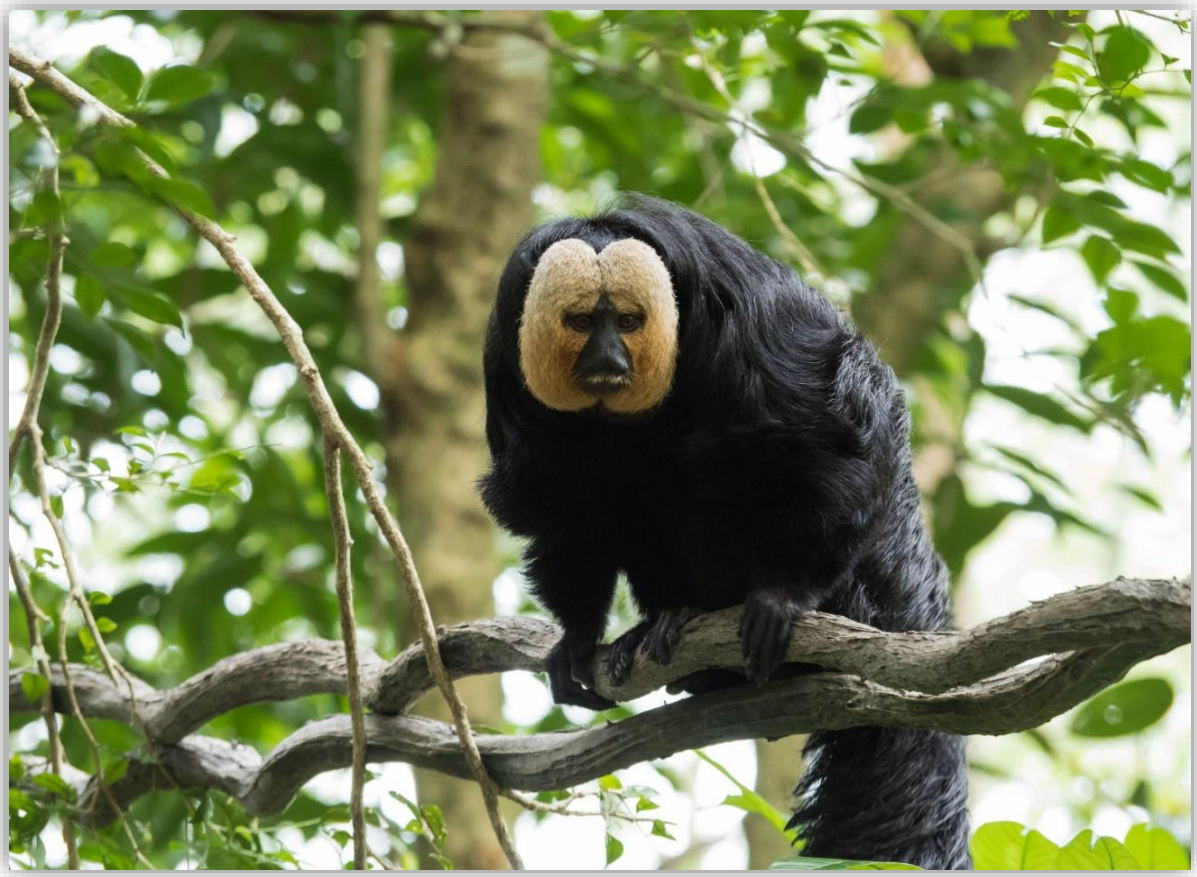
EAZA Best Practice Guidelines

White-Faced Saki Monkey (*Pithecia pithecia*)

First edition published 2019



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EAZA Preamble

Right from the very beginning it has been the concern of EAZA and the EEPs to encourage and promote the highest possible standards for husbandry of zoo and aquarium animals. For this reason, quite early on, EAZA developed the “Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria”. These standards lay down general principles of animal keeping, to which the members of EAZA feel themselves committed. Above and beyond this, some countries have defined regulatory minimum standards for the keeping of individual species regarding the size and furnishings of enclosures etc., which, according to the opinion of authors, should definitely be fulfilled before allowing such animals to be kept within the area of the jurisdiction of those countries. These minimum standards are intended to determine the borderline of acceptable animal welfare. It is not permitted to fall short of these standards. How difficult it is to determine the standards, however, can be seen in the fact that minimum standards vary from country to country. Above and beyond this, specialists of the EEPs and TAGs have undertaken the considerable task of laying down guidelines for keeping individual animal species. Whilst some aspects of husbandry reported in the guidelines will define minimum standards, in general, these guidelines are not to be understood as minimum requirements; they represent best practice. As such the EAZA Best Practice Guidelines for keeping animals intend rather to describe the desirable design of enclosures and prerequisites for animal keeping that are, according to the present state of knowledge, considered as being optimal for each species. They intend above all to indicate how enclosures should be designed and what conditions should be fulfilled for the optimal care of individual species.

Contributing authors

Fabienne Daalhuisen
Aeres Hogeschool Wageningen, the Netherlands

Steven van den Heuvel
Coordinator White-faced saki EEP, Zooparc Overloon, the Netherlands

Coverphoto credit

Aquazoo Friesland

Content

SECTION 1: Biology and Conservation

1.1 Taxonomy

Kingdom: Animalia
Phylum: Chordate
Class: Mammalia
Order: Primates
Suborder: Haplorhini
Infraorder: Simiiformes
Family: Pitheciidae
Genus: Pithecia
Species: Pithecia pithecia

Figure 1. White-Faced Saki monkey. On the left a female saki is shown and on the right a male saki (Photo credit: GaiaZoo).

Common names of the white-faced saki are showed in table 1.

Table 1. Common names of the white-faced saki.

Languages	Name(s)
Latin	*Pithecia pithecia*
English	White-faced saki, Guianan saki, golden-faced saki
Dutch	Witgezichtsaki
German	Weißkopfsaki, Blasskopfsaki
French	Saki à face blanche, Saki à face pâle
Spanish	Saki cariblanco

1.2 Morphology

The White-Faced Saki monkey (Pithecia pithecia) is a sexual dimorph animal in their coloration and size (figure 1), which is rare in New World Monkeys. The adults weigh between 1.4 – 2.0 kg, where the male is on average 500g heavier than the female. The average length of the male saki is 33-38 cm. Sakis have long, none prehensile, bushy tails which are used for balance while jumping from tree to tree.

The females have a brownish-grey fur with white or pale brown stripes around the corners of the nose and mouth. The males have a much blacker fur with a reddish-white face, forehead and throat. Their faces are also much whiter than females. Young sakis all look very feminine, but after approximately 2 months of age the differences start to show. The sexual dimorphism gradually becomes obvious over the next 3.5 to 4 years.

1.3 Physiology

Little information is known about the physiology of the pithecia genus. However, there is a considerable body of literature on the physiology of callitrichids as a result of their use in laboratory studies (Bairrão Ruivo & Stevenson, 2017). The Callitrichidae are a family of New World Monkeys in the same parvorder as saki monkeys; Platyrrhini. Relatively close relation between the two families indicate that physiological data such as heart rate, haematological values and body temperature would be considerably similar. Nevertheless, more research on the subject is needed to confirm this hypothesis.

1.4 Longevity

The lifespan of the sakis is longer in captivity than in wild. Wild sakis live on average 15 years while captive sakis usually live about 20 years. The oldest saki in captivity was one wild-caught saki 'Nanni' from Frankfurt, which has lived to the age of 37 year, 6 months and 24 days. The oldest living Saki at the moment with an age of 34 is 'Patric' from Basel, studbook number 107.

1.5 Zoogeography

1.5.1 Distribution

The species ranges from Brazil, remote parts of Venezuela, most of French Guiana, Guyana and Suriname (figure 2)(Marsh et al., 2015).

Group size is relatively small for those species. There are studies which found an average group size of 2-3 individuals (Oliveira et al., 1985; Vié et al., 2001,), while other studies found larger group sizes with an average of 5-9 individuals (Lehman et al., 2001; Norconk et al., 2003).

Figure 1. The home range of the White-Face Saki Monkey (Marsh et al., 2015).

1.5.2 Habitat

White-faced sakis exist in a variety of habitat types, including lowland to highland forests, relatively dry to seasonally flooded forests, primary to secondary forests and disturbed forests. They prefer areas with an abundance of watering holes and fruit trees. Sakis occupy the understory (3-15m) and the lower to middle canopy levels (15-25m) and will only come to the ground to search for food. They are active during the day and in the afternoon, they start to move slowly towards their sleeping site, which is usually in large upper canopy trees with a wealth of foliage for cover. White-faced saki groups occupy relatively exclusive home ranges with clearly defined boundaries. The size of this home range is relatively small for frugivorous primates, around 10 ha (Anzelc, 2009; Grubich, 2013). There have been sightings of much larger home ranges from observations of relocated animals. Their home ranges ranged from 68 to 152 ha (Vie et al., 2001).

1.5.3 Conservation Status

The IUCN Red list classifies the white-faced saki monkey as Least Concern, though the population trend is decreasing. The species has a relatively wide distribution, is present in number of protected areas and has a lack of any apparent major threats (Marsh et al., 2015) The exact amount of sakis in the wild is currently unknown. There is extensive information available about a few localised populations in Venezuela, Guyana and Suriname, but not throughout the entire range of the species (Marsh et al., 2018).

1.5.4 Threats

Habitat destruction through logging and wood harvesting is the main threat for the White-Faced Saki Monkeys. Additionally, they are sometimes captured for the pet trade and are hunted for their meat or tails (Grubich, 2013). Their natural enemies are tree dwelling snakes, birds of prey and small cats.

1.5.5 Conservation Actions

De White-Faced Saki Monkey is listed in CITES Appendix II. This appendix lists species that are not threatened with extinction now but may become threatened when trade is not regulated.

1.6 Diet and feeding behaviour

The white-faced saki monkey is known as a frugivorous seed predator (Ledogar *et al.,* 2013). They prefer unripe to ripe fruits (Kinzey and Narconk, 1990). Young seeds are an excellent source of lipids, proteins and structural carbohydrates (Narconk and Conklin-Brittain, 2004; Narconk *et al.,* 2002). Young seeds are often elastic in texture and have low levels of toxic secondary compounds, which would build up as the seeds age and the fruit ripens (Narconk and Conklin-Brittain, 2004). They have been observed actively foraging for unripe non-succulent fruits (Ferrari *et al.,* 2013). An animal which is adapted to forage and ingest seeds and fruits that are protected by a tough outer test or protective membrane are known as sclerocarpic foragers. This is uncommon amongst primates and may be an adaptive strategy used by the saki monkeys gain early access to fruits and seeds, therefore, avoiding competition and minimising food shortages (Kinzey and Narconk, 1990). They have been observed ingesting insects as well, specifically Orthopterans (Grasshopper family) (Barnett *et al.,* 2012). The ingestion of leaves is known to be opportunistic. The Sakis have been observed grabbing and ingesting a leaf as they moved through the forest (Narconk and Conklin-Brittain, 2004). Different studies have reported similar values for the saki's diet. These include the results shown in table 2 and table 3 below.

Table 2: This table includes data on three different studies done on the average amount of different feed categories chosen by the Saki Monkeys.

Food Item	Ledogar *et al.,* 2013 (%)	Norconk and Conklin-Brittain, 2004 (%)	Ferrari *et al.*, 2013 (%)
Seeds	53.3 - 60.6	88	61
Fruit Pericarp	27.8 - 31		28
Flowers	2 - 2.2	1.8	7
Leaves	7.1 - 10.4	5.7	2
Insects	2.3 - 3.7	3	2

Table 3: A reproduction from Narconk (1996), detailing the changes in diet per season. Every season lasts 3 months. Percentages of the components are expressed as log values.

Feed Group	Early Dry (%)	Late Dry (%)	Early Wet (%)	Late Wet (%)
Fruits and Seeds	94.84	86.83	90.91	88.92
Leaves	4.38	6.05	5.37	4.37
Pith	0.00	0.49	0.21	0.12
Flowers	0.59	4.13	0.53	0.96
Fauna	0.19	2.50	2.99	5.64

Most fruits species ingested are in the following families: Conneraceae, Lecythiadaceae, Loganaceae, Fabaceae and Erythroxylaceae (Ferrari *et al.,* 2013).

The dental morphology of the pitheciin primates is adapted to the extraction and mastication of seeds (Norconk *et al.,* 2002). Specifically, the saki monkey's cranial, mandibular and dental morphologies make it possible for the species to predate on challenging unripe fruits and seeds. (Ledogar *et al.,* 2013). They use their large canines and procumbent incisors to extract the nutrient rich seeds from inside the hard shelled fruits (Ferrari *et al.,* 2013 ; Ledogar *et al.,* 2013). Their post-canine teeth are then used to process said seeds. Their post-canine teeth have low and bulbous cusps which are inferred to be efficient at fracturing seeds and nuts (Lucas, 2004). A sharper cusp would have required a much greater force to break into these resistant plant parts. Therefore, their blunt cusps help to reduce the risk of tooth crown fractures, once again depicting how adapted they are to consuming hard shelled seeds and nuts (Berthaume *et al.,* 2010). Both the pre-molars and molars have an expanded flat surface area for efficient trituration of the fibrous seed tissue (Kinzey, 1992). The dentine of their teeth is relatively thin but crenulations help to reinforce the teeth to prevent breaks as well (Kinzey, 1992). Morphologically speaking, they are absolutely adapted to breaking open nuts and seeds that many other species simply cannot negotiate.

