactylus*

2.2 Subspecies

- Two subspecies have been listed in Gron, 2008a:
 - *S.s. syndactylus*, resident of the island of Sumatra
 - *S.s. continentis*, resident of the Malay peninsula

2.3 Recent Synonyms

- *Symphalangus syndactylus*, commonly used in publication
- *Symphalangus continentis*
- *Symphalangus gibbon*
- *Symphalangus subfossilis*
- *Symphalangus volzi*

2.4 Other Common Names

- Malayan Siamang
- Sumatran Siamang
- Siamang Gibbon

3 Natural History

3.1 Morphometrics

3.1.1 Mass And Basic Body Measurements

- Average Head Body Length: 75-90cm (MacDonald, 2004).
- Average Weight: 11.8kg (M) and 10.7kg (F) (both from Gron, 2008a).

3.1.2 Sexual Dimorphism

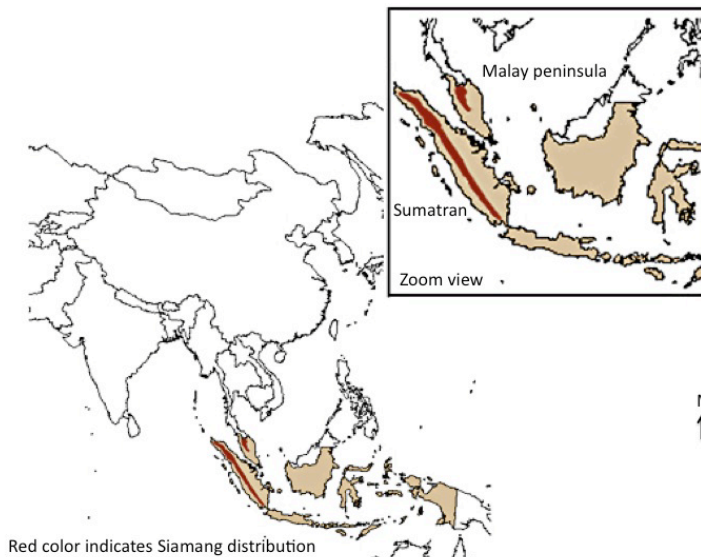
- There is no difference in coat color with regards to sex.
- Males and females are similar in size.
- When calling, male screams and female barks.

3.1.3 Distinguishing Features

- Largest of the gibbon family.
- Large throat sac.
- All black hair; however, facial coloration has occurred in some individuals
- Syndactylous, having 2nd and 3rd toes fused by thin webbing of skin (Eastridge, 1999).

3.2 Distribution and Habitat

- Generally the Malay Peninsula and the island of Sumatra.
- *S.s.syndactylus* is confined to Sumatra and occurs over most of the island but is mainly found in the west (Mootnick, 2006; MacKinnon 1984; Jenkins 1990, as cited in Gron, 2008a).
- *S.s.continentis* is confined to the northwest and central Malay Peninsula and is restricted in the east by the Pahang River, in the south by the Maur river and Tasek Bera, and in the north by the Perak river (Mootnick, 2006; Chivers, 1980, as cited in Gron, 2008a).
- There is one report of Siamangs from extreme southern Thailand, very near the border with Malaysia on the Malay Peninsula in the Narathiwat Province (Treesucon, 1997, as cited in Gron, 2008a).
- Distribution Map (modified from Gron, 2008a):



- Habitat is primarily tropical hill evergreen forests, usually in altitudes higher than 300m above sea level (MacDonald, 2004; Gron, 2008a).
- Siamang may occupy lowland to sub-montane areas, living in a sympatric relation with the agile gibbon *Hylobates agilis* (O'Brien et al., 2004).
- Other primate species living in sympatry include the slow loris (*Nycticebus coucang*), long-tailed macaque (*Macaca fascicularis*), pigtail macaque (*Macaca nemestrina*), Thomas's langur (*Presbytis thomasi*), lar gibbon (*Hylobates lar*), banded langur (*Presbytis melalophos*), ebony langur (*Trachypithecus auratus*), Horsfield's tarsier (*Tarsius bancanus*), and Sumatran orangutan (*Pongo abelii*) (Palombit 1992; Lappan 2005, as cited in Gron, 2008a).

3.3 Conservation Status

- IUCN: As of 2006, and again in 2008, the Siamang has been assessed as an Endangered (EN) status (Geissmann, 2007; Nijman & Geissmann, 2008).
- This species was previously listed as Lr/Nt, and some sources may incorrectly show this.
- US Federal List: Endangered.
- CITES: Appendix I prohibits all international commercial trade of all gibbon species.
- Threatened mainly due to human induced habitat destruction from selective and illegal logging, in addition to habitat conversion to agriculture. (Geissmann, 2007; Gron, 2008c).
- The palm oil production and world demand is negatively impacting this species.
- Infants and juveniles may be harvested for the illegal pet trade, often resulting in the parent(s) being killed in the process (Geissmann, 2007; Gron, 2008c).
- The wild Siamang population has decreased by at least 50% over the past 40 years.
- If the population continues to decline, this species may become critically endangered.
- There is a large worldwide captive population in more than 60 facilities.

3.4 Longevity

3.4.1 In the Wild

- Lifespan of 25-30 years in wild. (Macdonald, 2004)

3.4.2 In Captivity

- Lifespan up to 40 years in captivity (Macdonald, 2004; Gron, 2008a)

3.4.3 Techniques Used to Determine Age in Adults

- Age may be determined by wear on dentition; however, no available publications can be found at this time.
- Age of first permanent tooth eruption is suggested to occur at approximately 1.75 years, with complete permanent dentition at approximately 7.5 years (Smith, et al., 1994). This study also correlated the age of first erupted permanent molar with the age of weaning in nonhuman primates.
- A more recent tooth eruption studied conducted on two agile gibbons, *Hylobates agilis*, confirmed the eruption of permanent teeth started at the age of 1.4 years and was completed at the age of around 6.6 years. (Uchikoshi, M. & Matsuzawa, T., 2007).
- The author of this manual suggests that the development of song and pair bond formation may be used to determine age in young adults. No published studies are known.

4 Housing Requirements

4.1 Exhibit/Enclosure Design

- Siamang exhibits should allow for brachiation. Cocks (2002) suggests that the enclosure be rectangle in shape to allow for this locomotion.
- Rigid and semi-rigid materials should be used to provide brachiation, i.e. poles, ropes and branches. Metal should not be used for modes of brachiation as frostbite, burn or slippage could result.
- The exhibit should allow for varying levels of the canopy, with platforms to rest on at these levels.
- Substrate should be earth, except in night dens concrete can be used for ease of cleaning.
- The enclosure should contain visual barriers, which allow visual escape from both cage mates and the public.
- Shade should be available at all times of the day.
- The exhibit should be designed with a minimum flight distance of 5m, i.e. the distance from the public the average gibbon feels comfortable (Cocks, 2002).
- Island enclosure is recommended, but at a minimum fully enclosed exhibit should be 10x3x4m high (Mootnick, 1997).
- Fresh water should be available at all times and in a location free from contamination.

Image of Siamang exhibit with suggested structures.



4.2 Holding Area/ Night Den Design

- Sliding door to exhibit should have a locking mechanism to secure Siamangs off of main enclosure.
- The interconnecting slides in the holding cage and night quarter areas should allow a complete circular movement through the complex to avoid individuals being trapped by more dominant animals.
- Floors should slope to the drain.
- Drainage is recommended to be outside of the night quarters.
- Roof ideally should allow for arboreal locomotion, i.e. mesh roof and reinforcement bar steel.
- Public or other noise, especially above the Siamangs, should be reduced to a minimum.
- One night box per Siamang. Insulating bedding, such as straw or shredded paper, should be given during the winter months.
- Arboreal platforms need to be at or above the head height of the keepers.
- The holding area should be constructed steel mesh to prevent potentially dangerous contact between Siamangs and keepers. Mesh minimum diameter of 3.15mm and dimension 75x50mm (NSW Agriculture, 2000).
- A safety area should be provided for keeper (s).
- A crush system should be available for animal capture.

4.3 Spatial Requirements

The following are the spatial requirements stated in the Policy on Exhibiting Primates in New South Wales (NSW Agriculture, 2000):

- The size and shape of enclosure must provide freedom of movement, both horizontally and vertically.
- Enclosure size must be a minimum of 9 x 13.5 meters horizontally and 4 meters vertically for up to three individuals. For each additional individual, 39.5 cubic meters is needed.
- The enclosure must be of sufficient size to avoid or escape domination or conflict between subordinates or group members.

- Enclosure size must not exceed the carrying capacity of the enclosure.
- Enclosure size must be of appropriate size to prevent accumulation of parasites and other pathogens.
- Each gibbon must be provided with sufficient space to provide the social, breeding and husbandry needs.

4.4 Position of Enclosures

- The majority of enclosure must be out of visual range of neighbouring exhibits housing potential predators or group of the same species. When visual contact is available, if signs of distress occur, action must be taken to eliminate stressors. (NSW Agriculture, 2000)
- It is recommended that the exhibits be at least 75m apart and preferably no visual contact between pairs if individual gibbons are particularly territorial (Mootnick, 1996, as cited in Cocks, 2002).
- Gibbon pairs are highly territorial. Aggression between gibbons in adjacent enclosures have been known to cause the failure of pair formation and the miss-mothering or even killing of infants by gibbon parents (Cocks, 2002).

4.5 Weather Protection

- Open-air island enclosures are appropriate for this species.
- Access to shelter must be provided for climatic extremes. (NSW Agriculture, 2000)
- Fully enclosed dens must be available throughout night hours.
- It is important that breeding pairs with young have access to dens 24 hours a day for climate protection.
- If possible, three quarters of the exhibit should be in shade in summer and one quarter in the winter.

4.6 Temperature Requirements

- Shelters should provide temperature range of 18 to 30 degrees Celsius. (NSW Agriculture, 2000)
- Insulated bedding material should be available in winter.
- If daytime temperatures fall below twelve degrees Celsius heating is also required in the night den (Cocks, 2002).

4.7 Substrate

- For island exhibits, a combination of grass, dirt and vegetative substrate is appropriate.
- Night dens should be concrete, allowing for easy cleaning to avoid spread of disease.
- Substrates must be well drained to prevent water build up and flooding.

4.8 Nest boxes and/or Bedding Material

- Nest box to be provided for breeding pairs.
- Nest box to be in dry, quiet location away from public eye.
- Straw or shredded paper is the preferred bedding material.
- Nest box minimum dimensions are 1m x 1m x 1.5m (personal observation).

4.9 Enclosure Furnishings

- Climbing structures need to be a mixture of flexible, semi-rigid and rigid materials. On exhibit, these can include wooden posts, ropes, fire hose, and established vegetation.
- Ideal inter-structure distance (e.g. between poles and ropes) is 2m (Cocks, 2002).
- The larger the enclosure the greater the gaps can be made between ropes and branches. Larger gaps allow greater speed and leaping distances for the gibbons (Mootnick et al., 1987 as cited in Cocks, 2002).
- Climbing structures must be a least 5m from the top of external walls or island's edge.
- At least 4 horizontal pathways are required in the upper part of enclosure (NSW Agriculture, 2000).
- At least 4 vertical pathways are required in the upper part of enclosure (NSW Agriculture, 2000).
- Ideally arboreal pathways should be provided for the Siamangs at three vertical levels using posts, ropes and platforms or ground.
- Ropes should be of sufficient diameter or have limited movement (e.g. fixed tightly at both ends) in order to prevent accidental hangings.
- Rope diameter between 25mm and 40mm is recommended (Cocks, 2002).
- The majority of the climbing structures must be 5m from the public.
- There should be at least one feeding platform/space for every gibbon housed in an exhibit (Minimum size 1m x 1m).
- Platforms should be at least 2m above the ground and allow each adult animal to be by itself, but large enough to allow for mutual grooming (NSW Agriculture, 2000).
- Natural enrichment items (browse, aromatherapy, logs) can be added when possible.
- Unnatural enrichment items (ball, tires, tube feeders, hessian sacks, hammocks) can be added when possible; however, these should be placed out of view of public for aesthetic purposes.
- Ensure Siamang safety when selecting enrichment items.
- Change, add or remove enrichment items regularly.

5 General Husbandry

5.1 Hygiene and Cleaning

- Soil and soft substrate should be spot cleaned daily to remove organic waste.
- Hard-surfaced platforms, shelves and night den floors cleaned and disinfected regularly to prevent accumulation of urine, faecal and food matter.
- Nest boxes cleaned and bedding changed seasonally to prevent contamination when not in use.
- If labor has occurred, the nest box should to be cleaned as soon as the mother and baby have vacated.
- Animal House by Glason is recommended to use as a disinfectant, diluted 1-part solution to 10 parts water. (See Appendix 1)
- Anti-rust should be applied to steel mesh when necessary to eliminate rusting.
- Feeders and feeding equipment to be washed thoroughly after use and bleached monthly.
- Watering devices should be scoured daily.
- Gibbons must have access to dry area after cleaning process (NSW Agriculture, 2000).

Fig 1. Daily Cycle of Husbandry Activities for the Siamang, *Hylobates syndactylus*

	MON	TUES	WED	THURS	FRI	SAT	SUN
Routine health checks							

Bio matter removed							
Night dens disinfected							
Enrichment added							
Furniture rearranged							
Browse							
Maintenance if needed							

5.2 Record Keeping

- Records to be of high standard and updated regularly.
- Records should be stored in an easily accessible database.
- Each Siamang held within the zoo requires an individual record.

The following data should be recorded according to the Policy on Exhibiting Primates in New South Wales, Part 6: Records (NSW Agriculture, 2000):

- Microchip number, personal name and distinctive markings and/or photo image to be recorded.
- Date of birth and origin to be recorded.
- Details of parents and their origins to be recorded.
- Dates of acquisition and disposal, details of circumstances and facility addresses to be recorded.
- Vet records, such as, examinations, treatments, health checks, and results to be recorded.
- Breeding information including mating, reproductive cycling, parenting ability, and details of offspring to be recorded.
- Date of death and cause if known. Autopsy results to be recorded.
- Behavior changes.
- Dietary changes and consumption.
- Annual submissions to studbook keeper are required
- All records to be kept for life plus five years.

5.3 Methods of Identification

- A microchip to be implanted under the first anesthesia procedure.
- Distinctive markings can be used to determine individuals. For example lighter hair under the chin (personal observation), facial structure, and one study found the presence of circumfacial markings in 4.4% of the 250 Siamangs sampled (Geissmann, 2001).
- Ear tags may be used; however, are not recommended for primates as they may be pulled off in grooming.

5.4 Routine Data Collection

- Data collected on a regular basis can be part of a long-term scientific study.
- Reproductive stage and behavior.
- Birthing and offspring development.
- Age of young adult ostracized from group.
- Age of death/euthanasia

6 Feeding Requirements

6.1 Diet in the Wild

- Ripe fruit; 44% of feeding time (MacDonald, 2004)
- Leaves, mainly new; 45% of feeding time (MacDonald, 2004)
- Flowers
- Bark
- Occasionally insects, bird eggs, and small vertebrates
- Fruit available year round

6.2 Captive Diet

The following is based on diet guidelines at Mogo Zoo:

- Fruit, ripe and dried
- Vegetables, raw and cooked
- Browse (Willow, Mulberry, Banana leaves & Bamboo)
- Boiled chicken and boiled eggs
- Grains and cereals
- Primate cubes by Specialty Feeds (See Appendix 2)
- Breeding diet includes increased protein for pregnant female.
- AM Diet at Mogo Zoo for 1.1.1:

1.8kg apple
 600g banana
 700g orange
 100g grapes/kiwi fruit
 150g pear
 250g honeydew/rock melon/pawpaw/mango
 250g tomato
 1kg carrot
 200g sweet potato
 500g celery
 1 heads of lettuce (iceberg, fancy, endive)
 1 x bunch bok choy
 350g spinach (2x weekly)
 0.25 cabbage
 0.5 capsicum
 2 x cob of corn

- PM Diet at Mogo Zoo for 1.1.1
 - 50g sultanas or dried fruit
 - 50g dog kibble (dry, any size)
 - 50g primate cubes/cereal/grains
 - 3 x boiled egg (2x weekly *may be increased to daily for pregnant female)
 - 50g cheese (weekly)
 - 50g boiled chicken (2x weekly *may be increased to daily for pregnant female)

*Please note: Diet for each additional adult may be calculated by dividing proportions by 2.5.

- Alternative diet based on USA products from Mootnick (1997):

TIME OFFERED/ FOOD ITEM (g)	<i>agilis</i>	<i>moloch</i>	<i>pileatus</i>	<i>leucogenys</i>	<i>syndactylus</i>
0700 hours					
Monkey chow	45:00	30:00	52:50	52:50	60:00
Red apples	131:25	131:25	175:00	175:00	262:50
Yellow apples	100:00	100:00	100:00	150:00	100:00
1030 hours					
Green beans	20:00	10:00	10:00	20:00	40:00
Spinach	60:00	40:00	20:00	60:00	60:00
Carrots	20:00	30:00	40:00	20:00	40:00
Broccoli	10:00	10:00	10:00	10:00	10:00
Yam	80:00	80:00	80:00	80:00	100:00
Kiwi	20:00	20:00	20:00	20:00	20:00
Kale	15:00	15:00	15:00	30:00	30:00
Celery	30:00	30:00	60:00	30:00	45:00
Greens	90:00	45:00	30:00	60:00	130:00
1430 hours					
Red apples	87:50	87:50	87:50	131:25	131:25
Yellow apples	50:00	50:00	50:00	50:00	50:00
Bananas	280:00	350:00	420:00	420:00	350:00
Greens	30:00	15:00	30:00	45:00	45:00

Table 2. Mean amount of food offered daily to each adult *Hylobates* at the International Center for Gibbon Studies.

6.3 Supplements

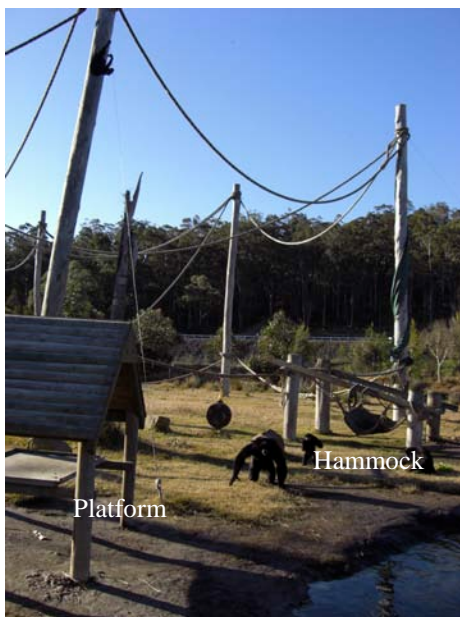
- Predamax by Vetfarm given once weekly sprinkled on PM feed. Dosage: 1/4 teaspoon per individual or as instructed. (See Appendix 2)

- Fish oil given 5x weekly in yogurt. Dosage: ½ capsule per individual.

6.4 Presentation of Food

- AM feed placed on platforms, in hammock and scattered in shady spots on ground between 7:00 to 9:00 hours.
- PM feed scattered around enclosure on ground and in enrichment furniture above ground level between 13:00 to 15:00 hours.
- Enrichment activities include:
 - Honey or ginger smears on wooden beams
 - Peanut butter/ dried fruit in logs
 - Yogurt smears in plastic containers hung around enclosure
 - Fruit in ice cubes
 - Novel fruits, such as, dragon fruit, persimmon, pomegranate, jack fruit, tamarillo, custard apple

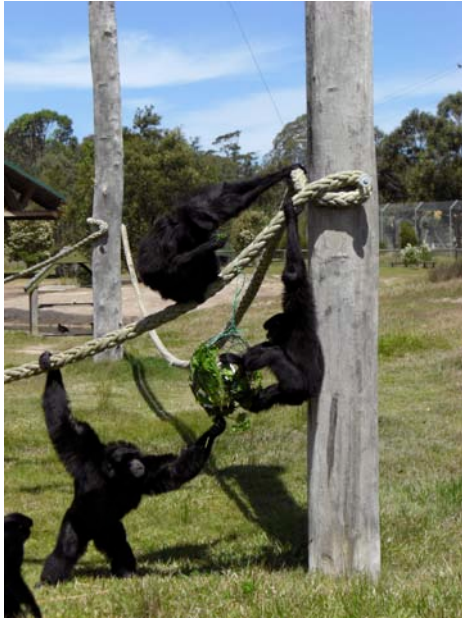
Feeding presentations:



AM feed on wooden platforms or hammock



PM feed scattered on grassy area



Enrichment presentation



Enrichment activities

7 Handling and Transport

7.1 *Timing of Capture and Handling*

- The ideal time for capture is in the early morning before the public arrives or late afternoon when public has departed.
- A morning capture allows adequate time for capture and transport. However, transport may be preferable in evening when animal is less active.
- Capture time may be altered depending on time of transport. It is important to minimize stress by limiting the amount of time spent in the transport box.

7.2 *Catching Bags*

- Capture bags are not used for the Siamang.
- A capture net may be used alternatively (Mootnick, 1997)

7.3 *Capture and Restraint Techniques*

- The ideal technique is to condition the animal to enter a crush and remain inside with door shut and transport box adjoined. The next step is to encourage animal to enter transport box.