The digestive system of the white-faced saki monkey is relatively simple but has an enlarged hind gut area. This, coupled with their long recorded food transit time of 14 hours, suggests some fermentation capability (Norconk *et al.,* 2002). Their mean retention time of food is recorded by Narconk *et al.(*2002) to be 25.6 hours which also suggests some level of hemi-cellulose digestion. The same article determined that white-faced saki monkeys can digest up to 70% fibre fractions. Their typical diets contain on average, 38.4% nitrogen detergent fibre (NDF) and 22.4% acid detergent fibre (ADF) all on a dry matter basis (Narconk *et al.,* 2002).

They contain special adaptations within their digestive tract to permit the exploitation of plant parts which contain toxic secondary compounds, such as cyanides (Ferrari *et al.,* 2013). During periods of low unripe fruit availability, the sakis have been observed eating the topsoil off termite mounds (Setz *et al.,* 1999). These mounds have been analysed and contain kaolinite which has the capacity to bind tannins and other secondary plant metabolites (Setz *et al.,* 1999).

The sakis are quite unusual in that they forage in the understory and lower level strata of the forest canopy (Ferrari *et al.,* 2013). They have very large home ranges and feeding occurs throughout the day, with an increase during the middle of the day (Vie *et al.,* 2001). Some individuals can forage for up to 50% of their active time (Vie *et al.,* 2001). They would remove fruit from the trees with their hands and process and ingest them on the same branch (Barnett *et al.,* 2012). While feeding behaviour has not yet been described in detail, they have been observed descending to the ground to capture grasshoppers. They immediately return up a tree to then consume it (Barnett *et al.,* 2012).

Dietary requirements have not yet been identified for this species. The recommendations most often used are the new world monkey recommendations from Jansen and Nijboer (2003) (Table 4). Note that these recommendations are not specific in the slightest to saki monkeys and should only be used as very loose guidelines. Narconk and Conklin-Brittain (2004) have analysed the nutritional content of the average diet consumed by a saki monkey (table 5) and these, in conjunction with Jansen and Nijboer (2003) should provide as adequate guidelines. While these values are not to be treated as absolutes or minimum/maximum values, they are the nutrient values that the saki monkey have evolved to cope with. Practical uses can include ratios of fibre fractions, approximate protein amounts to aim for, etc.

Table 4: Nutrient recommendations for new world primates from Jansen and Nijboer (2003). Values written here are concentrations of diet on a dry matter basis.

Nutrient	Recommendation
Crude Protein (g/kg)	278
Calcium (g/kg)	5.6
Phosphorous (g/kg)	4.4
Magnesium (g/kg)	1.7
Zinc (mg/kg)	11
Iron (mg/kg)	200
Vitamin A (IU A/ g)	14
Vitamin D (IU/g)	2
Vitamin E (Mg/kg)	56

Table 5: Average nutritional contents of a White-Faced Saki Monkey diet, collected over a years' time.

Nutrient	Amount (% dry matter)	Standard Deviation (% Dry Matter)
Lipids	16.05	+/- 8.60
Free Simple Sugars	3.40	+/-3.59
Soluble Carbohydrates	20.54	+/-17.83
Crude Protein	6.45	+/-4.45
NDF	38.40	+/-10.53
ADF	22.38	+/-6.86
Hemi-Cellulose	11.02	+/-4.48
Lignin	11.16	+/-6.03
Cellulose	7.96	+/-4.06
Condensed Tannins	3.29	+/-2.92
Bioactive Tannins*	3.74	+/-2.25

**This looks at the tannins in the food but detected using a different method than the Condensed Tannins column. Instead, the author used radial diffusion method to detect bioactive tannins*.

Saki monkeys have a relatively stable diet. Because they have such a large range, they are usually able to find a fruiting tree (Cunningham and Janson, 2006). During the dry seasons of March and May, they decrease the amounts of seeds eaten and would feed more heavily on leaves, insects and flowers (Cunningham and Janson, 2006). Because the sakis are adapted to ingest fruits of varying maturity, there is no major change in seasonal food intake (Vie *et al.,* 2001). During the rainy seasons, the sakis would move further out and move faster with no observed feeding peak (Vie *et al.,* 2001).

1.7 Reproduction

In captivity (zoo environments) Sakis are mostly monogamous, but in the wild Sakis are less monogamous than expected. Monogamy is less common in larger groups with more than one adult breeding male and female (Anzelc, 2009; Norconk, 2006).

Males reach sexual maturity at the age of 32 months (Grubich, 2013). Captive females reach sexual maturity at the age of 26-32 months. Wild White-faced Sakis gave birth for the first time between 4-6 years, while captive Sakis give birth at circa 3 years old (Savage et al., 1992). Their ovarian cycle lasts about 17 days and they have a gestation period of 138 – 152 days. Their cycle is non-seasonal and can happen the whole year. They are capable of giving birth once a year, with an interbirth interval ranging from 343 – 479 days (Savage et al., 1995)

1.7.1 Infant Development

Sakis mostly give birth to one young, but there is a low rate of twinning (15%). This rate is possibly heritable (Savage et al., 1995). Predominantly the mother takes care of the infant. Paternal care for the infant is minimal, but siblings from the previous year or 2 may help taking care of the infant.

The first month after giving birth the infant straddles to the mother's thigh. Between 1 and 4 months the infant shifts to a more dorsal position and after 4 months the infant gains increased locomotor independence (Norconk, 2006). The onset of solitary play has been documented at the age of 5 months, when the mothers leave the infants alone to follow them (Homburg, 1997).
Mothers are primary care-givers (Brush and Norconk, 1999), but male interest increases as infants mature; and adult males have been observed to play, and share food with older infants (Buzzel and Brush, 2000)

1.8 Behaviour

The behaviour of the white-faced Saki can be mainly divided into four categories: social behaviour, feeding behaviour, moving behaviour and other (rest) behaviour. According to the research of Vie et al. (2001) those behaviours occurs in different frequencies at different times during the day. Figure 2 shows an average activity pattern of a group of white-faced Sakis. The feeding behaviour and moving behaviour increases during the progress of the day. The rest behaviour decreases progressing the day but will increase towards de end of the day. The social behaviour has it peak in the afternoon about twelve a clock. On average, Sakis spend about 9 hours on the move, travelling distances of roughly 1 or 2 kilometres per day. These activity bouts are relatively short compared to related monkeys, who may be active 10 to 12 hours per day.

According to this research it can be said that the social and feeding behaviour increases during the day and will decrease at the end of the afternoon. Then the rest of the behaviour will increase for during the night.

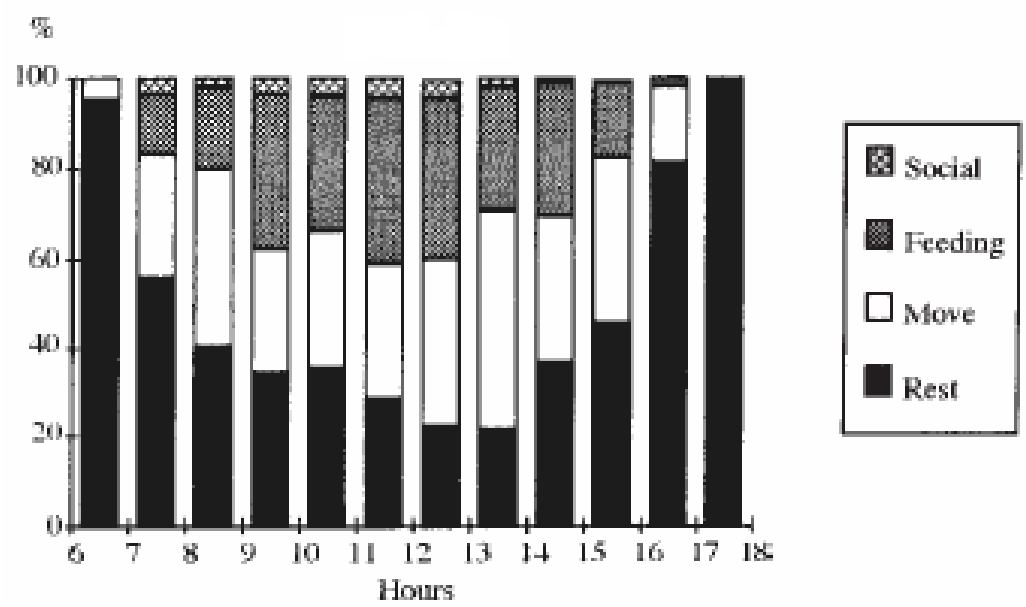


Figure 2. Abundance, Use of Space, and Activity Patterns of White-Faced Sakis (Pithecia pithecia) in French Guiana (vie et al., 2001)

The white-faced Saki moves through the forest both quadrupedally and by leaping (Fleagle, 1988). When the white-faced Saki takes off from a tree branch, most likely it does this from a vertical clinging position (Walker, 1993). When resting this species most often clings vertically to a tree trunk (Walker, 1992).

1.8.1 Sexual behaviour

Females do not show any obvious physical or behavioural changes at time of ovulation and they were also not observed actively asking for copulations from males (Savage et al., 1993, 1995). Males might

be able to distinguish cycling females from non-cycling females, as copulations are more frequent with cycling females (Thompson et al., 2011).
Scent-marking behaviour seems to be one of the common sexual behaviours. Among scent-marking are behaviour patterns like throat-and-chest rubbing, groin with the hand and urinating on marked branches. Marking behaviour is strongly sex related, with the adult male making 88.4% of the markings (Eleonore et al., 1997). Scent-marking frequency by the adult male increased during breeding periods. Scent-marking behaviour seems related to courtship, and possibly stimulates sexual behaviour.

1.8.2 Social structure

Sakis are social animals that live in small groups of 2 to 4 individuals. The white-faced Saki has a multimale-multifemale social system. (Fleagle and Meldrum, 1988) have suggested that this species lives in small groups that come together to form larger congregations. These groups of white-faced Sakis are described as closed social units (Soini, 1986). Both males and females do groom their young (Kinzey, 1997).

1.8.3 Communication behaviour

When sakis notice a predator, they will first make an alarm call, which is echoed by the group members. After this the group will get together and they try to scare the predator away. The biggest threat for the sakis are avian predators. A study found that 90% of saki alarm-calls are directed to avian threats (table 6) (Gleason and Norconk, 2002).

Table 6. frequency and percent alarm calls (Gleason and Norconk, 2002).

Predator class	Frequency	Precentage of total observations	Number of species of predator
Vulture	174	77.0	2
Raptor	11	4.9	2
Snake	6	2.7	1
Felid	2	0.9	1
Unknown	33	14.6	-
Total	226	100.0	6

SECTION 2: ZOO MANAGEMENT

2.1 Accommodation

The recommendations below are based on comparative research and elaborate experience from 39 different EAZA institutes with white-faced sakis, who participated in a questionnaire during May 2019 in order to facilitate this document. As is the case with all captive animal husbandry, it must be kept in mind that the quality of the space is just as important as the quantity when considering the housing requirements of white-faced sakis. This means the enclosure must provide a safe environment suited to their physical and psychological needs and taking the arboreal nature of the species into account. The standards for Accommodation and Care set by EAZA (EAZA, 2014) must be met at all times. It is in no way suggested that the following recommendations are the only suitable options for white-faced saki husbandry, but are merely meant to provide a general overview of what has been found to be appropriate through experience. As every group of animals and situation is different, the applicability of these recommendations depends on various aspects such as your local climate and the presence of other species in the same exhibit. In the section below the recommendations for indoor and outdoor enclosures will be discussed separately. In general, a combination of indoor and outdoor accommodation is appropriate, with at least two indoor compartments available so the animals can be separated when needed.

2.2 Indoor enclosure

Since white-aced sakis originate from an equatorial climate, Indoor enclosures with regulated temperature, humidity and ventilation are a necessity in temperate climates. It is recommended to have at least two separate indoor areas with multiple connections to the outdoor area. At least one indoor compartment should be able to function as a separation area, preferably out of sight for visitors, to facilitate introductions or medical treatment.

2.2.1 Boundary

Solid walls are the most practical and commonly used type of barrier when it comes to indoor enclosures, as they provide an enclosed shelter where climate control can be easily regulated. They can be constructed of brick, concrete or wood.

Glass is used as a barrier primarily at public viewing areas, and is generally used in conjunction with other materials to create some shelter. Benefits of glass are the ability for up close viewing, prevention of disease transmission and public feeding. Downsides of glass as a barrier include reflection problems, and keeping the glass clean (Bairrão Ruivo & Stevenson, 2017).

To separate the keeper area from the indoor compartments, wire mesh fencing is most commonly used, providing a safe distance between the animals and the keeper, while simultaneously increasing the usable vertical surface area and creating opportunities for health examination and potential treatment.

Figure 3. Outside view of an indoor enclosure for white-faced sakis combining solid walls, glass and wire mesh fencing as boundaries in Tierpark Berlin, Germany.

2.2.2 Outdoor access

Outdoor access, even for a limited time a day is beneficial to the animals, providing fresh air, sunshine and enrichment. To get to the outdoor exhibit, mesh tunnels are commonly used. These tunnels must be placed at a minimum height of about 1.5 meters, as sakis naturally only get closer to the ground when foraging for food and feel safest up high. If the outdoor enclosure is directly connected to the indoor accommodation, sliding doors will work just as fine. In both cases the entrance should measure about 30x30 cm in length and width. Keepers must be able to easily control the doors with a cable system or sliding doors. With a group larger than two individuals, or when the entrance to the outdoor is shared with other species, it is recommended to have at least two connections to the outdoor

exhibit. These connections must be spaced far enough to prevent dominant animals from controlling passage between enclosures. Especially in colder and temperate climates it is recommended to give the sakis the opportunity to go back inside. To conserve heat and prevent drafts in the inside area flaps can be added to the animal access doors. Several institutes indicate that they use soft perspex/pvc material as the draft excluder. This sits on an angled door frame and is easily lifted by the sakis as they move in and out.

Figure 4. A mesh tunnel used for sakis in Oasis park Fuerteventura

2.2.3 Substrate

Any type of substrate should be easy to remove for cleaning purposes to prevent illness and infection with disease. The pie chart in figure 5 shows the different types of substrate used and/or recommended for white-faced sakis by 39 different institutes. In general, any natural type of substrate such as bark, mulch, woodchips, biofloor or soil is recommended. Substrates that are used by only one institute are filed under "other". These include miscanthus, vlas, hay, phloem and hemp. Although used in multiple cases, it was stated as a downside by respondents that sawdust and woodchips can be excessively dusty, so these substrates should be used with care, especially around animals with sensitive respiratory systems. As shown in the pie chart in figure 5, some collections (14% of the 39 questioned institutes) consciously choose to not use any substrate on concrete flooring since this makes the environment more sanitary. However, a natural substrate like bark or biofloor provides the animals with foraging enrichment and will also decrease the possibility of injury due to falls. When choosing whether or not to use substrate, the nature of the animals in question must weigh in on the decision. While in their natural habitat, most white-faced sakis prefer to stay in the understory and lower to middle canopy of the rainforest, they have been recorded foraging for food on the ground (Barnett *et al.,* 2012). Some sakis will descent to the floor more than others. Factors increasing the risk of falling accident, such as infants or elderly animals in the group should also be taken into consideration when deciding whether or not to use a substrate in the enclosure. Faeces and scraps of food should be cleaned from the substrate on a daily base, and the entire substrate should be replaced periodically or when disease pathogens or parasites are found.

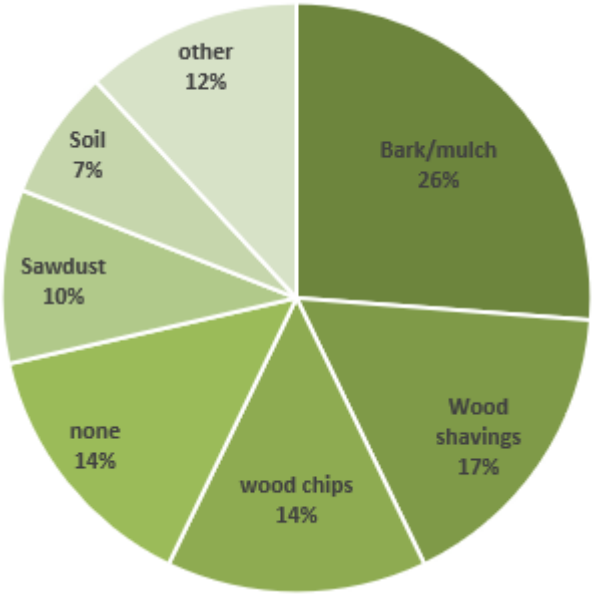


Figure 5. Percentage of collections using a specific substrate for White-faced Sakis.

2.2.4 Furnishing and Maintenance

The indoor enclosure must provide the animals with some level of complexity. This can be achieved by wooden structures and other climbing facilities such as wooden poles and branches, hammocks, platforms and securely placed fire hose. Helsinki Zoo also mentioned using curvy tree trunks on the floor to encourage foraging on the ground. A mix of permanent and temporary fixtures is ideal,

changing around the furniture allows the white-faced sakis to explore their environment and is great enrichment. Flexible materials such as branches, ropes, and ladders (with rungs spaced appropriately) will promote exploratory and locomotor behaviour, stimulate muscle tone and balance, as well as providing shelter, cover and (if applicable) visual barriers to escape the public view. Examples of furnishing for indoor exhibits can be seen in figure 3 (page 14) and in figure 6 below. It is strongly advised to at least have one wooden nest box per animal installed in the enclosure, so they can retreat in their own space if required. Nest boxes should be at least 40 x 40 x 40 cm and could double as capture device when fitted with appropriate sliding doors. Complete cleaning of the nest boxes and other furnishings should not be done all at once, as white-faced sakis mark their territory with their scent (Eleonore et al., 1997). Instead cleaning of the furniture should be carried out in stages. When housing a family of more than two sakis, it is advised to install at least two feeding and watering sites within the enclosure to make sure dominant animals are not keeping their subordinate family members away from the food and water. The sites should be easily accessed for all animals, and at least 1.5 metres high since most sakis don't go down to the ground. Food should be presented in trays or bowls, preferably on a flat surface for easy cleaning. Water can be given in either a bowl or in water bottles installed through wire mesh fencing. When designing an indoor enclosure, keep in mind not to place food and watering sites underneath branches, perches, or any other kind of instalment the sakis could sit and drop faeces or urine. Ideally the design should allow for the keeper to remove the feeding and watering trays or bowls for cleaning and refilling without having to enter the exhibit.

Figure 6. Indoor White-faced saki exhibit furnished with a construction of branches and hammocks to facilitate climbing at Connecticut's Beardsley Zoo, Bridgeport USA.

2.2.5 Environment

Temperatures and humidity levels maintained for white-faced sakis in a controlled environment highly vary per facility. Most institutions keep their temperature between 20°C and 28°C by day and somewhere between 18°C and 25°C for the night without any apparent problems, although some state their temperature doesn't go any higher than 16°C. Given the equatorial climate of their natural

habitat, it is recommended to keep the temperature of the indoor enclosure above 20°C by day, and not any lower than 18°C by night. Temperature is most often regulated through the use of a thermostat. Suitable heating systems include electronic heating, central heating, heat lamps, floor heating, radiators and decentral heating systems. Note that any hot pipes or other heating equipment should be placed out of reach of the animals. When the outside temperature drops below 16°C, a basking spot can be provided for the animals to warm up.

Humidity levels should be kept fairly high to maintain a good condition of the skin and coat. Most facilities keep their indoor humidity levels around 60%, although is not uncommon for sakis to be kept in an indoor greenhouse ecosystem, in which case humidity can reach up to 90%. Humidity can be raised with the use of humidifiers, misters, or simply by lightly spraying the floor with water on a daily base.

As for ventilation, Indoor enclosures should have a full air circulation system with air inflow points positioned in the upper part of the enclosure building and air outflow points in the lowest parts to keep the levels of CO_2 below 0.1%.

2.2.6 Dimensions

Recommendations for enclosure size depend on several variables. If a family of white-faced sakis are able to go outside every day, they will not need as much indoor space as a family that is bound to their indoor enclosure year-round. The number of animals also weighs in in the equation. At the moment it is nearly impossible to give exact recommendations applicable for every situation, so depending on the variables, some adaptation to these recommendations is possible.

Appendix 4 provides an overview of enclosure measurements for white-faced sakis in 39 different institutes, pointing out additional factors like group composition, if the enclosure is shared with other species and what kind, and other variables and information wort pointing out.

The overall recommendation can be made that the enclosure should be a minimum height of 2.5 metres, with at least 2 metres of climbable height so the sakis can perform their natural climbing behaviour. Indoor enclosures should also have a minimum total floor size of 3 sq. metres per animal, and should contain at least two separable areas to enable easier cleaning and to separate animals is needed.

2.2 Outdoor enclosure

2.2.1 Boundary

A number of different boundaries can be used to separate the white-faced sakis from the public and/or keep the animals in. **Walls** are relatively low cost, easy to construct and provide the animals with shade and protection from drought. They can either be constructed of sturdy wood, concrete or cement and can easily be disguised as a natural barrier by covering them in artificial rocks, which serves both the aesthetic and the complexity of the environment.

Glass is typically seen as a barrier at areas for public viewing, and is generally used in conjunction with other materials. Benefits of glass are the ability for up close viewing, prevention of disease transmission and public feeding. (Bairrão Ruivo & Stevenson, 2017). However, it is quite often more expensive to construct, can cause problems with reflection and has to be cleaned daily for a clear view of the enclosure.

The use of wire mesh fencing or netting as a barrier is commonly used for White-faced sakis. It is relatively cheap to build and increases the climbable surface area of an exhibit. 21 out of 39 respondents stated they use some form of wire mesh fencing as a form of containment for their white-faced sakis. The mesh size used is variable, as can be seen in table 7. The use of a mesh bigger than 50x50 mm is discouraged in breeding groups, as small infants could get stuck and/or attempt to climb through. A downside of wire mesh is that it disrupts the view for the public. If wire mesh is used in a public viewing area, a mesh size larger then 10x10 mm is preferred to reduce the obstruction of the view. Care must be taken in construction to bury the mesh approximately 1 metre below the substrate or to anchor the substrate to a solid foundation to prevent local predators from getting inside. The perimeter should be checked regularly for holes and weak spots.
Electric fencing is used sporadically, as it is not typically necessary to keep the white-faced saki in its habitat. When applied it must be used carefully, as too high a voltage could be dangerous or even fatal to the animals. The use of electric fencing is only recommended in case of very large enclosures or as a secondary barrier to keep out local predators.

Mesh size used in fencing of White-faced saki enclosure	amount of times used
none	18
25x25 mm	6
20x20 mm	3
30x30 mm	2
50x50 mm	2
5x5 mm	1
40x60 (hexagonal) mm	1
80x80 mm	1
35x35 mm	1
30x40 mm	1
40x40 mm	1
15x15 mm	1
10x10 mm	1
Total:	**39**

Table 7. Meshsize used in fencing for White-faced saki enclosures among 39 different EAZA institutes.

As sakis are not known to swim or otherwise interested in water surfaces, a water moat can provide a natural barrier without any obvious fencing, giving the public an unobstructed view of the enclosure. This moat doesn't need to be very deep as the sakis will avoid the water regardless of depth. 0,5 metre will most likely suffice. The moat should be at least 3 metres wide or more, depending on planting and climbable constructions up and around the island. The slope of the moat should not be too steep around the island regarding the danger of animals slipping and falling in the water. A slope of 30 degrees or less is suitable for the species. For safety reasons it is recommended to place a secondary barrier on the visitors' side of the moat, for example in the form of a wooden fence. This should prevent any unlucky accidents with visitors falling into the water.

2.2.2 Indoor access

White-faced sakis should always be given the opportunity to go inside during the day if they wish to do so, especially if the temperatures drop below 16°C or in rainy/windy weather conditions. If the temperatures reach below 10°C it is advised to keep the sakis inside all together.

2.2.3 Substrate

Natural vegetation is highly recommended as it provides the animals with cover, shade, and a more interesting and complex environment. Abundance of plants also makes an enclosure more aesthetically pleasing for visitors. Vegetation does not necessarily have to be from the sakis' natural habitat since not all climates are suited to harbour tropical plants, but it should obviously be checked for toxicity before being planted. In most cases a natural substrate of soil will suffice as a substrate in the outdoor enclosure. It should be made sure that the soil is rich enough to sustain the vegetation present in the exhibit.