Alternatives include:

- A sedative administered via juice in a juice bottled (animal should be conditioned to drink from a bottle).
- A hoop-net contraption, but is not recommended for adults as poses a high risk of injury to keeper. (Cocks, 2002)
- Chemical restraint may occur by conditioning gibbon to approach mesh in the night den, followed by anesthetic injection in to soft tissue by hand of the keeper (personal experience; Mootnick, 1997)
- It is not recommended that any gibbon species be darted due to long extremities. The possibility of hitting a bone is higher in all gibbons.

7.4 Weighing and Examination

- Anesthesia is required to examine adult as classed a dangerous and may cause injury to person by biting or scratching. Adult Siamangs are quite strong.
- Juveniles may be manually restrained using gloves but this is not recommended.
- Weighing usually must be done under anesthesia unless animal is conditioned to sit on a portable scale placed in enclosure.

7.5 Release

- A morning release is preferred as it allows for observation time of introduction to new enclosure and new group member(s). It also allows for time in the event of a problem, where animal requires removal from group or vet attention.
- Release location in enclosure should provide a path clear of obstacles the animal may collide with, resulting in injury.
- Release should occur on ground, even though an arboreal species. This prevents animal from falling if anesthesia/sedative has not worn off.
- Release should not be facing a corner. Should be towards a wide-open space.
- If water is surrounding enclosure, release should occur well away from waters edge.

7.6 Transport Requirements

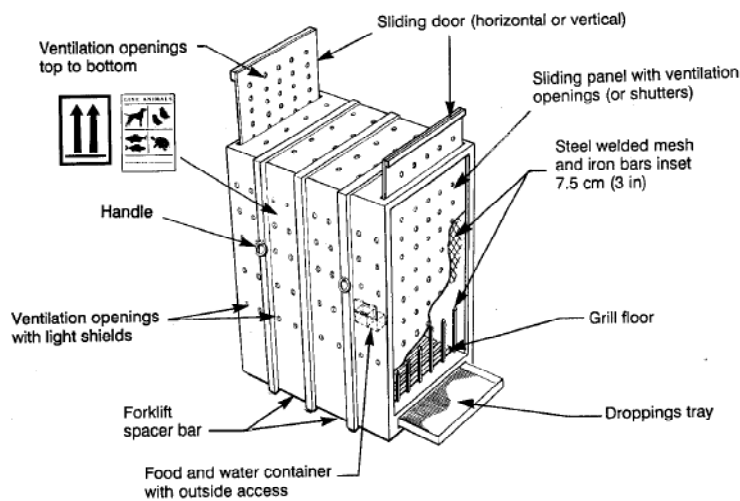
Transport must follow IATA regulations. The following is taken from these regulations (IATA, n.d.):

- Primates must be carried in closed containers. The containers must be well constructed.
- The container must be well constructed and be 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 re-enforced containers due to size and weight.
- It must be constructed of non-toxic materials. Chemically impregnated wood may be poisonous which must not be used.
- The container must be suitable to keep the animal inside at all times and protect the animal from unauthorized access. The door must be constructed so that accidental opening cannot occur, either from the inside or the 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 gnawing or clawing from inside the container cannot damage the joints.

- 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 sterilized prior to reuse.
- The shipper that is suitable for the species must provide absorbent bedding. 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 (2 in) thick. Allowance for the extra height must be made when calculating the dimensions of the container.
- Because all primates are CITES 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.

7.6.1 Box Design



- IATA container guidelines for a young or sub-adult Siamang recommend the space per animal be no less than 0.5 cubic meters in multiple containers.

The following are the requirements for an adult Siamang according to the Policy on Exhibiting Primates in New South Wales (NSW Agriculture, 2000).

- Frame: Welded metal lined with smooth wood or other similar material of a minimum thickness of 1.2 cm (1/2 in).
- Sides: Solid wood or lined metal. The front must consist of strong iron bars, spaced in such a manner that the animal cannot push its arms through the bars. The bars must have a sheet of welded mesh fixed at a distance of 7.5 cm (3 in) in front of them. A wooden shutter with slots or holes for ventilation must cover the whole front in order to reduce the amount of light inside the

container as well as to reduce the disturbance to the animal and to protect the handling personnel. The other three sides, one of which is the door, must be solid with ventilation openings.

- Handling Spacer Bar/Handles: Must be provided on three sides of the container.
- Floor: The base of the container must be solid and leak-proof. A grill flooring must be securely fixed and placed over a leak-proof droppings tray in order that the excreta falls onto it. If a grill or slatted floor is not suitable there must be sufficient absorbent bedding material on the floor to absorb all the excreta, sills must then be used at the front and rear of the container.
- Roof: Solid with meshed ventilation openings.
- Door: A sliding door, the same height and made of the same material as the container, must be placed in the rear of the container. It must have strong and secure means of fastening that cannot be opened accidentally.
- Ventilation: Meshed ventilation openings, approximately 2.5 cm (1 in) in diameter must be provided at heights that will give good ventilation at all levels but particularly when the animal is in a prone position. Openings must cover the sides, rear door and top as well as the sliding shutter as shown in the illustration. All the openings can have exterior mesh screening. A muslin, or similar material, curtain must cover all ventilation opening including the front.

7.6.2 Furnishings

- Furnishing must be minimal to prevent injury during transport.
- Shredded paper can be used for soft bedding.

7.6.3 Water and Food

- Separate food and water containers, either revolving or fixed, must be provided. If fixed they must be placed above the floor at a suitable height and must have outside access for filling and emptying.
- Food should be minimal and low in fiber to reduce excretion.
- The water container must be emptied after use as primates will splash themselves and become wet and chilled.

7.6.4 Animals per Box

- One Siamang per transport box.

7.6.5 Timing of Transportation

- Transport by air can occur when it is available. Evening is preferred as animal is less active.
- Transport by road or train is preferred through the night, when air temperature is cooler. Siamang can overheat in transport box.

7.6.6 Release from Box

- Release should occur once animal is fully recovered from any sedative or anesthesia.
- Release should occur when animal has settled after moving to new location.
- Release path should be clear of obstacles and conspecifics.

8 Health Requirements

8.1 Daily Health Checks

- Observed first thing in morning before first feed.
- Observe each individual for signs of abnormal behaviour or condition. Abnormal behaviours include, but are not limited to, lethargy, lack of interest in food, vomiting, separation from the group, and lack of coordination. See also Sections 9.5 on Behavioural problems and 9.6 on Signs of stress.
- Observe each individual for physical signs of illness.
- Investigate faecal matter for any abnormal qualities, such as, blood, loose consistency, mucous, etc.
- Observe any excreted bodily fluids for abnormal qualities, such as, blood.
- Records are kept of all abnormal observations.
- Veterinarian consulted as needed.
- In order to observe their physical condition and behaviour, a person familiar with the Siamangs must spend sufficient time each day observing the Siamangs.

8.2 Detailed Physical Examination

- Observe eyes for brightness, responsiveness, and clarity.
- Observe ears for any fluids.
- Observe condition of teeth.
- Investigate body condition by massaging all over.
- Listen to lungs for regularity in beating.
- Listen to heart for regularity in beating.
- Records are kept of all observations.

8.2.1 Chemical Restraint

- The gibbon is encouraged to the mesh to be groomed and injected in the outer thigh, biceps or lumbar region (Mootnick, 1997). The injection must occur in a soft tissue area. The needle should to be carried out of Siamang sight.
- A blow dart or dart gun may be used (Mootnick, 1997) but is heavily advised against due to delicate nature of the gibbon skeleton and possible darting inaccuracy.
- The dose of the tranquilizer depends on condition and age of the Siamang and climatic conditions. All dose rates should be calculated in conjunction with the veterinarian.

Drugs used for chemical restraint (See Appendix 3):

- Ketamine for anesthesia. All dose rates should be calculated in conjunction with the veterinarian. *Dose rate of 0.5ml/8.2kg gibbon has been used in the past and was successful for *Hylobates lar*, but unsuccessful for *Hylobates muelleri* (personal experience).
- Domatol recommended for deep sleep. All dose rates should be calculated in conjunction with the veterinarian. *Dose rate of 0.4ml/8.2kg gibbon has been used in the past and was unsuccessful for *Hylobates lar* and *Hylobates muelleri* (personal experience).
- Mootnick (1997) suggests 90mg of Ketamine hydrochloride and 0.5mg Acetylpromazine per 10kg body weight. 0.5 mg Diazepam Intensol per 10kg body weight may be administered to reduce rigidity and tremors from Ketamine. 0.15ml Atropine sulphate may be given if hypersalivation occurs.
- Isoflurane gas can be administered for deep sleep, ad libitum as necessary.
- A pet carrier may be used for temporary transport under chemical restraint

8.2.2 Physical Restraint

- Manual restraint is not recommended, as Siamang is classed a potentially hazardous animal.
- Mechanical restraint in the form of a net or heavy blanket may be used. Tranquilization should follow.
- Siamangs have incredibly long, delicate limbs and care should be taken not to cause injury.
- Mootnick (1997) suggests a disposable respirator, face shield, disposable gloves and two-ply elbow length gloves be used for manual restraint.
- Siamangs will climb under restraint and therefore care should be taken to maintain animal of the ground.
- A wooden crate may be used for temporary transport under physical restraint.

8.3 Routine Treatments

- Faecal checks should occur seasonally, at least twice annually.
- Intestinal worm treatment may be given every 3 months or upon infestation.

8.4 Known Health Problems

- Zoonotic diseases (from Cocks, 2002):
 - Keepers of non-human primates should be aware of the potential for exchange of pathogens between the animals in their care and humans.

- There are a large number of potentially zoonotic pathogens carried by non-human primates, including bacteria (*e.g. Salmonella* spp., *Shigella* spp., *Mycobacterium* spp.), viruses (*e.g. measles* (rubella) virus, Hepatitis B virus) nematodes (*e.g. oxyurids*) and protozoa (*e.g. Giardia intestinalis*, *Balantidium coli*, *Entamoeba histolytica*).
- Transmission can occur via physical contact (bites, scratches), contact with animal tissues (blood, faeces, secretions), via airborne particles that are aerosolised, via ingestion, via insect vectors and via indirect transfer on fomites (*e.g. cleaning equipment used for servicing enclosures, keeper uniforms*).
- Keepers are advised to follow precautionary measures. Adherence to such precautionary measures will reduce the risk of zoonotic transmission.
- Parasitic disease:
 - Non-human primates are potential hosts to a large number of parasites.
 - Many of the parasites encountered in non-human primates can potentially be transmitted to humans (notable examples include *Giardia intestinalis*, *Entamoeba histolytica* and *Balantidium coli*). Readers are advised to consult appropriate veterinary and human medical texts for further information about potentially zoonotic parasites of non-human primates (*e.g. Schultz 1986, Ott-Joslin 1993*).
 - Parasite Species that may be observed on Examination of Faeces (Bodley 2000). Some of the parasites that may be encountered on examination of faeces from *H. moloch* are listed below. Readers are advised to refer to appropriate veterinary texts for details of epidemiology, clinical signs of infection and treatment.
 - Protozoa: *Balantidium coli*, *Entamoeba histolytica*, *Giardia intestinalis*
 - Nematodes: Rhabditoids, *i.e. Stongyloides stercoralis*; Trichurids, *i.e. Anatrichosoma cynomolgi*; Oxyurids, *i.e. Enterobius* spp.
 - Cestodes, *i.e. Hymenolepis nana*
- Tuberculosis (from Cocks, 2002)
 - The bacterial organisms *Mycobacterium tuberculosis* and *Mycobacterium bovis* can cause tuberculosis in non-human primates.
 - Non-human primates may acquire tuberculosis via contact with infected humans or contact with other infected primates.
 - Transmission is usually aerosol, but can occur through ingestion, and direct and indirect contact. Clinical signs vary, are non-specific (depending on the location of the lesions and disease severity), and can include any of the following: chronic cough, anorexia, weight loss, lethargy, diarrhoea, and cutaneous abscesses.
 - Prevention of the disease is via quarantine and testing protocols to reduce the probability of collection primates being exposed to the pathogenic Mycobacteria.
 - Strict importation testing protocols should be followed, and regular surveillance of captive groups for the disease using intradermal skin testing and blood testing is recommended.

- Hepatitis B Virus
 - Humans are the natural host for Hepatitis B (HBV) and serve as the primary reservoir for infections in non-human primates (Bielitzki, 1999 in Cocks, 2002).
 - HBV has recently been discovered in 47% of 30 sampled Silvery gibbons *Hylobates moloch*; however, no markers for HBV were found in the Siamang (Lanford et al., 2000). Precautions should be taken with all gibbon species and keepers you be vaccinated.
 - Bite wounds and needle stick injuries are possible routes of transmission between non-human primates and humans (Cocks, 2002).
 - Infection in non-human primates may be asymptomatic, or may result in signs of hepatitis including anorexia, lethargy, jaundice and elevated liver enzymes detected on blood testing Cocks, 2002).
- Spondyloarthropathy (Rothschild & Woods, 1992)
 - This erosive arthritis has been found in the *Hylobates* sps.
 - Causes may be the infectious agent in diarrhea: *Salmonella*, *Shigella*, *Yersinia*, *Camplobacter*, and enteropathic *Escherichia coli*.
 - Treatment may be that used for humans.

8.5 Quarantine Requirements

The following are requirements outlined in the Policy on Exhibiting Primates in New South Wales (NSW Agriculture, 2000):

- 33 day quarantine required, with two faecal checks negative for intestinal parasites and three tests negative to tuberculosis to be completed (Mootnick, 1997)
- 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.
- Primates that 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.
- 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. All equipment must be used solely for the quarantine facility.
- 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. This author recommends Virkon by DuPont.
- The physical and psychological needs of the animals whilst in quarantine must be provided for.
- Newly received primates must be vaccinated in accordance with the vaccination program of the resident animals.

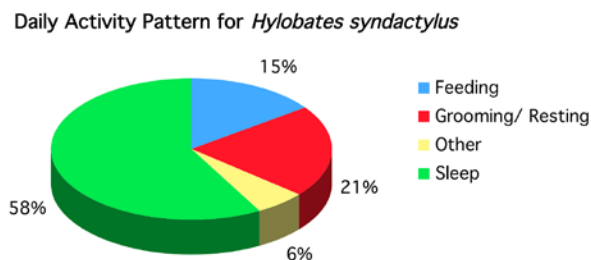
- While primates are in quarantine, examination and, where indicated, treatment for internal and external parasites and any other tests or treatments prescribed by the veterinarian must be undertaken.

9 Behaviour

9.1 Activity

- Diurnal, active approximately 9-10 hours a day (MacDonald, 2004; Gron, 2008)
- Up to 50% spent of the daytime activity spent resting and/or grooming.
- 35% of daytime activity spent feeding (Gron, 2008)
- Resting/grooming occurs mainly during midday, while feeding occurs in the morning and after resting time.
- Other daytime activities may include travel in search of food and/or play.
- 58% sleep during the night hours, sleeping upright with arms folded and head resting between the knees.
- Locomotion is 90% by brachiation and 10% by bipedal walking (Geissmann, 1999).

Fig. 2 Daily Activity Pattern based on a 24-hour cycle:



9.2 Social Behaviour

Social structure

- Monogamous pair.
- Produce offspring every 2-3 years.
- Usually 2 immature animals in the family group.
- Sub-adult will be forced to leave the group between 6-8 years. At this time it will be essential to remove the captive sub-adult from the group (personal experience).
- High cohesion among group throughout daily activities. Individuals will be no more than 10 meters distance from each other (Gron, 2008b).
- Grooming is the most common social activity and next is play.
- Grooming occurs between adults and sub-adults, and adults and young.
- Play is centered on the infant.

Communication

- In captivity, a total of 20 communicatory gestures are observed; 8 visual and 12 relating to touch which is more common (Liebal et al. 2004; Liebal 2007, as cited in Gron, 2008b).
- Inter-group communication includes feeding “glunks”, “squeals” to show submission, and “squeaks” made by juveniles during play (Gron, 2008b).
- Agonistic gestures occur infrequently, but consist of open-mouth threats, grimace and lip-smacking displays (Palombit, 1996a, as cited in Gron, 2008b).
- Siamang groups regularly perform a song, or a duet, which mainly involves the adult pair and is used to advertise their territory, used in defense (Orgeldinger, 1997) and may also be used to reinforce pair bond (MacDonald, 2004).
- Singing may last up to 15 minutes and occur from twice daily to once every five days.
- Singing occurs more frequently when mated males feel threatened by competing males (Orgeldinger, 1997).
- The group song can be divided into three categories of vocalization; "booms," "barks," and "screams" (Chivers, 1974, as cited in Gron, 2008b).

Territory Defense

- In the wild there are five levels of territory defense: calls from the centre, calls from the boundary, confrontation across the boundary, chases across the boundary by males, and physical contact between males.
- Territory intruders may also be chased out, with the defending male practicing bipedal walking, brachiation, staring, and piloerection; these behaviours was carried over to captive Siamang defense (Orgeldinger, 1997).

- Protective and territory duetting occurs more frequently in captivity than in the wild (Orgeldinger, 1997). Males tend to be more aware of outside happenings and spend more time at the front of the enclosure.

9.3 Reproductive Behaviour

- Monogamous pair, known as the pair bond. Mating occurs typically with only one individual and typically for life of the individual. Evidence of polyandry has been found in groups with more than one adult male (Gron, 2008b), although very uncommon.
- There are no major courtship displays; however, the pair may practice duetting to reinforce the pair bond.

9.4 Bathing

- Siamangs do not practice bathing, nor be provided water for cleansing.
- Siamangs spend a considerable amount grooming members of the group.

9.5 Behavioural Problems

- Siamangs are an intelligent ape species and will become destructive when bored. Ensure enclosure furniture is sturdy.
- Siamangs will destroy vegetation when available in small quantities.
- Siamangs, like all apes, have a natural fear of fire and water. When exposed to these may become so fearful, and will often not enter night den or a confined space.

9.6 Signs of Stress

- Spending time away from group.
- Loss of appetite
- Diarrhea, loose faeces
- Lethargy

9.7 Behavioural Enrichment

Exhibit furnishings

- Ropes, poles, tree stumps and platforms
- Installed to provide multiple levels of rigid to semi-flexible items
- Allowing natural art of brachiation.

Mechanical devices

- Sound recording of Siamang duet played to captive group to stimulate territory defense by calling or by action.
- Swings, tires, hammocks, and Aussie-Dog® toys (see Appendix 4) may be used to encourage play.



Social grouping

- A social species
- Must be housed with at least one other individual



- Best in a family group of up to 1.1 adults and 2-4 juveniles to provide entire repertoire of social behaviours.
- At Adelaide Zoo and San Diego Zoo, Siamangs have been housed in a mixed species exhibit with Orang-utans (Zoos South Australia, n.d.; Zoological Society of San Diego Zoo, 2008).

Feeding strategies

- Food is scattered around exhibit to encourage foraging behaviour.
- A variety of fruit, leaves, proteins and cereals/grains are offered due to wide variety of food items in wild.

The following may be used as feeding stimulation:

- Novel food items, such as, Dragon fruit, Persimmon, Pomegranate, Jack fruit, Tamarillo, and Custard apple are offered occasionally as may encounter new varieties in the wild.
- Insects, such as, mealworms, crickets, wood roaches, or silkworms presented in plastic container or scattered in enclosure.
- Fresh browse, such as, Bamboo stalks & shoots, Eucalypt, Wattle, Mulberry, Banana leaves, Willow, and Casuarina offered. (See Appendix 2 for a list of suitable primate browse options.)
- Whole branches given to allow Siamangs to eat, strip, manipulate or play with as would be natural behaviours in the wild.
- Log (approx. 50cm length & 20cm diameter with holes drilled approx. 10cm deep) may be filled with honey, jam, sultanas, vegemite, peanut

butter, and mashed banana to encourage Siamangs to use digits to get reward.



- Smears of honey, jam, peanut butter, or smashed banana smeared on any surface in enclosure allowing Siamangs to forage for reward and consume by licking or using fingers.
- Plastic container puzzle filled with small pieces of food, such as, sultanas, cereal, and beans. Container has a small opening, encouraging Siamangs to manipulate to get reward. In wild may need to manipulate tree to get to desired food item.

Exhibit design

- Open-air enclosure surrounded by a moat to act as a barrier due to natural fear of water.
- Large expanse of space to allow room for multiple individuals. Fairly large home range in the wild.

Human interaction

- Human interaction may occur; however, Siamangs should be locked in a den away from keeper.
- Mesh dens allow keeper to groom willing individuals and establish bond with the gibbons.
- Considered to be a possible threat and also a territorial species.

Training/conditioning

- Siamangs conditioned to travel to enter den for reward and permit to be locked in.



- Food rewards are useful, as they would travel to desired food item in the wild.

Sensory stimulation

- Access to natural light, but adequate shade as a rainforest species.
- Protection from cold, wet conditions as not adapted to this climate
- Aromatherapy may be presented with spices, herbs, or novel smells. This could include ginger, cinnamon, allspice, lemon grass, mint, basil, rosemary, lavender, and tea tree oil. A variety of smells may be encountered in the rainforest habitat.
- Frozen Treats, such as, yogurt, diluted juice, and fruit pieces in water Ice would most likely not be encountered in the wild; however, provides stimulation to a change in temperature.