2.2.4 Furnishing and maintenance

As is the case with the indoor furnishing, the outdoor enclosure should provide the white-faced sakis with some level of complexity. A vast amount of live plants, trees and/or shrubbery at different heights is great enrichments on its own as it provides dimension, climbable surface and attracts insects as well. Care must be taken to ensure that none of the vegetation is positioned in such a way that it may provide a potential escape route from the enclosure. A usable vertical height of at least 3 metres is desired, preferably higher. Additionally, the enclosure can be made more exciting for the animals as well as the visitors by adding climbable structures, preferably made from natural yet sturdy material such a thick branch, tree trunks, horizontal and vertical perches and platforms. Care must be taken that these permanent types of structures are firmly fixed in the ground. A mix of permanent and temporary fixtures is ideal. Changing around the furniture allows the white-faced sakis to explore their environment and is great enrichment, although generally speaking the outdoor enclosure provides a more challenging environment then the indoor enclosure, so temporary fixtures don't need to be changed around as often as inside. Examples of temporary fixtures that can be
added into the enclosure are ladders (with rungs spaces appropriately), nets, hanging baskets, ropes, loose tree branches, puzzle feeders, various and different feeding stations, cargo nets, log piles, and

Figure 7. A visitors' view of the white-faced saki exhibit (shared with red howlers) in Tierpark Berlin.

hammocks. Obviously, all furnishing should be made out of non-toxic materials and should be resistant to rain and other weatherly conditions. The diameter of perches and branches for climbing should be appropriate to the sakis' anatomy, so that they are able to grab onto the material with their hands and feet. Appropriate shelter should be provided in case of bad weather. The furnishing should provide shade as well as areas with direct sunlight. Cleaning is less of an issue as natural substrates and natural climatic conditions will help maintain standards of hygiene. Minimizing access by vermin is also advisable in the outside enclosure by selecting materials appropriately.

Figure 7 on the previous page provides an example of a species appropriate exhibit in Tierpark Berlin. The exhibit is enclosed with an artificial rock wall combined with a glass barrier in a wooden construction. There's trees, branches and logs in different sizes and heights, as well as temporary fixtures like a ladder, providing an interesting environment.

2.2.5 Dimensions

Recommendations for enclosure size depend on several variables. Like the number of animals in the group and potential other species present in the enclosure. The factors weighing in are so many and diverse, making it nearly impossible to give exact recommendations applicable for every situation at the moment. Appendix 4 provides an overview of enclosure measurements for white-faced sakis in 39 different institutes, pointing out additional factors like group composition, if the enclosure is shared with other species and what kind, and other variables and information worth pointing out. Given the information in this overview, it is recommended that an outdoor enclosure for white-faced sakis measures at least 15 m2 per animal with a usable vertical height of 3,5 metres at a minimum.

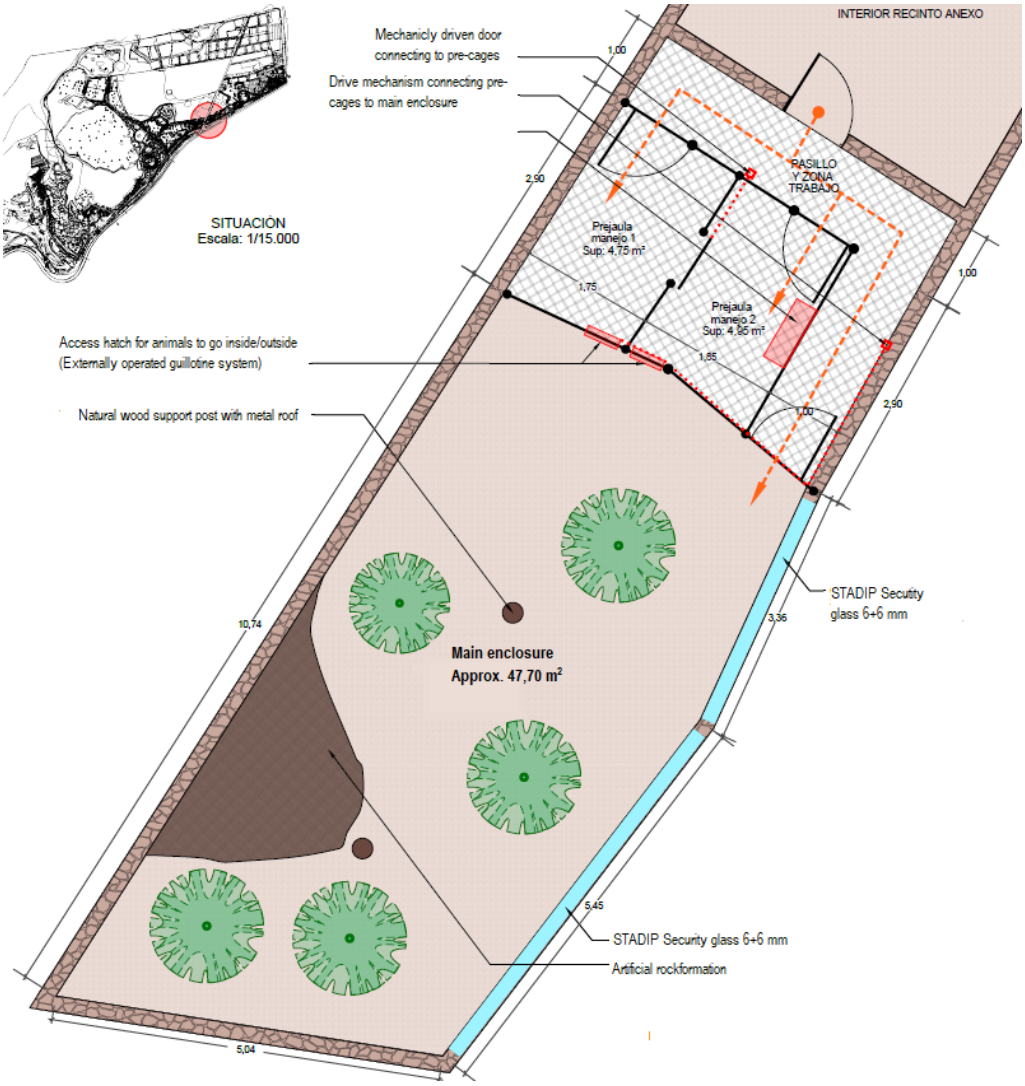
Figure 8 shows a construction map for a white-faced saki enclosure in Fuerteventura. The dimensions in this map can be taken as an example for an exhibit for 2-3 animals.

Figure 8. (left)
The map shows a layout for a white-faced saki enclosure, suitable for 2-3 animals.

The average height of the indoor enclosure is 2.50 metres and measures 16.40 m² including the aisle

Approximate height of the main enclosure is 5.50 metres and surface area is 47,70 m²

Approximate volume of the main enclosure: 238.50 m³



2.2.6 Free range

Several zoos have successfully kept White-faced sakis in a free-ranging exhibit, i.e. where there is no barrier between the animals and the public and visitors are allowed to roam on designated paths in the enclosure. As sakis are typically docile in nature they are a well-suited species for free range exhibits. The free-range exhibit should be large enough with sufficient possibilities for the animals to withdraw from the public. White-faced sakis tend to keep a safe distance from visitors, but a strict no-feeding regulation must be maintained to keep the animals at a safe distance from the visitors. Hand-reared individuals are naturally drawn more towards people, and are therefore not recommended to

keep in a free-ranging exhibit. Although most experiences with white-faced sakis in a free ranging exhibit are fairly positive, one zoo reported to have problems with juveniles becoming too bold. Therefore, it is advised to keep a keen eye on the young once they enter the adolescent stage.

2.3 Feeding

2.3.1 Basic Diet

Two separate surveys were done within EAZA zoos inquiring about the different aspects of saki husbandry, particularly feeding. We received 36 replies on the first, and 39 replies on the second survey. Results from these surveys will be used to illustrate common practice but does not necessarily reflect what is recommended as best practise.
Assuming that evidence based naturalistic diets are "ideal" diets in terms of appropriateness, some recommendations can be made about what general food groups should and shouldn't be included in the everyday diet of the saki monkey. Please refer to the table 2-5 on pages 9-11 of this of this best practice guideline for referenced evidence.

Diets *should* include the following:

Concentrate Pellet

An adequate concentrate pellet is very popular in primate diets and ensures that the specimens receive their daily needs of vitamins and minerals. The energetic value of pellets is generally quite dense; therefore, care should be taken to deliver the right amount necessary to reach daily nutrient requirements and no more (generally 25% of necessary energy). Saki monkeys are larger than callitrichids and have very different dentition, for this reason small callitrichid pellets may not be suitable. Care has always been taken with new world primate pellets in that they should provide high amounts of protein and very high amounts of vitamin D. Oftedal et al. (2007) disproved the myth of high protein. When factoring in the digestive morphology of the saki monkey, pellets should have high fibre (30% or more NDF), they should be big enough to be held and fed dry and solid. Leafeater pellets of different brands have had success with saki monkeys.

Vegetables

Most vegetables can be included and varied within this diet. It is recommended to divide your available vegetables into three groups: Leafy greens (lettuce, kale, cabbage etc.), Watery vegetables (cucumber, broccoli, peppers, peas, beans, leeks etc.) and Root vegetables (carrot, sweet potato, kohlrabi, turnip etc.) – a detailed list is available in Appendix I.
Vegetables should represent the bulk of the diet. Watery and root vegetables should dominate, with leafy vegetables being sparse. Daily kinds of vegetables should be restricted to 3-4 kinds, but these can change throughout the week on a rota like system, or whatever from that vegetable group is available. The large variety of vegetables fed to sakis should be given throughout the week and not on any given day. Approximately 60% of energy content should come from vegetables.

Seeds and Nuts

Saki monkeys are seed specialists so different kinds of raw, un-salted seeds and nuts should be given as a regular part of the diet. Due to the low level of physical activity in captivity, the amounts of seeds and nuts given must be strictly monitored. Raw seeds and nuts with a tough coating or shell are ideal and can be given daily such as almonds, walnuts, palm nuts etc. and to a lesser extent: sunflower seeds and peanuts can be given when there is nothing else available and in small amounts. Seeds and nuts should not be given to be over 10% of an individual's daily energy needs.

Insects

A variety of insects should be given to sakis (crickets, locusts, mealworms, wax moth larvae etc.). They have been observed ingesting a small quantity of insects every day in nature. The feeding of live food should be enriching and not given in a bowl. Letting a few locusts loose on the branches of the enclosure or employing the use of an insect trickle feeder will only reap positive benefits for the saki monkeys.

Currently every zoo surveyed feeds invertebrate. 47% of them feed some daily, 14% feed some every other day and 14% only three times a week. Every other day should be the bare minimum for saki monkeys. If your institution cannot afford to give live insects every other day, then please contact the author who can help you set up your own breeding colony.

Browse

Browse is somewhat of a topic of debate for saki monkeys. 37% of zoos do not offer fresh browse and 34% only occasionally do, however 75% of all establishments report that saki monkeys showed no interest in the browse. Browse species offered include:

- Hawthorn
- Apple
- Cherry
- Beech
- Hazel
- Sycamore
- Willow
- Bamboo
- Maple
- Oak
- Hornbeam
- Silver birch
- Acacia
- Bramble

On average, 9% of saki monkey diets are leaves and 4% is flowers. Providing natural branches of the species listed above with young leaves, buds, seeds or flowers tends to increase its attractiveness to saki monkeys. Even if interest is low, keep offering browse and varying the tree species offered.

Supplements

Currently, 83% of institutions use supplements. Depending on the current diet, supplements can be given in order to round out the nutrient levels of a diet. Most popular are multi vitamin and mineral powder/drops and/or pure vitamin D. The most effective vector for supplements is in gum or inside a boiled root veg and dusted insects are also suitable. Sprinkling over vegetables or fruit is not recommended and this is very inaccurate and promotes nutrient loss of the supplements.

Diets *can* include the following:

Exudates

Around 30% of zoos include exudates as part of their saki monkey diets. Raw or refined gum Arabic is an excellent source of nutrients and necessitates specialist feeding behaviours to consume. Including this in the diet once in a while can only be beneficial but is by no means necessary. Try spreading it into cracks and holes in branches for maximum enrichment purposes. Nectar can also be given as long as it is sporadic, dilute, and presented in as naturalistic was as possible (eg. hummingbird feeder).

Marmoset or tamarin jellies/cakes are not necessary and should be avoided. Their ingredients are mostly made up of food items saki monkeys would not ingest in the wild, and do not promote the performance of natural behaviours, other more appropriate dietary items would stimulate.

Whole Grains

Only whole grains such as cooked brown rice, quinoa or bulgur wheat are appropriate. Occasional scatter feed of these items can keep the animals busy and active while providing nutrients and fibre. Any other cereals or refined grains are too high in soluble carbohydrates and can cause saki monkeys to feel hungrier faster.

Diets should **not** include the following:

Fruits

Sakis do eat many different un-ripe fruits in nature; the nutritional composition of uncultivated South American fruit is very different than the cultivated fruits we use at our disposal (Oftedal and Allen, 1997; Schwitzer and Kaumanns, 2003). The soluble carbohydrate contents are much higher than that of the wild fruits, even more so if comparing with un-ripe fruit. The protein and fibre amounts are also significantly different, both being significantly less in cultivated fruit. Sugar, protein and fibre concentrations of wild fruit were generally closer to the levels our vegetables offer. A reduction of fruit in the diet to a minority or to a complete removal will benefit the physical and mental health of the saki monkeys (Oftedal and Allen, 1997; Schwitzer and Kaumanns, 2003; Plowman, 2013).