9.8 Introductions and Removals

- Unrelated pairs should be introduced in a neutral territory.
- “Gibbons that are intimidated easily, especially those that have been housed alone for a number of years, should not be housed with aggressive conspecifics ” (Mootnick & Nadler, 1997, as cited in Cocks, 2002).
- A submissive hand-reared gibbon should be familiar with its surroundings before a conspecific enters the enclosure, and a slow introduction is preferred (Breznock et al., 1979; Mootnick & Nadler, 1997, as cited in Cocks, 2002).
- Initially introduced gibbons should be allowed to interact for approximately five minutes to one hour per day under constant human observation until the keeper is assured that no fighting will occur (Mootnick, 1996).
- Indications of compatibility are grooming, copulating, food sharing and vocal duetting.
- The interaction time should be increased each day, if no aggression is observed.
- To prevent aggression it is recommended that newly introduced gibbons have separate feeding areas.
- If one or both of the gibbons is very aggressive, Mootnick (1996) recommends having three connecting enclosures, so that the gibbons have visual contact with each other before they are housed into the adjoining enclosure.

- When the breeding pair performs a vocal defense against conspecifics and become aggressive towards maturing same sex offspring in the family group, removal may be required.
- Adult offspring should be removed from the natal group before they are peripheralized (Mootnick, 1996, as cited in Cocks, 2002).
- Peripheralization or outcasting can occur between six to eight years of age at age of maturity.

9.9 Intraspecific Compatibility

- It is not recommended to house adult same-sex pairs together as this may result in aggressive encounters.
- Indications of compatibility are grooming, copulating, food sharing and vocal duetting.

9.10 Interspecific Compatibility

- Successful mixed-species with Siamangs and Orang-utans exist at San Diego Zoo's Absolutely Apes exhibit and Adelaide Zoo's Immersion exhibit (Zoological Society of San Diego Zoo, 2008; Zoos South Australia, n.d.;).

9.11 Suitability to Captivity

- The Siamang is easier to house than the great apes, due to its smaller size and lesser strength.
- However, the Siamang is more difficult to house than the other gibbon species, mainly due to its larger size and potential threat.
- If held in a family group, Siamangs will rarely become bored and destructive due to stimulation of group dynamics.
- Sub-adults must be removed after 6-8 years.
- They have a complex diet, with a variety of foods.
- The exhibit must provide adequate space, especially with family groups, because this species is fairly mobile and arboreal, traveling long distances in the wild.

10 Breeding

10.1 Mating System

- Monogamous. Typically one mate for lifespan of an individual.
- New pair bonds can be formed if required for breeding management purposes (see Geissmann, 1999 for pair exchange).
- Occasionally groups with multiple males will be polyandrous (Gron, 2008b).

10.2 Ease of Breeding

- If female and male get along, breeding will need no keeper assistance or intervention.
- Allow pair to engage in bonding and copulation.

10.3 Reproductive Condition

10.3.1 Females

- Females must be in good, healthy condition to carry young.
- Natural sunlight as a source of Vitamin D is necessary for a healthy pregnancy gestation in primates.
- Females must have the physical ability to carry and nurse young after birth.

10.3.2 Males

- The reproductive male must be the dominant male in the pair bond.
- In the wild, males must be in good physical condition in order to defend the female from potential male threats. However, this is not so much the case in captivity as groups are typically housed separately.

10.4 Techniques Used to Control Breeding

- Breeding may be controlled by male vasectomy or female contraception.
- Separating the female and male may also control breeding; however this is not recommended as this species is highly monogamous and this process may be very stressful.
- Males and females may be housed in single sex groups to prevent breeding.
- Breeding may be prevented by female hysterectomy.

10.5 Occurrence of Hybrids

- There are no other known subspecies of Siamang; therefore hybridization may not occur.
- Wild groups are found on Sumatra and the Malaysian peninsula and are separated by a body of water; however, these variations have not been maintained in captivity.
- There are no known cases of successful breeding with any other *Hylobates* spp.

10.6 Timing of Breeding

- In captivity, breeding may occur at any time of the year and ovulation may occur monthly.
- In the wild females show seasonality for the breeding season based on the fruiting and flowering peaks. The conception peak is from May to July, with the parturition peak from December to February (Koyama; Chivers; Chivers & Raemaekers, as cited in Gron, 2008b). This peak may be evident in captivity.
- Copulation usually occurs once a day, alternating days during the peak season (Gron, 2008b).
- Reproductive females may begin to ovulate approximately 2-3 months after complete weaning (usually occurs around 1 year after parturition) reproduce an average of once every 2-3 years.

Fig 3. Annual cycle of maintenance activities for Siamang, *Hylobates syndactylus*

	Ja n	Fe b	Ma r	Ap r	Ma y	Jun e	Jul y	Au g	Sep t	Oc t	No v	De c
Breeding season	Black											
Peak Copulation period					Red	Red	Red					Blue
Peak parturition period	Blue	Blue										
Major enclosure repairs if needed			Grey	Grey				Grey	Grey	Grey	Grey	
Minor enclosure repairs if needed	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey
Nest box cleaning				Grey						Grey		
Routine health checks (daily)	Black											

10.7 Age at First Breeding and Last Breeding

- Age of first breeding could be as early as 6-8 years (Geissmann, 1991) if a successful pair bond has formed.

- Last breeding generally occurs around 30 years.

10.8 Ability to Breed Every Year

- The Siamang is unable to breed every year when parturition and infancy are successful.
- The gestation is 8 months.
- A female may breed again in the same 12-month period if the first fetus is aborted in the first trimester.

10.9 Ability to Breed More than Once Per Year

- The Siamang is unable to breed more than once per year.

10.10 Nesting, Hollow or Other Requirements

- In captivity, Siamangs do not practice nesting behaviour.
- A nesting box with straw may be provided; however, it appears this is not used for birthing.
- Birthing typically occurs in the night den, but not in the nesting box.

10.11 Breeding Diet

- An increase in protein may be given to pregnant female.
- Increased appetite may result in aggression to other family members over food. In this instance, pregnant female may be hand fed additional portions.

10.12 Oestrus Cycle and Gestation Period

- Females ovulate monthly.
- Gestation is 7- 8 months (Gron, 2008b).

10.13 Litter Size

- Typically one infant; however twins have occurred on a very rare occasion (Tintinger, in revision)

10.14 Age at Weaning

- Weaning begins at 6 months and typically completes around 12 months of age. Food sampling may begin as early as 2 months (personal observation; Campbell, in revision)
- Young may continue to suckle after this time if mother allows it.

10.15 Age of Removal from Parents

- Offspring will remain with the family group until peripheralization occurs.
- Peripheralization from the group typically occurs during the sub-adult stage, and when there are an additional two juveniles.
- Sub-adult will be forced to leave the group between 6-8 years. At this time it will be essential to remove the captive sub-adult from the group.

10.16 Growth and Development

- The mother-infant bond in Siamangs is very strong, with the mother protecting the infant from other group members as well as sympatric species.

- The newly born infant always clings to the mother's belly and feeds on her milk for up to 6 months, after which weaning starts.
- The mature newborn, which spends time feeding and playing with other group members, but will return to mother when frightened or for sleeping/resting.
- After 12 months of age, the young Siamang will begin spending time with the father (personal observation).
- Play is usually centered on the young, with older siblings partaking the most.

11 Artificial Rearing of Mammals

- Artificial rearing should be avoided if at all possible.
- A Hand Raising Paper: Hand raising a White-cheeked Gibbon infant (*Hylobates leucogenys*) at Perth Zoo: A Preliminary Report. (Campbell, in revision) will be used extensively for this section.
- A paper in revision on the hand raising of a Siamang at Auckland Zoo will also be used. No known published sources have been found on hand raising a Siamang.

11.1 Housing

- A humidicrib may be used for infants (Campbell, in revision; Tintinger, in revision). (See Appendix 4)
- A baby cot may be used when the infant has outgrown the humidicrib (Campbell, in revision).
- When strength allows infant to climb out of cot, will need to be upgraded to a fully enclosed set-up with soft bottom and climbing furniture. A mesh birdcage is suitable (Tintinger, in revision).

11.2 Temperature Requirements

- Depending on the age of the infant, it is unlikely that it will be able to maintain its own body temperature so suitable housing must be provided. For newborns, a humidicrib would be appropriate, at least until stabilized (Campbell, in revision).
- The temperature should be set to 30°C (85°F) (Strasser, 2002, in Campbell, in revision). The infant should always be provided with a heat source. This can include heat lamps and heat pads. Care must be taken to avoid over heating. Only cotton blankets should be used and the infant should have the opportunity to move away from or closer to the heat source (Strasser, 2002, in Campbell, in revision).

11.3 Diet and Feeding Routine

As suggested in Campbell (in revision), this regime was used on 3 gibbons with success:

- Human milk formulas are the most suitable for gibbons. In Australia, S26 Gold has been found to be a successful formula that has not required additional supplements. Karicare may be used alternatively (Tintinger, in revision). (See Appendix 5)
- Recommended teats are Enfamil neonatal Nipple by Mead Johnson or Similac Special Care teats by Abbott Laboratories. (See Appendix 4)
- When calculating milk volumes a target of 20% of the infant's body weight in total milk volume should be used. Milk should be offered at 50% strength to begin with and gradually increased to full strength over a period of a few days. Cooled pre boiled water should be used to make formula. Guargol (thickening agent) has been added to milk during periods of unexplained diarrhoea. (See Appendix 2) Discard unused formula after 24 hours.

- Volume of each feed can be increased gradually and the frequency of feeds reduced.
- Solid foods should be offered to gibbon infants at about 60 days and gradually increased.

Table 1 shows a comparison between weights, milk and solid intake and number of feeds per day for the three infants raised at Perth Zoo (Campbell, in revision).

Age (days)	Expected Body Weight (gms)			Total milk intake			Number of feeds per day			Total Solid intake		
	Jermei	Meili	Lily	Jermei	Meili	Lily	Jermei	Meili	Lily	Jermei	Meili	Lily
0-5	-	560	552	-	160	143	-	10	11	-		
10	-	638	593	-	224	120	-	10	11	-		
20	-	742	688	-	189	144	-	8	11	-		
30	-	824	748	-	230	160	-	8	11	-		
40	642	908	796	159	232	178	8	8	8	-		
50	656	970	832	154	264	205	7	8	8	-		
60	640	1034	874	118	264	200	7	7	7	10	10	
70	644	1024	916	150	205	210	7	7	9	10	10	
80	742	1030	950	174	201	220	7	7	9	10	50	
90	830	1096	954	194	224	220	7	7	9	10-20	50-80	
120	1052	1199	1118	208	226	230	6	6	7	20-30	80-100	
150	1174	1362	1258	139	194	178	4m 2s	6	5	30-80	120	
180	1282	1500	1410	120	200	135	3m 2s	6	4	80 +b	120	
210	1400	1590	1588	120	185	108	3m 2s	5	3	130 +b	150	
240	1520	1688	1660	170	126	120	3m 2s	3	3	150+b	150	+b
270	1500	1800	1872	165	99	120	3m 2s	3	3	160+b	150	*

300	1700		2036	150	77	120	3m 2s	2	3	160+b	150	
330	1750		2207	180		120	3m 2s		3	160+b		
360	1850		2364	170		120	3m 2s		3	160+b		
400	2000			180			3m 2s			160+b		
450	2100			180			3m 2s			200+b		
500	2300											

m= milk formula

S = solids (fruit and vegetables)

b= milk balls made from formula and Farax or Heinz baby cereal

Tintinger (in revision) suggests the following schedule for weaning to solids:

- At 6 weeks, 7-8 milk feed only (30mls of milk)
- At 2 months of age, juvenile was introduced to pureed baby food, with 6 milk feeds.
- At 3 months, juvenile was offered apple, pear and banana, with 506 milk feeds.
- At 4 months, juvenile was offered a variety of vegetables, fruit, bread, dried fruit, and greens, with 4-5 milk feeds (milk increased to 60mls).
- At 5 months, access to solids at all times in cage, with 3 milk feeds, daytime only.
- At 6.5 months, milk feeds reduced to two, am and pm only. Begin drinking from a water bottle.
- At 7.5 months, milk feed only once a day. Milk remained at 60mls.
- Juvenile was fully weaned off the milk feed at 14 months 2 weeks.

11.4 Specific Requirements

- Siamang infants will require an increased proportion of milk due to greater size.
- Siamang infants require song development opportunities.

11.5 Data Recording

- Scales will also be required to accurately weigh the infant.
- Rectal thermometer to assess body temperature. A lubricant should be applied to the thermometer and disinfected before and after each use.

11.6 Identification Methods

- Siamangs generally give birth to only one infant; therefore, identification should be easy.
- Facial marking or other physical markings may be used for identification.

11.7 Hygiene

- Hygiene should be high during the first few days of infant's life. If the infant has not received any milk from its mother, it will not have acquired important antibodies.
- Keeper should wash hand thoroughly before handling infant.
- Human illnesses are easily transferable to infants, especially very young ones; therefore, ill keepers should not make contact with infant.

11.8 Behavioural Considerations

- Development of normal behaviours are of primary concern when hand raising any primate infant. Opportunities for socialization with other juvenile gibbons provide the best exposure to the full range of normal behaviours (Campbell, in revision).
- Whilst infant apes require some level of affection and attention from keepers, imprinting should be avoided. Imprinting can lead to serious behavioural issues at a later date.
- Infant gibbons would normally experience some level of discipline from their parents and siblings. It is important that they have some understanding of this concept prior to reintroduction. Keepers should provide a similar level of discipline that they would experience from their natural parents (Campbell, in revision). In addition, when available juvenile should be provided with same species interaction. For instance, the juvenile's cage may be placed near the family's enclosure and/or the juvenile allowed to play with non-threatening siblings (Tintinger, in revision).
- In the absence of socialization opportunities, normal behavioural, i.e. locomotion and vocal, development should be considered (Campbell, in revision).
- Calling behaviours in gibbons appear to be instinctive and these behaviours will often develop in the hand-raised infant prior to any exposure to or experience with adults (Campbell, in revision).
- Young gibbons should be given the opportunity to develop climbing and brachiation skills from quite an early stage (Campbell, in revision).
- Male gibbons, which were hand raised, appear to be more adversely affected sexually than female gibbons. Although females may be sexually inadequate they can usually be induced to present sexually by dominant male partners (Mootnick et al 1997, as cited in Cocks 2000).

11.9 Use of Foster Species

- There has been no known published cases of rearing by another species.
- It could be possible for rearing to occur by another gibbon species; however, there would be direct behaviour consideration with regards to social structure development and song development.

11.10 Weaning

- Weaning may begin as early as 60 days and may complete as late as 500 days (Campbell, in revision; Tintinger, in revision).

- Weaning may require slowly introducing solids by using Farax (rice cereal) to make a porridge-milk mix. This was successful in the hand rearing of a Cotton-top Tamarin.
- See weaning regime (above).

11.11 Rehabilitation and Release Procedures

- Young should be encouraged and aided in development of motor and sensory skills.
- Keepers should provide adequate stimulation for development of natural gibbon behaviors.
- Imprinting should be minimized.
- Release back into the family group may occur (see procedures below for juvenile reintroduction) or the hand-reared sub-adult may be introduced to a potential mate, forming a pair bond.

Reintroduction procedures taken from Campbell (in revision):

- Reintroduction should be attempted at the earliest possible opportunity that will not compromise the wellbeing of the infant. This is not necessarily at the time of weaning as mothers and infants can be trained for supplementary feeding after reintroduction. The infant should however be able to maintain it's own body temperature and be independent enough to remain mobile should the mother abandon it.

The keys to a successful reintroduction are:

- The mother has some recognition of what the infant is.
- There should be no obvious aggression from either parent or enclosure mates during visual contact sessions.
- The infant should recognize a food source, if not from the mother then from an external human carer.
- The mother should have some ability to handle the infant.
- Staff involved in any reintroduction should have an in depth understanding of the individual characters involved and have a good rapport with the animals.

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13 References

- ARAZPA. (2007). *Census of Mammalia in ARAZPA institutions*, 84 pages.
- Campbell, C. (in revision), *Gibbon handraising at Perth Zoo: Analysis of methods and suggested guidelines*, in revision, 30 pages. Perth Zoo.
- Cocks, L. (2002). *Husbandry manual for the Silvery Gibbon (Hylobates moloch)*, 23 pages. Perth Zoo.
- Eastridge, A. (1999). *Symphalangus syndactylus*, Animal Diversity Web. http://animaldiversity.ummz.umich.edu/site/accounts/information/Symphalangus_syndactylus.html. Last accessed 20 November 2008.
- Geissmann, T. (1991). *A reassessment of age of sexual maturity in gibbons (Hylobates spp.)*. American Journal of Primatology 23: 11–22.
- Geissmann, T. (1999). *Duet songs of the Siamang, Hylobates Syndactylus, II: Testing the pair-bonding hypothesis during a partner exchange*, Behaviour 136: 1005-1039.
- Geissmann, T. (2001). *Circumfacial markings in Siamang and evolution of the face ring in Hylobatidae*, International Journal of Primatology (2003) 24(1): 143-156.
- Geissmann, T. (2007). *Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006*. Gibbon Journal 3, pp.5-15.
- Gron, K.J. (2008a). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Taxonomy, Morphology, & Ecology. <http://pin.primate.wisc.edu/factsheets/entry/siamang/taxon>. Last accessed 22 November 2008.
- Gron, K.J. (2008b). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Behavior. <http://pin.primate.wisc.edu/factsheets/entry/siamang/behav>. Last accessed 22 November 2008.
- Gron, K.J. (2008c). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Conservation. <http://pin.primate.wisc.edu/factsheets/entry/siamang/cons>. Last accessed 22 November 2008.
- IATA, (n.d.). *Container requirements 33*, pp. 215-216.
- MacDonald, D. (Ed). (2004). *The new encyclopedia of mammals*. Oxford University Press.
- Mootnick, A. (1997). *Management of gibbons (Hylobates spp.) at the International Center for Gibbon Studies, California: with a special note on Pileated gibbons (Hylobates pileatus)*, International Zoological Yearbook (1997) 35: 271-279, The Zoological Society of London.
- Nijman, V. & Geissmann, T. (2008). *Symphalangus syndactylus*. 2008 IUCN Red List of Threatened Species. www.iucnredlist.org. Last accessed 20 November 2008.

- NSW Agriculture, (2000). *Policy on exhibiting primates in New South Wales, Exhibited Animals Protection Act*, 74 pages.
- O'Brien, T.G., Kinnaird, M.F., Nurcahyo, A., Iqbal, M., & Rusmanto, M. (2004). *Abundance and distribution of sympatric gibbons in a threatened Sumatran rain forest*, *International Journal of Primatology* 25(2): 267-284.
- Orgeldinger, M. (1997). *Protective and territorial behavior in captive Siamangs (Hylobates syndactylus)*, *Zoo Biology* 16:309–325.
- Reichard, U. (1998). *Sleeping sites, sleeping places, and presleep behavior of gibbons (Hylobates lar)*, *American Journal of Primatology* 46:35–62.
- Rothschild, B.M & Woods, R.J. (1992). *Erosive Arthritis and Spondyloarthropathy in Old World Primates*, *American Journal of Physical Anthropology* 88:389-400.
- Smith, B.H., Crummett, T.L. & Brandt, K.L. (1994). *Ages of eruption of primate teeth: A compendium for aging individuals and comparing life histories*, *American Journal of Physical Anthropology* 37(S19): 177-231.
- Straus, W.L.Jr. (n.d.). *Locomotion of gibbons*, in Notes, pp.354-357, Department of Anatomy.
- Tintinger, C. (in revision). *Handraising baby Siamang at Auckland Zoo: Personal notes*. Email correspondence.
- Uchikoshi, M. & Matsuzawa, T. (2007). *Tooth eruption in two agile gibbons (Hylobates agilis)*, *Gibbon Journal* 3, pp.66-73.
- Wikipedia. (n.d.). Wikipedia online. Wikipedia Foundation, Inc. Last accessed 20 November 2008.
- Zoological Society of San Diego (2008). *Absolutely Apes*. www.sandiegozoo.org/zoo/ex_absolutely_apes.html. Last accessed 20 November 2008.
- Zoos South Australia (n.d.). *Adelaide Zoo Immersion exhibit*. <http://www.zoossa.com.au/adelaide-zoo/animals-exhibits/exhibits/immersion>. Last accessed 20 November 2008.