Dairy Products

There is absolutely no reason or evidence to support giving any dairy products to adult saki monkeys. The main sugar in dairy products (Lactose) requires a specific enzyme called lactase to catalyse its digestion (Stevens and Hume, 2001). All primates have an abundance of this enzyme in their infant life stages, but as weaning occurs (less mother's milk intake and more solid food intake), the amount of lactase in the digestive system is heavily reduced. No adult mammal is known to ingest any dairy or milk products in the wild because milk is only produced for infants. Dairy products are not a healthy source of protein or calcium for captive primates and instead contribute to health problems and obesity.

Meat Products

Sakis have a digestive system adapted for feeding on plants parts, made evident by their capability for hindgut fermentation. They do not need to ingest any animal matter, except for insects. Their average diet contains at most 10% protein. Providing meat in their diet will definitely provide more nitrogen than their kidneys are able to cope with and can cause health issues over a period of time. The occasional hardboiled egg is acceptable.

To see total food items currently used in diets as detailed by our surveys, please view Appendix I and II**.**

2.3.2 How Much to Feed

The total amount of food and different proportions of food given will vary depending on the type of pellet available. If your institution has the program Zootrition, then this can be used to construct a diet while keeping to the guidelines in this chapter and the nutrient recommendations found in table 2-5 of this best practice guideline.

You can also employ the pen and paper method and calculate for yourself the nutrients of every diet using basic math. While this is more time consuming, it will give you the same result as the Zootrition program.

Basic rules of thumb if neither method is available to you.
For small primates, 4-5% of bodyweight as total dry matter intake is a place to start (about 80-100g DRY MATTER). Aiming with these amounts over a two-week period, it will become evident if there is much food left over (reduce food offered) and if no food is left at all (slowly keep increasing until a desired balance is obtained).
Use this simple guide as a start, and then adjust as needed to fit the nutritional requirements.
Concentrate feeds (Pellets and seeds + nuts) = not more than 25% of diet AS GIVEN.
Vegetables = 60% of diet AS GIVEN.
Enriching food items (Browse+ insects, exudates, whole grains) = no more than 15% of diet AS GIVEN

2.3.3 Seasonality

The majority of zoos do not change their saki diets seasonally (69% of survey respondents). Their diet does in fact, vary seasonally in the wild and a replication of that can be enriching in captivity. So far, no evidence to support its necessity. Using the vegetable groups proposed above, it is easy to allow for seasonal changes of your vegetables. This helps to keep costs low, increased food diversity over the year and gives your zoo the opportunity to buy its produce locally.

2.3.4 Medication

Medication such as tablets should be hidden in a highly palatable food item such as a little piece of boiled root vegetables or fruit (for this case, an exception to the no fruit-rule is alright). Some tablets can be opened up, or ground and the resulting powder can be mixed in with a natural nut butter which can then be placed on any vegetable but check with veterinarian before employing this method.

2.3.5 Special Dietary Requirement

Pregnant Animals

The current trend with saki monkeys is not to increase the total amount of diet during gestation or lactation (83% of survey respondents). Gestating females will require larger quantities of nutrients overall, but special attention must be paid to calcium and phosphorous. The calcium to phosphorous ratio should always be at the very minimum 1.2:1, but during pregnancy 2:1 is preferred. For this reason, a more concentrated or extra dose of vitamin and mineral supplement in suggested. Not every day but only twice a week.
Gestating female primates have been shown to have a more efficient digestive process than non-gestating females (Kemnitz et al. 1984). They will metabolise more energy and assimilate more nutrients than they normally would which renders giving extra food, not necessary.

Lactation

Lactation is the most energetically expensive state for mammals. Daily energy needs are estimated to increase by 23% (NRC, 2003). The majority of zoos did not increase total food quantity in the diet with great success. One common tactic is to add in an extra portion of food for the baby, at first perhaps eaten by the mother when more energy is expensive; afterwards it becomes the juvenile's ration of food.

2.3.6 Method of Feeding

All animal diets should be prepared in a sterile, clean environment that has not been in contact with any animal products as described in Kleiman et al. (2010) and which follows the agricultural laws of your country. All utensils used in food preparation should be clean and gloves should be worn at all times.
According to the nutrition survey, zoos are split between amounts of feedings per day. 19% of zoos feed three times a day with 14% feeding two times a day. Ideally you would provide your primates with many small meals which has been shown to keep them active for a longer part of the day. They can forage for up to 50% of their days. Three feeds per day should be the norm with some zoos able to perform even more feeds. This will also help to control their appetite and reduce possible aggression

during hunger (Speechly and Buffenstein, 1999). The first meal of the day should be the pellets to encourage ingestion.
The majority of zoos feed their sakis at set times (75%) which is only a problem if abnormal anticipatory behaviours are observed. If so, then the switch should be made to random and/or increase the number of feeds per day.
A study was done at Paignton Zoo Environmental Park on food presentation with *Macaca nigra* where their daily diets were either cut in pieces or left whole, and scattered or placed in piles. According to the nutrition survey, 52% of zoos chop their diets (usually fruit and vegetables). This is commonplace with the ideology that the more pieces there are; the easier it will be for all members of the group to eat enough. This is carried out in most zoos because it is how they have always done it, although there is no evidence to support this belief. Plowman *et al.* (2009) showed us that diets actually should NOT be chopped. Results indicated that subordinate members of the troop ingested a larger quantity and diversity of food when food was left whole and not cut up. It was mentioned that monkeys are prone to picking up coveted food items first, taking a few bites out of it and then dropping it before grabbing something else, allowing other troop members to then pick it up themselves (Plowman *et al.,* 2009). As well as increasing the welfare of subordinate individuals, leaving food items un-chopped will also save keeper time. It will take much less time to prepare diets, as well as take less time to clean up afterwards. The nutritional content of a fruit or vegetable begin declining immediately after being cut therefore, offering un-chopped food items will also ensure a higher nutritional fidelity.

The diet should be presented as naturally as possible. Hanging baskets across the enclosure (which can then be changed location), scatter fed across multiple vertical levels and hidden food items in bags and in boxes of leaves or sand. Feed presentation should always be enriching (it should always promote natural feeding behaviours) and the feeding in bowls should be discouraged. This will also look better for visitors, seeing active “foraging” monkeys instead of individuals sat down eating from their plate.

2.3.7 Water

Water should always be available in both indoor and outdoor enclosures. Bowls can be used as well as water bottles, as long as the white-faced sakis have an unhindered access to clean, potable drinking water. More than one sources of water are desired to allow all members of the troop to drink if they want to.

2.4 Social structure

2.4.1 Basic Social Structure

Most of the saki groups consists of a breeding male, a breeding female and their offspring. The offspring stays with its parents until it is kicked out of the group, which happens mostly after three years.
The maximum size of a bachelor group is two. Sometimes a group of three will manage, but this is mostly when the group consists of a father with his offspring. With larger bachelor group sizes, the animals will start fighting with each other regardless of the amount of space in their enclosure.

2.4.2 Changing Social Groups

For the programme management it is essential for animals to be transferred and introduced in new, existing groups. Introducing animals to each other is a gradual process which takes some time. All introduction should have increasing olfactory, visual, auditory and physical contact. There have been successful reports of adults of both sexes being introduced to existing groups.

There has been a case where a zoo received a female with a for the receiving zoo unexpected young on her back. The female and her young have been introduced to an unrelated male without any problems.

2.4.3 Mixed Species Exhibits

Saki's are very tolerant animals and therefore ideal to keep in multi-species exhibits. A lot of zoos currently house their sakis together with other animals. A list of all the species that zoos have a positive experience with can be found in Appendix II. About some species there are mixed experiences by different zoos. A list of those species can be found in Appendix III.
If different species are together in an exhibit all species should have their own indoor enclosures. This allows separation of species and escape.

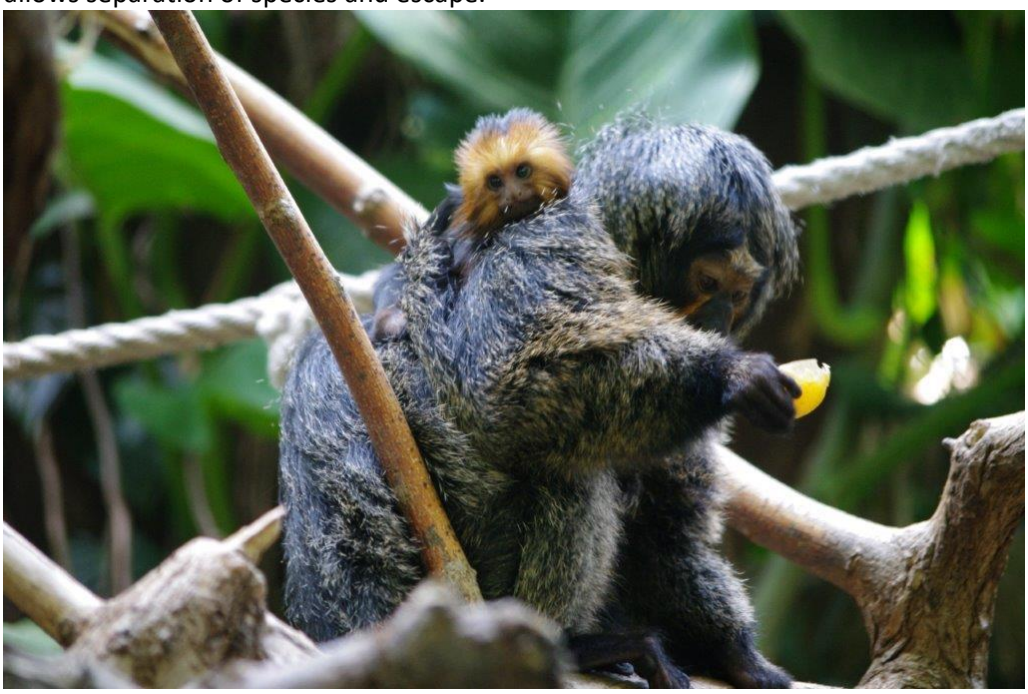


Figure 9. Golden Headed Lion Tamarin young on the back of a White Faced Saki female. Photographer Heidi Schneider, Zoo Wilhelma Stuttgart

2.5 Breeding

2.5.1 Oestrus and mating

Sakis don't have a breeding season, and births can occur throughout the year. Females do not show any obvious physical or behavioural changes at time of ovulation and they were also not observed actively asking for copulations from males (Savage et al., 1993, 1995). Males might be able to distinguish cycling females from non-cycling females, as copulations are more frequent with cycling females (Thompson et al., 2011).
Scent-marking behaviour seems to be one of the common sexual behaviours. Among scent-marking are behaviour patterns like throat-and-chest rubbing, groin with the hand and urinating on marked branches. Marking behaviour is strongly sex related, with the adult male making 88.4% of the markings (Eleonore et al., 1997). Scent-marking frequency by the adult male increased during breeding periods. Scent-marking behaviour seems related to courtship, and possibly stimulates sexual behaviour.

2.5.2 Pregnancy and birth

During May 2019 a questionnaire on zoo management and husbandry was conducted among Saki holders within EAZA. Among the 39 responses, two institutions reported to have experience with caesareans on a female White-Faced Sakis. In both cases the procedure was done because the infant died in utero. The breeding female in Zoo Basel even had as much as four c-sections, before she was able to give birth and raise young independently. She however has raised 7 young since then without

complications. Why this was difficult before and if a similar situation could occur with another individual of the species is unclear. Pregnancy in sakis is usually assessed by weight or belly size.

2.5.3 Maternal behaviour

Females sakis are the predominant caretakers. Infants stay attached to their mother's thigh from birth to 1 month. From age one to four months, the young shift to a dorsal position where they can achieve greater mobility. The mothers carry their infants for the first 3 months. After the infant is around the age of 5 months, the mother will stop carrying it. They feed, protect, and nurture young until they are ready to be on their own. However, in the wild infants observe one birthing event prior to leaving their family group (Waters 1995). In captivity, sakis overall show good parenting behaviour. Nyiregyhaza Animal Park in Hungary reported that when their female saki died, the male took over the role of caretaker and started carrying the young on his back. Cross-fostering is also frequently seen and documented in sakis. Often the older offspring will carry and take care of their younger sibling, or a grandparent will tend to their grandchild. As long as the young gets sufficient opportunities to nurse this is completely fine.

2.5.4 Infanticide

Infanticide is very uncommon in the species, only one animal in the current zoological collection is known to kill her offspring. She has been together with her partner since 2013 and has only fully reared one young. She shows normal behaviour and no signs of stress.

2.6 Population Management

As of the first of November 2018, the population consists of 175.138.7 animals at 102 institutions. 25 of those institutions have bachelor groups composed of 2 to 4 animals. There are four zoos with only one animal, which should be avoided. The population is created from 32 founders with 100% of the pedigree known.

Most groups in the zoo population consists of one breeding male, one breeding female and their offspring. Sub-adults are placed in other collections after they have seen their parents give birth to and raise a young or if they have been kicked out of the group.
Culling is currently used as a management tool in two institutions.

2.6.1 Contraception

A big part of the European population has received contraception. The main reasons to apply contraception are to prevent breeding or inbreeding, but other reasons to apply contraception can be reduction of aggression, for sub-adults to stay longer in the group or health reasons. Hormonal implantation is the most commonly used form of contraception. Castration of vasectomy is only applied if it is certain that the animal will not breed its entire life. The majority of the contraceptive users do not see any behavioural, physical or hierarchical problems or changes (Prins, 2015; Stenger, 2014). However, an increase in positive behaviours, negative behaviours, self-directed behaviours and sexual behaviours were reported for animals on hormone implants. One animal which was on a hormonal implant had a mild weight change. A castrated animal which never really developed full-male colours now has a female physical appearance (figure 10). No issues with reversibility have been observed and there have been individuals who have successfully reproduced after their implant was expired (Prins 2015).

Figure 10. Male saki with a feminine appearance after castration. Photo credit GaiaZoo

The EAZA group on Zoo Animal Contraception has produced a set of contraceptive guidelines which can be assessed when planning to contracept your animal.

2.7 Behavioural Enrichment and Training

Just as all New World Monkeys, sakis are highly intelligent animals. They may be trained to perform certain behaviours that could be useful for both medical and management purposes through the use of positive reinforcement. For example, they can be taught to enter and exit an exhibit on command, to shift between enclosures, to enter a crate, shifting onto a scale to be weighed or to allow certain medical procedures such as the injection of insulin by stationing themselves at the bars or mesh of the fencing (Reinhardt 2005). However, take note not to use additional food as reinforcement, but only use food types and quantities that are part of the daily diet of the animal, as it is easy to overfeed.

2.8 Handling

Handling of the animal should be avoided If other methods are available. In cases where handling of the animal is necessary, for example with the placement of a microchip transponder as a mean of identification, safety measures should be taken at hand.

2.8.1 Individual identification and sexing

Sexing is usually done by visual examination through wire mesh fencing. Training the animals to position themselves against the fence for examination through the use of positive reinforcement can be a useful tool in sex determination. As an individual identification method, a microchip transponder is usually placed subdermal in either the shoulder or chest.

2.8.2 Catching/Restraining

Capturing a white-faced saki can be done in multiple ways. Ideally enclosures are built with a crush tunnel system in which the animals can be captured if necessary. When such a system is not available nets are commonly used as a capturing method. The animal should first be separated from the others to keep family members from interfering. Wearing protective gloves as precaution is recommended when performing this method.

When saki has to be captured for transport, it is recommended to start training the animal to go into a training cage by itself a few weeks in advance. This can easily be achieved through the use of positive reinforcement.

Physical restraint should only be applied if no other methods are available and should only be carried out by experienced handlers as it causes a lot of stress for the animal and could potentially be dangerous for an unexperienced handler (Fowler & Miller 2015). When handling the white-faced saki it is recommended to wear thick leather gloves and long-sleeved clothing to avoid scratching or biting.

2.8.3 Transportation

Generally speaking, sakis are best transported in plastic or wooden crates or carriers designed for dogs and cats. The crate can also be built specially for monkeys, but a regular crate or carrier for housepets will do just fine, given that it is sturdy, well ventilated, in good condition and substantial enough to safely contain the animal and prevent people from accessing it during transport (Fowler & Miller 2015). Sakis should generally be transported individually. Exception is when they have a suckling youngster or newly weaned juvenile.

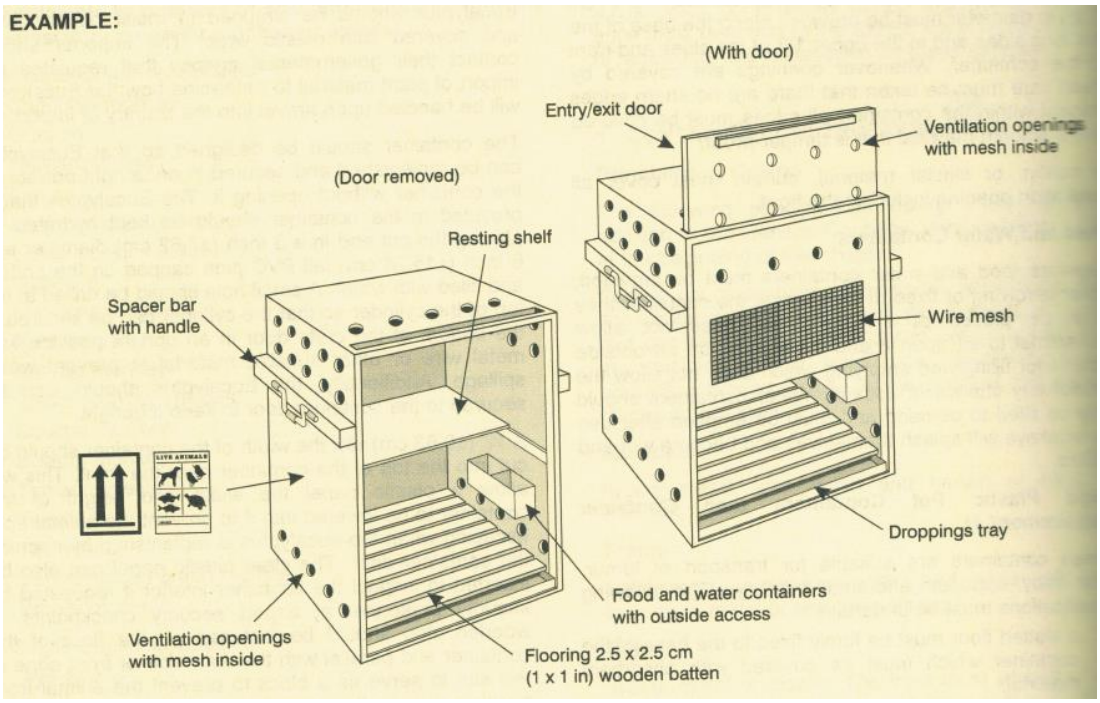


Figure 11. Example of a crate conforming to container requirements 31, set by IATA for multiple primate species, including the White-faced saki.

When travelling by plane, compliance with shipping regulations of the international Air Transport Association (IATA), local and national regulatory agencies, and those of the airline are required. The crate must meet all requirements of design by IATA (see figure 11 above for an example crate fit for transport of the species). Food and water should be provided in transit when the shipment is delayed. Therefore, the crate construction should prevent the spilling of food, water or waste. Any necessary pre-shipment medical testing should be completed, and the health certificate, the medical record, and copies of test results should be included with the shipment (Fowler & Miller 2015). Pregnant females and females with suckling young are not allowed to be transported by plane. Young animals must not be separated from one another while traveling as this increases stress. They must be in portioned containers or in separate containers loaded adjacent to each other in the aircraft (International Air Transport Association, 2014).

2.9 Veterinary Care

2.9.1 sedation and anaesthesia

When possible, anaesthesia should be avoided since the procedure is stressful for the animal. For any given situation the cost and benefits of sedation or no sedation should be weighed against each other. Since the correct dose of anaesthetic is vital, it is important that the animals are weighed periodically so the correct dosage can be provided (Hosey, Melfi and Pankhurst, 2013).

2.9.2 Preventative medicine

Preventive medicine is very important in the care for white-faced sakis. A preventive medical program should typically include either scheduled or opportunistic tetanus and rabies vaccination, a routine check for parasites through faecal examination (at least annually, preferably several times a year), and prophylactic parasite treatment protocols based on the parasite history of the colony or zoo collection and faecal parasite results. In many cases, prophylactic parasite treatments will be administered for both protozoal and helminth parasites.

Other preventive medical procedures should be based on the medical history of the individual animal and/or the medical history of the group. The decision to perform any examination or procedure should

be based on a risk-benefit analysis, calculating in the risks involved with anaesthesia and handling of the animal, the social impact on the individual animal or the group, and the expected benefit from the procedure. If performed, annual examinations *can*, but *should* not include: Physical examination, dental evaluation, hematologic and biochemical screening from blood sample, viral serology specific to the species, vaccinations, tuberculin testing, radiography and ultrasonography (Fowler & Miller 2015).

2.9.3 Health examination before and during animal transportation

Vaccination must be done far in advance of the departure date to allow for immunity to develop. Health certification and serological testing must be arranged several weeks before transport. Only animals which appear to be in good health, judging by appearance, behaviour and the documents above, should be transported. If there is any chance of pregnancy in a female saki scheduled for air transport, this must be checked. Pregnant monkeys of any kind are not accepted in air travel and should be transported long distances otherwise. If an animal appears to have become ill or has been injured during the transport, veterinary treatment must be arranged when executable (International Air Transport Association, 2014).

2.9.4 infectious diseases

White-faced sakis are susceptible to a range of diseases caused by pathogens, including parasites, bacteria and viruses. This section highlights infectious diseases commonly found in the species, ordered by causative pathogen. Signs indicating presence of the disease are provided, as well as how a diagnosis is established. Notable cases of treatment are also mentioned for future reference.

2.9.4.1 Viral diseases

The most common serious viral disease in White-faced sakis as well as other New World and Old World monkeys is infection with the human herpesvirus 1 **HHV1.** HHV1 infection is transmitted through direct contact with a human host with active lesions. Signs include: Conjunctivitis, nasal discharge, ulcerative dermatitis, lingual ulcers, and necrotic plaques. Analysis of conjunctival swabs can confirm if the infection is indeed caused by HHV1 (Fowler & Miller 2015).

In most cases the disease is rapidly fatal in White-faced sakis. However, one case was reported in which an ocular infection with HHV1 in a 20-year-old male saki was successfully managed for over 2 years by using acyclovir (5 mg/kg PO twice daily) during flare-ups before the disease progressed and the animal was euthanized. This is the first reported case of successful management of HHV1 infection in a platyrrhine primate and the first case of HHV1 in a white-faced saki that was not rapidly fatal (Bauer et al., 2018).

Raspatory diseases may be caused by viral infections, but are less frequently diagnosed although infections with paramyxoviruses and influenza A and B viruses are common (Fowler & Miller 2015).

2.9.4.2 Bacterial diseases

Table 8 below shows a comprehensive list of bacterial diseases commonly found in White-faced sakis specific or New World Monkeys in general, which are zoonotic and thus should be handled with protective precautions. Non-zoonotic bacterial diseases are portrayed in table 9.

Table 8. Selected list of zoonotic bacterial diseases in White-faced saki's and New World Monkeys alike (Fowler & Miller 2015).

Disease	Epizoology	Signs	Diagnosis
Mycobacteriosis	Mycobacteriosis: Saprophytic opportunistic organisms acquired by contacting contaminated water or soil via respiratory, oral or skin contact	Mycobacteriosis: Diarrhea, wight loss, lymphadenopathy, splenomegaly, segmental to diffuse thickening of intestinal mucosa mainly terminal ileum and proximal colon; draining fistula or ulcerated cutaneous lesion.	Intradermal tuberculin skin test with Mammalian Old Tuberculin read at 24, 48 and 72 hours; radiographs; antibody-based testing (see text); faecal and gastric samples for acid-fast stain, culture and PCR, acid-fast stain; necropsy, histopathology; biopsies ay aid in diagnosis and culture is definitive, but only if positive.
Yersinia	Food contamination by rodents and birds carry faecal-oral transmission	Diarrhoea, anorexia, dehydration, suppurative enteric and hepatic lesions, abortions, stillbirths.	Culture and histopathology, impression smear from necrotic foci
Shigellosis	Faecal-oral transmission; initial infection from humans. Colony infection is probably due to asymptomatic carriers and rodent reservoirs. Stress may be a factor in causing overt disease.	Bloody, mucoid, dysentery, weakness, dehydration; facial edema.	Rectal culture (May require several cultures); Necropsy, histopathology; Tissue PCR
Salmonellosis	Fecal-oral transmission; Aerosol transmission is rare. Insects and rodents may be source of infection.	Can be asymptomatic carries, watery to bloody mucoid diarrhea and dehydration.	Culture, gross and histopathology

Escherichia coli	Fecal-oral transmission	Diarrhea, pneumonia, enteritis, meningitis, hepatomegaly, splenomegaly	Culture; Necropsy, histopathology, identification of specific serotypes of E. Coli (reference laboratory to type and isolate), HEp-2 adherence assay, detection of E. Coli toxin genes by PCR.
Campylobacteriosis	Fecal-oral. Recovered animals shed bacteria for up to 21 days after diarrhea resolves	Asymptomatic carriers, watery to muchohemorrhagic diarrhea, colitis, electrolyte imbalances, weight loss. C. fetus caused fetal death	Culture; histopathology, serology; fluorescent antibody or avidin-biotin antibody staining of intestinal biopsies.

Table 9. List of selected non-zoonotic bacterial diseases in White-faced saki's or New World Monkeys alike (Fowler & Miller 2015).