14 Bibliography

- ARAZPA. (2007). *Census of Mammalia in ARAZPA institutions*, 84 pages.
- Campbell, C. (in revision), *Gibbon handraising at Perth Zoo: Analysis of methods and suggested guidelines*, in revision, 30 pages. Perth Zoo.
- Cocks, L. (2002). *Husbandry manual for the Silvery Gibbon (Hylobates moloch)*, 23 pages. Perth Zoo.
- Dahl, J.F. & Nadler R.D. (1992). *Genital swelling in females of the monogamous gibbon, Hylobates (H.) lar*, American Journal Of Physical Anthropology 89:101-108.
- Eastridge, A. (1999). *Symphalangus syndactylus*, Animal Diversity Web. http://animaldiversity.ummz.umich.edu/site/accounts/information/Symphalangus_syndactylus.html. Last accessed 20 November 2008.
- Geissmann, T., (1991). *A reassessment of age of sexual maturity in gibbons (Hylobates spp.)*. American Journal of Primatology 23: 11–22.
- Geissmann, T. (1999). *Duet songs of the Siamang, Hylobates Syndactylus II: Testing the pair-bonding hypothesis during a partner exchange*, Behaviour 136: 1005-1039.
- Geissmann, T. (2001). *Circumfacial markings in Siamang and evolution of the face ring in Hylobatidae*, International Journal of Primatology (2003) 24(1): 143-156.
- Geissmann, T. (2007). *Status reassessment of the gibbons: Results of the Asian Primate Red List Workshop 2006*. Gibbon Journal 3, pp.5-15.
- Gron, K.J. (2008a). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Taxonomy, Morphology, & Ecology. <http://pin.primate.wisc.edu/factsheets/entry/siamang/taxon>. Last accessed 22 November 2008.
- Gron, K.J. (2008b). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Behavior. <http://pin.primate.wisc.edu/factsheets/entry/siamang/behav>. Last accessed 22 November 2008.
- Gron, K.J. (2008c). Primate Factsheets: Siamang (*Symphalangus syndactylus*) Conservation. <http://pin.primate.wisc.edu/factsheets/entry/siamang/cons>. Last accessed 22 November 2008.
- IATA, (n.d.). *Container requirements 33*, pp. 215-216.
- Jackson, S.M. (2002). *Standardizing captive-management manuals: guidelines for terrestrial vertebrates* revised, in International Zoo Yearbook (2003) 38: 229-243, The Zoological Society of London, London.
- Koda, H., Oyakawa, C., Kato, A., & Masataka, N. (2007). *Experimental evidence for the volitional control of vocal production in an immature gibbon*, Behaviour 144: 681-692.
- MacDonald, D. (Ed). (2004). *The new encyclopedia of mammals*. Oxford University

Press.

Maestriperi, D. & Roney, J.R. (2004). *Primate copulation calls and postcopulatory female choice*, Behavioral Ecology 16(1): 106-113, International Society for Behavioral Ecology.

Mootnick, A. (1997). *Management of gibbons (Hylobates spp.) at the International Center for Gibbon Studies, California: with a special note on Pileated gibbons (Hylobates pileatus)*, International Zoological Yearbook (1997) 35: 271-279, The Zoological Society of London.

Nadler, R.D. & Mootnick, A.R. (1996). *Sexual behaviour of maternally separated gibbons (Hylobates)*. Available online from John Wiley and Sons, Inc (1997). 13 pages.

Nijman, V. & Geissmann, T. (2008). *Symphalangus syndactylus*. 2008 IUCN Red List of Threatened Species. www.iucnredlist.org. Last accessed 20 November 2008.

NSW Agriculture, (2000). *Policy on exhibiting primates in New South Wales, Exhibited Animals Protection Act*, 74 pages.

O'Brien, T.G., Kinnaird, M.F., Nurcahyo, A., Iqbal, M., & Rusmanto, M. (2004). *Abundance and distribution of sympatric gibbons in a threatened Sumatran rain forest*, International Journal of Primatology 25(2): 267-284.

Orgeldinger, M. (1997). *Protective and territorial behavior in captive Siamangs (Hylobates syndactylus)*, Zoo Biology 16:309–325.

Palombit, R.A. (1997). *Inter- and Intraspecific variation in the diets of sympatric Siamang (Hylobates syndactylus) and Lar gibbons (Hylobates lar)*, Folia Primatol 68: 321-337.

Rafferty, K.L. & Ruff, C.B. (1994). *Articular structure and function in Hylobates, Colobus, and Papio*, American Journal of Physical Anthropology 94: 395-408.

Redmond, J.C. & Lamperez, A. (2004). *Leading limb preference during brachiation in the gibbon family member, Hylobates syndactylus Siamangs): A study of the effects of singing on lateralization*, Laterality 9(4): 381-396.

Reichard, U. (1998). *Sleeping sites, sleeping places, and presleep behavior of gibbons (Hylobates lar)*, American Journal of Primatology 46:35–62.

Rothschild, B.M & Woods, R.J. (1992). *Erosive Arthritis and Spondyloarthropathy in Old World Primates*, American Journal of Physical Anthropology 88:389-400.

Smith, B.H., Crummett, T.L. & Brandt, K.L. (1994). *Ages of eruption of primate teeth: A compendium for aging individuals and comparing life histories*, American Journal of Physical Anthropology 37(S19): 177-231.

Smithsonian National Zoological Park (n.d.). *Siamangs fact sheet*, <http://nationalzoo.si.edu/Animals/Primates/Facts/FactSheets/Gibbons/Siamang/default.cfm>. Last accessed 20 November 2008.

Straus, W.L.Jr. (n.d.). *Locomotion of gibbons*, in Notes, pp.354-357, Department of

Anatomy.

Tintinger, C. (in revision). *Handraising baby Siamang at Auckland Zoo: Personal notes*. Email correspondence.

Tyler, M.J. (2002). *Husbandry Manual for the Chinese White-cheeked Gibbon (Hylobates (Nomascus) leucogenys)*, 27 pages. Perth Zoo.

Uchikoshi, M. & Matsuzawa, T. (2007). *Tooth eruption in two agile gibbons (Hylobates agilis)*, *Gibbon Journal* 3, pp.66-73.

Wikipedia. (n.d.). Wikipedia online. Wikipedia Foundation, Inc. Last accessed 20 November 2008.

Zoological Society of San Diego (2008). *Absolutely Apes*.
www.sandiegozoo.org/zoo/ex_absolutely_apes.html. Last accessed 20 November 2008.

Zoos South Australia (n.d.). *Adelaide Zoo Immersion exhibit*.
<http://www.zoossa.com.au/adelaide-zoo/animals-exhibits/exhibits/immersion>. Last accessed 20 November 2008.

15 Glossary

Brachiation (from "limb" or "branch") is a form of arboreal locomotion in which primates swing from tree limb to tree limb using only their arms (modified from Wikipedia, n.d.).

Also: brachiate

Duet is the composition or song for two performers, usually the dominant adult pair. Juveniles may participate (modified from Wikipedia, n.d.). This may also be termed the song or call of the Siamang.

Also: duetting

Enrichment is the practice of providing animals under managed care with stimuli such as natural and artificial objects (modified from Wikipedia, n.d.).

Epidemiology is the study of factors affecting the health and illness of populations, and serves as the foundation and logic of interventions made in the interest of health and preventive medicine (modified from Wikipedia, n.d.).

Hysterectomy (from Greek hystera "womb") is the surgical removal of the uterus (modified from Wikipedia, n.d.).

Monogamy is the condition of having a relationship that remains exclusive in some way. The word monogamy comes from the Greek word monos, which means one or alone, and the Greek word gamos, which means union (modified from Wikipedia, n.d.). This may be signified by a pair bond.

Also: monogamous

Peripheralization The outcasting or ostracizing of a younger member of the social group.

Piloerection is when the hair erects; usually involuntarily develop when the Siamang experiences strong emotions such as fear or aggression.

Polyandry (Greek: poly- many, andros- man) refers to a female's sexual union with two or more males at the same time.

Also: polyandrous

Spondyloarthropathy is an inflammatory joint disease associated with the MHC class I molecule HLA-B27 (modified from Wikipedia, n.d.).

Sympatry refers to two or more species living in the same habitat.

Also: sympatric relation

Syndactylous refers to the condition of having 2nd and 3rd toes fused by thin webbing of skin (Eastridge, 1999).

Vasectomy is a surgical procedure in which the vasa deferentia of a male are cut for the purpose of sterilization (modified from Wikipedia, n.d.).

Zoonosis is any infectious disease that is transmitted (by a vector) from other animals, both wild and domestic, to humans or from humans to animals (modified from Wikipedia, n.d.).

Also: zoonose; zoonotic disease

16 Appendix

Appendix 1: Chemicals

- Animal House by Glason available through www.glason.com.au/index.php?option=com_content&task=view&id=31&Itemid=36



- Virkon by DuPont available through www2.dupont.com/DAHS_EMEA/en_GB/products/disinfectants/virkon_s/index.html



Appendix 2: Supplement Information

- Primate Pellets “Leaf Eater Primate 3” by Specialty Feeds available through www.specialtyfeeds.com/sp-frameset.html?standiets/zooanimals.html



DIET	
LEAF EATER PRIMATE 3	
A fixed formulation diet for Leaf Eating Primates. Updated formulation to improve palatability 20/7/2006 Diet is packed under nitrogen in oxygen impermeable bags to improve shelf life.	
Calculated Nutritional parameters	FEEDING RECOMENDATIONS
Protein 25 %	Feed ad-lib to animals of all ages in combination with fresh fruit, vegetables and leafy materials.
Total Fat 6 %	
Crude Fibre 11 %	
AD Fibre 16 %	
Digestible Energy 11 MJ / Kg	
Ingredients	DIET FORM
A fixed formula ration using the following ingredients. Lupins, Millmix (Bran and pollard), Soya meal, Torula yeast, Guar gum, Molasses, Methionine, Lysine, Dicalcium Phosphate, Calcium carbonate, Magnesium oxide, Sodium chloride and a Vitamin and Mineral premix.	8mm diameter cubes. Packed in 10 Kg boxes under nitrogen or 20 Kg bags.
Added Trace Minerals	Added Vitamins
Magnesium 150 mg / Kg	Vitamin A (Retinol) 13,000 IU / Kg
Iron 93 mg / Kg	Vitamin D3 (Cholecalciferol) > 2,600 IU/Kg
Copper 21 mg / Kg	Vitamin K (Menadiione) 26 mg / Kg
Iodine 1 mg / Kg	Vitamin E 130 mg / Kg
Manganese 93 mg / Kg	(a Tocopherol acetate)
Zinc 80 mg / Kg	Vitamin C 455 mg / Kg
Molybdenum 1 mg / Kg	Vitamin B1 (Thiamine) 106 mg / Kg
Selenium 0.1 mg / Kg	Vitamin B2 (Riboflavin) 40 mg / Kg
	Niacin (Nicotinic acid) 130 mg / Kg
	Vitamin B6 (Pyridoxine) 33 mg / Kg
	Calcium Pantothenate 66 mg / Kg
	Biotin 400 ug / Kg
	Folic acid 7 mg / Kg
	Vitamin B12 200 ug / Kg
	(Cyanocobalamin)

Page 1

- Predamax by Vetafarm with active constituents: Calcium, Phosphate, Vitamin A, D3, K, B1, B2, B6, B12. Pantothenate, Niacin, Folic Acid Choline Bitartrate, Salt, Iodine, Iron, Cobalt, Magnesium, Manganese, Zinc. Available through www.vetafarm.com.au/products/PREDAMAX.html
- Guargol is a non-hazardous thickening agent made from guar gum and added to milk during periods of unexplained diarrhoea. By Orion, available through www.orion.net.au