Disease	Epizootiology	Signs	Diagnosis
Gram-positive cocci	Respiratory, aerosol transmission; carriers harbour bacteria in nasal passages, throat. Animals may be predisposed to infection by stress, viral infections, immunosuppression.	Asymptomatic carriers; Pneumonia, septicaemia, bacterial meningitis, purulent conjunctivitis, panophthalmitis, peritonitis and arthritis.	Culture, CSF tap, clinical signs, histopathology
Tetanus	Soil contamination of wounds, post-partum infection, frostbite	Progressive over 1-10 days; lethargic, excessive thirst, unable to prehend food, difficulty swallowing, progressive stiff gait and adduction of forelimbs, biped walking or hopping, piloerection, tenesmus, extensor rigidity exacerbated by noise, seizures, opisthotonos.	History and signs; bioassay for tetanospasmin. PCR test for human diagnosis, tetanus IgG (Antitoxin) Enzyme-linked immunosorbent assay (ELISA)
Helicobacteriosis	Transmission occurs in young in social groups, likely oral to oral from dam to offspring. Some enterohepatic helicobacters are identified with no definitive link of causality.	Usually asymptomatic. Gastric: Gastritis, occasional vomiting, gastric ulcers. Enteric: Chronic wasting, diarrhea.	Gastric helicobacters: gastric endoscopy and gastric biopsy, culture, rapid urease test, H pylori plasma IgG. Enteric helicobacters: Culture, colonoscopy, colonic biopsies with PCR.

2.9.4.3 Fungal diseases

Table 10 below shows two fungal diseases commonly found in white-faced sakis or other related New World Monkeys, including signs that could indicate infection as well as how the disease is diagnosed.

Table 10. List of selected fungal diseases found in White-faced sakis or New World Monkeys alike (Fowler & Miller 2015).

Disease	Epizootiology	Signs	Diagnosis
Pneumocystis	Pneumocystis species infecting different hosts are genetically distinct taxa. Life cylcle includes a trophic and cyst (generative) phase.	Clinical disease is secondary to immunodeficiency, stress, neoplasia etc.	History (pulmonary disease with immunodeficiency); necropsy; histopathology; bronchoalveolar lavage (BAL)
Coccidioidomycosis	Transmission through inhalation of arthrospores. Exposure usually in non-human primates housed outdoors exposed to dust storms or dust from recent construction with disturbance of virgin desert.	Disseminated disease: lessions in lung, vertebrae, liver, kidneys, spleen, esophagus, and lymph nodes. Nasal discharge, cough, dyspnea, pneumonia, weight loss, lameness, altered gait, paralysis, ascites, failure to thrive.	Culture; Identification of organism in cytology or histopathology; clinical signs, history, serology (completement fixation or tube preciptin test) or skin testing with cocci dioidin, radiography.

2.9.4.4 Parasites

Table 11 below shows a list of diseases found in white-faced sakis or other related New World Monkeys caused by the infection with a parasite. Information on whether or not the disease is zoonotic is included, as well as where in the body the parasite is usually found, signs indicating infection and how the disease is usually diagnosed.

Table 11. List of diseases commonly found in White-faced sakis or New World Monkeys alike caused by parasites (Fowler & Miller 2015).

Disease	Zoonotic	Location in host	Clinical signs	Diagnosis
Giardia ***Enteric flagellates***	Yes	duodenum, jejunum, upper ileum	Asymptomatic carriers, usually self-limiting, vomiting and diarrhoea	Trophozoites/cyst in feces, DFA; fecal EIA
Ameba ***Amebiasis***	Yes	Ameba and cysts in cecum, colon. Invasive trophozoites cause abscesses in lung, liver and brain.	Asymptomatic to severe disease (weight loss, lethargy, hemorrhagic, diarrhea, rectal prolapse), pulmonary, neurological signs, Virulence depends on host, strains, nutritional status, gastrointestinal, microflora, and environmental factors.	Fresh fecal examination for O and PI Histopathology, Fecal trophozoites may be non-pathogenic

Toxoplasmosis	Yes	Found in any organ but especially the liver, lypmph nodes and brain.	Retinal lesions; respiratory distress and central nervous system signs.	Histopathology (IHC), Sabin-Feldman dye test, Serology: CF, IFA, HA
Malaria	Yes	Asexual phase: Schizogonic phase in erythrocyte (erthrocytic; blood phase) or in liver (exoerythrocytic; liver phase)	May be fatal even in adults because of destruction erythrocytes.	Identification of organisms in red blood cells, PCRF, fluorescent antibody, serology.
Pinworms ***Oxyuriasis***	Yes	Adult worms reside in colon. Deposit eggs in perianal and perineal area; hatch into larvae.	Perianal pruritus, restlessness, self-mutilation, increased aggressiveness.	Fecal O and P; Examine sample of anal area with cellophane tape and perianal or perineal swabs; adult worms coming out of anus.
Filarioidea ***Filariasis***	No	Adult worms in subcutaneous tissues, thoracic and peritoneal cavity; subserosal connective tissue of abdominal and thoracic cavities. Microfilariae in blood biting and blood sucking insects transfer microfilariae to primate host with blood meal.	Asymptomatic. In heavy infestations with D. graciliformes, D. gracile, D. Robini, D. caudispina or D. Freitas may cause pleiritis or peritonitis; anemic, eosinophilia, hyperproteinemia, decreased A/G ratio. Lesions: Haemorrhage, thickening of connecting tissues, adhesions in sites where worms are located.	Microfilariae in blood, adult worms found in peritoneal cavity.

2.9.5 Non-infectious diseases

Wounds inflicted through conflict are generally not that common in White-faced sakis, but can still occur in unstable groups. Wounds should be disinfected as soon as possible to prevent inflammation.

2.9.6 Necropsy

Necropsies should be conducted on all monkeys that die in quarantine or in the colony or zoo collection. This should include gross necropsy, histologic evaluation of the tissue, and appropriate ancillary testing (cultural, molecular diagnostics, etc.) Thorough necropsy will not only determine the cause of death but also serves as a way to evaluate the group, species and colony or zoo collection for the presence of infectious, parasitic, nutritional, toxic, or metabolic diseases that are relevant to the care of the remaining group of sakis.

2.10 Recommended research

As stated in paragraph 1.3, little research is done about the physiology of the White-faced saki. To aid future medical treatment and examination, a research comparing information such as heart rate, respiratory rate and body temperature from several healthy adult individuals is recommended. This research is best executed in captivity and would shine a light upon the physiology of the captive white-faced saki population.

Infection with the Human Herpesvirus 1 is a serious threat among various primates and is generally fatal. But a report published in Comparative Medicine in 2018 stated that an ocular infection in a white-faced saki monkey was successfully managed for over two years (Bauer et al., 2018). This is the first reported case of successful management of HHV1 infection in a platyrrhine primate and the first case of HHV1 in a white-faced saki that was not rapidly fatal. Extended research on the management of HHV1 infection is recommended, as it would not only be interesting for the species but for non-human primates in general if successful management of the viral infection could be reproduced.

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APPENDIX

Appendix I: Food items used in Saki diets by different zoos (study 1)

Food item name	Number of collections currently using item	Food item name	Number of collections currently using item
Apple	24	Arabic Gum	5
Banana	19	Baby cereal	4
Grapes	18	Cat biscuit	2
Mango	5	Cereals	5
Melon	10	Dog biscuit	1
Orange	12	Hummingbird mix	1
Other fruits	19	Marex	7
Papaya	6	Marmoset jelly	3
Pear	19	Primate pellet	11
Tomato	15	Tamarin cake	7
Fruit	3	Trio munch	8
Avocado	3	Boiled egg	19
Beetroot	4	Boiled rice	7
Boiled potato	7	Cheese	7
Broccoli	8	Cooked meat	13
Carrot	20	Edible flowers	1
Celery	13	Honey	2
Chicory	4	Jam	1
Courgette	6	Livefood	27
Cucumber	16	Nuts	16
Fennel	6	Peanuts	6
Other Veg	18	Puree mix	2
Parsnip	5	Raisins	7
Pepper	7	Seed mix	8
Swede/ turnip	4	Sunflower seeds	12
Vegetables	4	Yoghurt	2

Appendix II: Food items used in Saki diets by different zoos (study 2)

Food item name (Vegetables)	Number of collections currently using item
Carrot	39
Cucumber	34
Celery	33
Broccoli	32
Zucchini	30
Peppers	30
Fennel	29
Sweet potato	25
Beetroot	22
Boiled potato	20
Leek	18
Parsnip	18
Chicory	18
Peas	16
Turnip	14
Beans	13
Kohlrabi	12
Cauliflower	7
Corn	5
Eggplant	5
Bok Choi	2
Kale	2
Radish	2
Cabbage	2
Brussel sprout	1
Mushrooms	1
other	5

Insects	Number of collections currently using item
Mealworms	32
Crickets	18
Grasshoppers	15
Morioworms	7
Wax moth larvae	3
Earthworms	1
Dubias	1
Unknown	1

Food item name (Fruits)	Number of collections currently using item
Apple	35
Pear	25
Tomato	23
Melon	22
Banana	20
Grapes	20
Orange	17
Mango	15
Papaya	15
Watermelon	4
Berries	4
Pineapple	3
Kiwi	3
Other	7

Nuts and seeds	Number of collections currently using item
Sunflower seeds	28
Walnuts	27
Seed mix	21
Peanuts	18
Hazelnuts	16
Almonds	15
Pumpkin seeds	12
Macadamia nuts	1
Pecans	1
Cashew	1
Brazil nuts	1
Other	3

Supplements	Number of collections currently using item
Mealworms	32
Crickets	18
Grasshoppers	15
Morioworms	7
Wax moth larvae	3
Earthworms	1
Dubias	1
Unknown	1

Appendix III. Possible species to mix White-Faced Saki monkeys with

Primates		
Species	**Latin name**	**Experienced Zoos**
Black Howler	Alouatta caraya	Frankfurt
Cotton-top tamarin	Saguinas oedipus	Besancon, Faunia, Karlsruhe, Natur'Zoo de Mervent, Opole, Skansen Akvariet
Emperor tamarin	Saguinas imperator	Asson, AviFauna, Dudley Zoo
Golden headed lion tamarin	Leontopithecus chrysomelas	Amazon World, Calviac, Chessington, Copenhagen, Drayton Manor, Furuvik, Karlsruhe, Zoo Plzen
Grey-bellied night monkey	Aotus Lemurinus	Den Lille Dyre Hague
Pygmy marmoset	Callithrix pygmaea	Beauval, Copenhagen, Den Lille Dyre Hague, Helsinki, Peaugres, Zoo Plzen, Montpellier, Wroclow
Red-faced spider monkey	Ateles paniscus	GaiaZoo
Red handed tamarins	Saguinas midas	Besancon, Chessington, Drayton Manor, Loro Parque
Silvery marmoset	Callithrix argentata	Drusillas, Leipzig
Venezuelan red howler	Alouatta seniculus	Planete Sauvage, Berlin
Yellow-breasted capuchin monkey	Sapajus xanthosternos	Berlin

Other mammals		
Species	**Latin Name**	**Experienced Zoos**
Azari Aguti	Dasyprocta azarae	AquaZoo, Berlin, Gettorf
Big hairy armadillo	Chaetophractus villosus	Frankfurt
Gaint anteater	Myrmecophaga tridactyla	Sosto
Giant otter	Pteronura brasiliensis	AquaZoo, Leipzig
Golden Aguti	Dasyprocta leporina	Asson, Furuk Yalçin Zoo, Zurich
Greater guinea pig	Cavia magna	Frankfurt, Karlsruhe
Linnaeus's two-toed sloth	Choloepus didactus	Amazon World, Bassin d'Arcachon, Frankfurt, Karlsruhe, Krefelder Zoo, Loro Parque
Long-tailed tamandua	Tamandua tetradactyla longicaudata	Berlin
Lowland Paca	Cuniculus paca	Berlin
Paca	Cuniculus	Bassin d'Arcachon, Montpellier
Palla's long-tongued bat	Glossophaga soricina	Nuernberg
Red acouchi	Myoprocta acouchy	Gettorf

Birds		
Species	**Latin Name**	**Experienced Zoos**
Amazonian Motmot	Momotues momoota momota	Zurich
Channel-billed toucan	Ramphastos vitellinus	Zurich
Croaking ground dove	Columbina cruziana	Nuernberg
Elegant crested tinamou	Eudromia elegans	AviFauna
Golden pheasant	Chrysolophus pictus	Selwo Marina
Nocturnal curassow	Nothocrax urumutum	AviFauna
Northern Cardinal	Cardinalis cardinalis	Zoo de la Fleche
Paradise tanager	Tangara chilensis	Nuernberg
Red-legged seriema	Cariama cristata	AviFauna
Ringed Teal	Callonetta leucophrys	La Fleche
Scarlet ibis	Eudocimus ruber	Selwo Marina
Sunbittern	Eurypyga helias	Montpellier
Trumpeter birds	Psophiidae	GaiaZoo
Turquoise tanager	Tangara mexicana	Nuernberg
Violaceous euphonia	Euphonia violecea	Nuernberg
Ibis		Faunia
Macaw		Faunia
Toucan		Faunia, Skansen Akvarit
Different birds		Den Lille Dyre Hague, Karlsruhe, Krefelder Zoo, Zoo Zlin-Lesna

Reptiles		
Species	**Latin Name**	**Experienced Zoos**
Green Iguana	Iguana iguana	Krefelder Zoo, Loro Parque, Selwo Marina
Martinique's anole	Anolis roquet	Nuernberg
Red-footed tortoise	Chelonoidis carbonarius	Furuvik
Yellow-headed gecko	Gonatodes albogularis	Nuernberg
Yellow-spotted river turtle	Podocnemis unifilis	Nuernberg
Lizards		Den Lille Dyre Hague, Krefelder Zoo

Amphibians		
Species	**Latin Name**	**Experienced Zoos**
Anthony's poison arrow frog	Epipedobates anthonyi	Nuernberg
Golden poison frog	Phyllobates terribilis	Nuernberg
Red-eyed tree frog	Agalychnis callidryas	Nuernberg

Insects		
Species	**Latin Name**	**Experienced Zoos**
Butterflies		Nuernberg
Leaf cutting ants		Nuernberg

Appendix IV. Mixed experience species in housing the White-Faced Saki monkeys with

Primates			
Latin name	**Species**	**Zoos with positive experience**	**Zoos with negative experience**
Common marmoset	Callithrix jacchus	Calviac, Chemprepus, Faunia, Wroclow	Halle
Geoffrey's marmoset	Callithrix geoffroyi	Calviac, Chessington, Faunia, GaiaZoo,	AviFauna
Goeldi's marmoset	Callimico goeldii	Beauval, Calviac, La Fleche, Montpellier, Opole	Bassin d'Arcachon, Den Lille Dyre Hague, Marlow Bird Park
Golden lion tamarin	Leontopithecus rosalia	Beauval, Copenhagen, Frankfurt, GaiaZoo, Helsinki, Skansen Akvarit	Champrepus, Drusillas, Peaugres
Red-bellied titi	Callicebus moloch	AviFauna	Skansen Akvarit
Squirrel monkey	Saimiri sciureus	Vienna Zoo	Dudley Zoo
White-lipped tamarin	Saguinas labiatus	Oasis Park	Amazon World

Appendix V. An overview of white-faced saki enclosure size in different zoos compared to group composition and other relevant factors

Groupcomposition	Shared with	Enclosure size	Other notes	Zoo
1.1	Breeding group emperor tamarins and goldagouti	**Indoor:** 4x6x3m 3 separate compartments, 4x3m + 3x1m + 1x4m **Outdoor:** 6x10x4.5m, roofed with wire mesh 3x3 cm	A part of the accommodation is in public view, excluding the separation area	Blackpool
2:0	-	**Indoor:** 2.5x3.5x3m One compartment but can easily be adjusted if needed **Outdoor:** 10x122x5m, partially roofed and designed to create a raised conservatory that traps heat and stops wind, 50 mm chainlink	In public view	Not stated
1.2	Motmot, goldagouti, channel-billed toucan	**Indoor:** 40 m2, 4 m high, 1 behind the scenes management stall of 10 m2 **Outdoor:** No outdoor exhibit	A part of the accommodation is in public view, excluding the separation area	Parc Zoologique de Lille
5.3	2 golden lion tamarins and 1.1 white faced marmoset	**Indoor:** 3 separate rooms +/- 3x4x5m which are all accessible through sliders **Outdoor:** Open outdoor exhibit with trees, 15x8m, 15 m useable height	Indoor accommodation is out of public view	GAIA Zoo

2.0 (father+son)	Golden lion tamarins	**Indoor:** 7.20m x 3.00m x 2.50m high **Outdoor:** Open top Island about 10x4m, about 8-10 m useable height, Water barrier	Indoor accommodation is out of public view	Not stated
2.1 (father+offspring)	-	**Indoor:** 4m2, split in 2 compartments **Outdoor:** Island: 10-15m2 , about 6 m useable height open top exhibit. Small wooden fence, water barrier	Indoor accommodation is out of public view	Not stated
2.0	White-lipped tamarins, 2m1 common marmosets, armadillos and iguana's	**Indoor:** 3,6 m x 2,90 m 2 compartments of 1,75x2,9m//1,85x2,9m **Outdoor:** 4707 m2, 5,5m useable height, roofed with fence, glass fencing	Indoor accommodation is out of public view	La Lajita
1.2	3.0 Goeldi's monkey, 1.1 lowland paca, 1.1 Sunbittern, 0.1 Black-tailed trogon. No problem except with nutrition	**Indoor:** The aviary is in a greenhouse. Approximatively Width 10 m x Depth 6 m x Height 6 m **Outdoor:** No outdoor exhibit	Entirely in public view	Montpelli
2.0	Emperor tamarins	**Indoor:** 2x3.5x2.5m **Outdoor:** 5x7x10, mesh and timber roof	A part of the indoor accommodation is in public view, excluding the separation area	Not stated
2.3	Common Marmosot, Golden headed lion	**Indoor:** 6 x 9m 2 separate compartments of 6 x 9 m and 2 x 1,5 m	Tension before with 2 more male offspring (they are gone now and male is castrated, everything is fine.)	Faruvik

	tamarin, red footed toiroise	**Outdoor**: 5x5x4 ,roofed with 2,5x5 cm netting	A part is in public view, excluding the separation area	
2.0	Cotton top tamarin, Azara agouti and red howlers	**Indoor:** 15x4x3 m 1 compartment of 1.5x5m **Outdoor**: 40x15x10, open top	Aggression between the males 3-4 times a year	Not stated
2.1 (couple and young of the female)	Azara's night monkey. Titi monkey, golden lion tamarin, pygmy marmoset	**Indoor:** 2000m2 **Only indoor**	Entire accommodation in public view	Not stated
2.0	Cottontop tamarins	**Indoor:** 4x3 2 different compartments (1 for saki's, one for tamarins) of 2x2 m **Outdoor**: 100m2, useable height 4 m, roofed with an iron net of about 5mm	A part of the indoor accommodation is in public view, including the separation area	Not stated
1.1	-	**Indoor:** 15m2, 2 compartments **Outdoor**: 45 m2, useable height 5 m, roofed with fence with 2,5 x 2,5 cm mesh	A part is in public view, including the separation area	Not stated
1.2	-	**Indoor:** 8 m2 3 compartments of about 2 m2 each **Outdoor:** 47m2, height 6 m, roofed with 4x6 cm hexagonial mesh	Indoor accommodation is out of public view	Not stated

2.0 (but separated)	1 with 2.0 red-handed tamarins//1 with 2.0 golden-headed lion tamarins	**Indoor:** 2 separate compartments, both H 3m W 1,5 m D 2,5 m **Outdoor:** H 20 ft, W 18 dr L 24 ft 18 ft useable vertical height Roofed, wooden frame with 8mm metal mesh	Arrived at the zoo as bachelor pair, however displayed aggressive/over dominance behaviour which led to separation.	Not stated
1.1	Goeldi monkeys, golden headed lion tamarins	**Indoor:** 20 m2 (2 separate compartments of 3,5m2 and 10 m2) **Outdoor:** 80 m2//4000 m3 with a useable height of 5 m and a netted roof with 3,5 c meshsize	A part is in public view, excluding the separation area	Reserve Zoologique Calvac
1.2 (castrated M + 2 sisters)	3.0 Red howler and 2.0 mara	**Indoor:** 14m2 2 separate compartments (7 m2 for 1.1 and 7 m2 for 0.1) **Outdoor:** 600 m2 with a useable height of 5-6 m, open top and watermoat barrier	aggression between the sisters after the arrival of the male. A part of the indoor accommodation is in public view, excluding the separation area.	Not stated
2.0	Red howler, capuchins, agouti, paca, tamandua	**Indoor:** 40 m2, 4,5 m height 2 separate compartments (2x 20 m2) **Outdoor:** 1100 m2 with a useable height of 4-7m, open top exhibit with 3 x 4 cm mesh wirefencing, secured with electric wire.	No problem introducing young male to older male A part is in public view, including the separation area	Zoo Berlin
1.1	Goeldi's marmoset	**Indoor:** 6x3x3 m No compartments	Entirely in public view	Not stated

		Outdoor: No outdoor exhibit, hight over 3 m		
2.0 (father+son)	Giant anteater	**Indoor:** 3 indoor area's: 20,5 m2, 20,5m2 and 11m2 **Outdoor:** 22 m2 with a useable height of 3 m, open top exhibit with 2 cm meshsize for the fench and windows	A part of the indoor accommodation is in public view, including the separation area.	Nyíregházi Állatpark/SóstóZoo
1.2	Golden headed lion tamarins, pygmy marmosets and sloths	One big indoor hall with 600m2 with a large pool for manatees and fishes. Two islands that the animals can use. It's a high room, approx.. 10 m, a lot of rope and plants for climbing. It's all one big room. There are cages for the different monkeys in case of conflict, illness or introduction.	Entirely in public view	Odense ZOO, Denmark
1.1	Green iguana, scarlet ibis, chaina torquata and other small bird species	**Indoor:** Small wood house of approx. 1 m x 0,8 x 0,8 m	All in public view Spend most of their tie outside because of warm climate	Selwo Marina
3.3, breeding pair with offspring	Titi monkeys recently, did not work well (titi's were stressed) so not currently	**Indoor:** 16.9 m2 + 12.6m2 +24.2m2 Height: 2.7 3 big compartments: 10.4.2, 11.3m2, 20.4m2 1 med. Sized compartment: 4.4m2 and 7 small compartents >1,5 m2	Seperation area out of public view	Zoo Basel
1 group of 2.1 couple w/ son **1 group 2.1 pair w/ son** **1 male surpus**	Golden headed lion tamarin, emperor tamarin, alaotra gentle lemur, pied tamarin, goeldi's monkey	**Indoor:** Approx.. 4-8 m2, devided in 2 compartments or more	In the second group the oldest son was expelled and is surplus. Indoor accommodation is out of public view.	Apenheul

2.1 (bachelor M als non-breeding pair)	Pygmy marmosts, goolden lion tamarin	**Indoor:** 6m2, Height: 4m No compartments.	Indoor accommodation is in public view	Beauval
1.1.1	Pair of titis, a pair of pied tamarins and a sloth. There were problems at first with the male pied Tamarins.	90m2 greenhouse + 10 m2 night accommodation	A part is in public view, excluding the separation area	Paris Zoo
2.0	-	**Indoor:** 15 mt square One compartment	The entire indoor accommodation is in public view.	Exmoor Zoo
2.2 breeding pair and offspring	-	**Indoor:** 2 compartments each 3.2x3.2x2.5 m	A part of the indoor accommodation is in public view, excluding the separation area	Edinburgh Zoo
1.1	Two-toed sloth, red-handed tamarin, iguana	**Indoor:** 8m2, 2 compartments of 4m2	Out of public view	Loro Parque
1.1	Golden headed lion tamarin	**Indoor:** 11m2 with 2.8 height, 2 compartments (one of 3m2 and one of 8m2)	A part of the accommodation is in public view, excluding the separation area	Thoiry ZooSafari
1.3, neutered male, female and 2 adult duaghters	-	**Indoor:** 6x4 2 compartments, 4x2 and 2x1.5m	A part of the indoor accommodation is in public view, excluding the separation area.	Fota Wildlife Park
1.3 (couple and offspring)	0.2 Golden headed lion tamarin, blue-crowned parakeet	**Indoor:** 1.2x6x2.8m 2 compartments, 1m2x2.8x2.8 and 1.2x2.8x2.8	Out of public view	Zoo de Lyon
2.0 (brothers)	Red howlers and spider monkeys	**Indoor:** Night lodge divided into 2 compartments of 2x2x2.5m	Out of public view	Zoo de Guadeloupe

3.4	0.1 Hofmann's sloth	**Indoor:** 48m2 Indoor back area ca 16m2 (2 cages of 4m2 connected with tunnel) and a training area 8m2	A part of the indoor accommodation is in public view, excluding the separation area	Helsinki Zoo
1.3, mother with offspring	None at the moment	**Indoor:** 13m2, no compartments	Entire indoor accommodation is in public view. Occasionally aggression in the group. Male and one daughter (both neutered) are catalysts.	Zoo Dortmund
0.2	Sloth, agouti, howler monkey	**Indoor:** 25,6m2, no compartments	Entire accommodation is in public view	Frankfurt
1.1 (mother and son)	2 golden lion tamarins and 2 common marmosets	**Indoor:** 6m2 3 compartments of 1,5m2/1,5m2/3m2	The indoor accommodation is out of public view	Parc Zoologique de Champrépus
1.1	Cottontop tamarins	**Indoor:** 3x3m, 1 compartment	The entire indoor accommodation is in public view	Zoo du Bassin d'Arcahon