Calculated Amino Acids		Calculated total Vitamins	
Valine	1.0 %	Vitamin A (Retinol)	15,000 IU / Kg
Leucine	1.6 %	Vitamin D3 (Cholecalciferol)	> 2,600 IU / Kg
Isoleucine	0.9 %	Vitamin E (Tocopherol)	150 mg / Kg
Threonine	0.8 %	Vitamin K (Menadiione)	27 mg / Kg
Methionine	0.2 %	Vitamin C (Ascorbic acid)	500 mg / Kg
Cystine	0.4 %	Vitamin B1 (Thiamine)	110 mg / Kg
Lysine	1.2 %	Vitamin B2 (Riboflavin)	44 mg / Kg
Phenylalanine	1.0 %	Niacin (Nicotinic acid)	190 mg / Kg
Tyrosine	0.8 %	Vitamin B6 (Pyridoxine)	38 mg / Kg
Tryptophan	0.2 %	Pantothenic acid	82 mg / Kg

Calculated Total Minerals	
Calcium	0.5 %
Phosphorous	0.6 %
Magnesium	0.7 %
Sodium	0.3 %
Chloride	0.3 %
Potassium	1.2 %
Sulphur	0.3 %
Iron	180 mg / Kg
Copper	34 mg / Kg
Iodine	0.7 mg / Kg
Manganese	160 mg / Kg
Cobalt	0.03 mg / Kg
Zinc	140 mg / Kg
Molybdenum	0.7 mg / Kg
Selenium	0.1 mg / Kg
Cadmium	trace
Chromium	no data

Calculated Fat Composition	
Myristic Acid 14:0	trace
Palmitic Acid 16:0	0.6 %
Stearic Acid 18:0	0.1 %
Palmitoleic Acid 16:1	0.01 %
Oleic Acid 18:1	1.1 %
Godoleic Acid 20:1	0.02 %
Linoleic Acid 18:2 n6	1.9 %
a Linolenic Acid 18:3 n3	0.3 %
Steridonic Acid 18:4 n5	trace
Total Carotenoid	no data
Total Phospholipid	no data
Cholesterol	trace

Calculated data uses information from typical raw material composition. It could be expected that individual batches of diet will vary from this figure.
We are happy to provide full calculated nutritional information for all of our products, however we would like to emphasize that these diets have been specifically designed for manufacture by Glen Forrest Stockfeeders.

Page 2

- List of browse options suitable to primate species. Mainly North American plant species.

EURASIA / AMERICAS BROWSE LIST Compiled Aug. 2000, by Brent Huffman

Animal	Plant	Rate	Comments	
Macaques	Norway maple	<i>Acer platanoides</i>		
	Silver maple	<i>Acer saccharinum</i>		
	Sugar maple	<i>Acer saccharum</i>		
	Monkey apple	<i>Acmena smithii</i>	3	
	Onion	<i>Allium cepa</i>		Fed bulb
	Juneberry, shadbush	<i>Amelanchier sp.</i>		
	Giant reed grass	<i>Arundo donax</i>	4	
	River birch	<i>Betula nigra</i>	2	
	Calendula	<i>Calendula officinalis</i>	0	Picked petals from bloom
	American hornbeam	<i>Carpinus caroliniana</i>	2	
	Hackberry	<i>Celtis laevigata</i>	2	
	Coprosma	<i>Coprosma sp.</i>	3	
	Red-twig dogwood	<i>Cornus sericea</i>		
	Cotoneaster	<i>Cotoneaster sp.</i>		
	Pumpkin	<i>Curcubita pepo</i>	5	Great toy! Can stuff with fruits/vegs
	Black tree fern	<i>Cyathea medullaris</i>	3	
	Papyrus	<i>Cyperus papyrus</i>	4	
	Queensland itch tree	<i>Davidsonia pruriens</i>	5	
	American beech	<i>Fagus grandifolia</i>		
	Ash	<i>Fraxinus sp.</i>	3	
	Chinese rose	<i>Hibiscus rosa-sinensis</i>	5	
	Sweet gum	<i>Liquidamber styraciflua</i>	4	
	Tulip tree	<i>Liriodendrum tulipifera</i>	3	
	Chinese fan palm	<i>Livistona chinensis</i>	1	Play with fronds and eat tips
	Honeysuckle	<i>Lonicera sp.</i>		** BERRIES POISONOUS
	Crabapple	<i>Malus sp.</i>	5	
	Puka	<i>Meryta sinclairii</i>	4	
	Variieg. maiden grass	<i>Miscanthus sinensis</i>	5	Played with it more than ate it
	Mulberry	<i>Morus sp.</i>	5	
	White mulberry	<i>Morus alba</i>	5	
	Black mulberry	<i>Morus nigra</i>	2.5	
	Banana palm	<i>Musa sp.</i>	4	
	Purple basil	<i>Ocimum basilicum</i>	4	Adults like eating blooms
	Oregano	<i>Origanum vulgare</i>	1	No interest
	Bamboo	<i>Phyllostachys sp.</i>	4.5	Enjoys shoots
	Lemonwood	<i>Pittosporum sp.</i>	2	
	Sycamore, buttonwood	<i>Platanus occidentalis</i>	2,4	
	Nanking cherry	<i>Prunus tomentosa</i>	5	
	Strawberry guava	<i>Psidium cattleianum</i>	4	
	Yellow guava	<i>Psidium guajava</i>	4	
	Blackberry	<i>Rubus sp.</i>		
	Cabbage palm	<i>Sabal palmetto</i>	1	
	Willow	<i>Salix sp.</i>	5	
	Sassafras	<i>Sassafras albidum</i>	4	
	Buffalo berry	<i>Shepherdia argentea</i>	4	Will only eat till full - won't strip
	Sorghum	<i>Sorghum sp.</i>	5	
	Tree lucerne	<i>Tagasaste sp.</i>	5	
Dandelion	<i>Taraxacum officinale</i>			
Winged elm	<i>Ulmus alata</i>	2		
Sparkleberry	<i>Vaccinium arboreum</i>	2	Primarily eat fruit	
Bean foliage	<i>Vicia sp.</i>			
Grape vine	<i>Vitis sp.</i>	4		
Mexican fan palm	<i>Washingtonia robusta</i>	1		
Corn	<i>Zea mays</i>	5	Will shuck corn if unhusked	

Appendix 3: Drug Information

***All dose rates should be calculated and recommended by a veterinarian.**

- Domatrel used as a deep sleep drug for restraint purposes.
- Ketamine is a general anesthetic given intravenously or intramuscularly and used especially for minor surgical procedures in which muscle relaxation is not required.
- Acetylpromazine is used in animals as a means of chemical restraint. Its principal value is in quietening and calming frightened and aggressive animals.
- Diazepam is a tranquilizer used in the treatment of anxiety and tension and as a sedative, muscle relaxant, and anticonvulsant.
- Atropine sulphate is used as an anticholinergic drug and smooth muscle relaxant drug for animals.
- Isoflurane used as an anesthetic inhalant.

Appendix 4: Equipment

- Aussie-Dog® products for animal enrichment available from www.aussiedog.com.au
- Humidicrib from Campbell, (in revision)



- Infants teats from Campbell (in revision)



Appendix 5: Milk solutions

- S26 Gold Alpha Pro milk formula by Wyeth Nutrition available from most supermarket and pharmacy stores. See product information below or visit www.wyethnutrition.com.au



S-26 GOLD ALPHA PRO (from birth)

S-26 GOLD ALPHA PRO, with the Wyeth Biofactors System, is a premium infant formula designed to provide the best start for formula fed babies through its advanced protein blend and unique combination of nutrients.

- Advanced protein blend: Increased alpha-lactalbumin (alpha-protein) with reduced beta-lactoglobulin* to provide a unique balance of whole proteins
- Omega 3: to help support brain and eye development
- Nucleotides: to help support immunity

*compared to standard infant formula

Available

Pharmacy, grocery and other retail outlets

Packs Available

900g can and single serve stickpacks

Ingredients

Lactose; vegetable oils (palm, coconut, oleic (safflower or sunflower), soybean); non-fat milk powder; **alpha-lactalbumin** (alpha protein) enriched whey protein concentrate; emulsifiers (soy lecithin, monoglycerides); **long chain polyunsaturated fatty acids from single-cell sources [arachidonic acid (AA) and docosahexaenoic acid (DHA)]**; L-methionine; taurine; **nucleotides** (cytidine-5'-monophosphate; disodium uridine-5'-monophosphate; adenosine-5'-monophosphate; disodium inosine-5'-monophosphate; disodium guanosine-5'-monophosphate); antioxidants (mixed tocopherols concentrate, ascorbyl palmitate).

Minerals

Calcium carbonate; sodium citrate; magnesium chloride; potassium bicarbonate; calcium hydroxide; calcium chloride; potassium chloride; ferrous sulphate; zinc sulphate; copper sulphate; manganese sulphate; potassium iodide; sodium selenite.

Vitamins

Vitamin C; choline chloride; inositol; vitamin E; niacin; calcium pantothenate; vitamin A palmitate; vitamin B2; vitamin B1; vitamin B6; vitamin D3; **natural carotenes**; folic acid; vitamin K; biotin; vitamin B12.

S-26 GOLD ALPHA PRO protein source is alpha-lactalbumin enriched whey and non-fat milk. Contains milk and soy lecithin.

Nutritional Information

S-26 GOLD ALPHA PRO		Per 100 ml	
Energy	281 kJ		
Protein	1.4 g		
60% Whey of which alpha-lactalbumin	0.84 g		
40% Casein	0.56 g		
Fat	3.6 g		
AA	12 mg		
DHA	7.1 mg		
Linolenic Acid	520 mg		
alpha-Linolenic Acid	45 mg		
Carbohydrate	7.3 g		
Nucleotides	2.6 mg		
Taurine	4.7 mg		
Vitamin A	75 µg		
Carotenes	21 µg		
Vitamin B1	100 µg		
Vitamin B2	150 µg		
Vitamin B6	55 µg		
Vitamin B12	0.2 µg		
Vitamin C	9 mg		
Vitamin D	1.1 µg		
Vitamin E	0.74 mg		
Vitamin K	6.7 µg		
Biotin	2 µg		
Choline	10 mg		
Folate	8 µg		
Niacin	500 µg		
Pantothenic Acid	300 µg		
Inositol	4.5 mg		
Calcium Chloride	49 mg		
Chloride	43 mg		
Copper	46 µg		
Iodine	10 µg		
Iron	0.8 mg		
Magnesium	4.5 mg		
Manganese	5 µg		
Phosphorus	28 mg		
Potassium	65 mg		
Selenium	1.4 µg		
Sodium	16 mg		
Zinc	0.6 mg		

- An alternative, Karicare Infant formula by Nutricia is available at most supermarket and pharmacy stores. See www.nutricia.com.au for product information.