Australasian Primate TAG

Guidelines for the Housing and Management of Orang utans (*Pongo pygmaeus and Pongo abeli)*

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Contents

1.0 Introduction

To provide the best care for captive orang utans, it is necessary to replicate as much as possible the important elements of the wild environment.

1.1 Orang utans in the Wild

The orang utan lives in a variety of rain forest types including mixed dipterocarp forest, montane forest, primary lowland forest, tropical heath forest, riverine seasonal swamp forest, shallow peat swamp forest and coastal nipa-mangrove forest. The abundance and diversity of the tree species in the rainforest are influenced enormously by the different physical features, such as wind shelter, soil type, rainfall, drainage and topography (Mackinnon 1974). In general, these rainforests are dominated by trees in the Dipterocarpae family (Rijksen 1978; Rodman 1988). Throughout this range annual rainfall averages 3000mm with most areas having daily rain throughout the year and a daily relative humidity ranges from 60% to 100% (Galdikas 1978).

Although orang utans range from sea level to approximately 1700m above sea level, maximum population densities occur at lower altitudes with populations densities decreasing as the habitat becomes less suitable in the higher altitudes. The restriction of orang utan population densities in high-altitude regions appears to result from food scarcity, not an inability to cope with harsh climatic conditions. The equatorial regions of the orang utans range have little seasonal variations in climate, but some regions have a distinct wet and dry, fruiting and non-fruiting season.

Although orang utans use all vertical levels of the rainforest, they predominantly inhabit the 'middle canopy', (approx. 6-20m above ground) where food is most abundant and the canopy continuous. Large adult males spend approximately 5 -10% of their diurnal time travelling on the ground. The large size of the adult male restricts opportunities for utilising arboreal pathways (Sugardjito 1982; Rodman and Mitani 1987; Rijksen 1978).

Galdikas' (1978) study showed adult female orang utans have a core range of two to three km². (The core area is an area a female orang utan nests in and uses more intensively and to the exclusion of any other female). The adult female's home range is between 5-6km². This home range overlaps with home ranges of other females and provides sufficient food resources for a year-round supply for herself and up to two dependant offspring (Rijksen 1978; Rodman 1973; MacKinnon 1974; Horr 1977). Because daughters move out gradually into adjacent ranges to their mothers, the neighbouring females in any given area are usually related.

Adolescent males leave their mother's home range and travel long distances into territories new to them (Rodman 1973; MacKinnon 1974). This results in the adult males in an area being unlikely to be related to the resident females (Rodman 1973; MacKinnon 1974). In a particular area, adult males are either resident or nomadic (MacKinnon 1974; Galdikas 1978; Rijksen 1978). Galdikas (1978) also found resident adult males may move away from their home ranges when all the resident females have young infants (ie: unable to become pregnant) and there were seasonal food shortages. The adult resident male's home range (at least 10km²) takes in part the home ranges of up to five adult females and occasionally may overlap with home ranges of other resident adult males (Rodman 1973; MacKinnon 1974; Galdikas 1978; Rijksen 1978). Adult resident males do not appear to maintain a core range (Galdikas 1978).

The extreme sexual dimorphism in orang utans suggests a polygynous mating system with inter-male competition for both territory and females (Galdikas 1978). The resident adult male tries to maximise his reproductive potential by following a ranging pattern, which

contacts as many females as possible, while excluding other adult males from his home range (Horr 1972, 1977; Rodman 1973, 1977; Galdikas 1978).

As young males leave the maternal range, they are subject to an increased mortality in unfamiliar territory (Horr 1977). Young females are exposed to fewer risks by moving gradually into neighbouring territories. This difference in potential risk reduces the ratio of males to females by the time they reach adulthood. Subadult males will follow adult females to gain access to their food resources, while becoming familiar with the territory and the resident females. They engage in forcible copulation with the adult females as a haphazard attempt at reproduction and a method of establishing dominance (Galdikas 1978). As most copulations are performed by subadult males Mackinnon (1974,1979) concluded that subadult males were the main sires in the population and the less potent adult males acted as guardians to the offspring within their home ranges. This has been successfully refuted by Galdikas (1978) and Rijksen (1978). At the subadult stage females begin to establish a relationship with the resident adult male through periodic consortships (Galdikas 1978). Although most copulations are performed by subadult males, adult female enter consortships with adult males for a few days during periods of receptivity. Adult females are usually either suckling an infant or pregnant, in which case they are not ovulating, or they are receptive and consorting with an adult male. Subadult males, therefore, have little chance of impregnating an adult female. In forced copulations, it is unlikely that transmission of semen is achieved as this requires cooperation from the adult female.

The vegetative parts of many plants are toxic in large quantities. The orang utan's intolerance to leaf toxins may account for its preference for fruit. The fruit of plants contains few if any toxins as they depend upon animals for seed dispersal. As fruit is seasonally and sparsely dispersed in the rainforest, it would be impossible for a large animal such as an orang utan to travel in groups to exploit this food resource. Thus the scattered seasonal nature of fruiting trees and the large size of the orang utan has resulted in the solitary nature of the species (MacKinnon 1971; Horr 1972, 1975; Rodman 1973, 1977; Galdikas 1978; Rijksen 1978; Wheatley 1982).

In areas of overlapping home ranges, close kinship of neighbouring female orang utans allows them to tolerate each other while exploiting seasonal food sources, such as in large fruiting trees. It has been observed that in such gatherings of females and their offspring in large fruiting trees, there is never more than one adult male present and the only physical contact is between infants. Usually seasonal food sources are likely to be exploited by consecutive visits of female orang utans and their dependant off spring (Galdikas 1978, 1979; Horr 1977). As adult males are unrestricted by dependent young, they are generally able to forage over larger areas than females (Horr 1972). Competition for resources between adult males and females is restricted, because of temporal and spatial separation. Males generally forage lower in the tree canopy. (Horr 1972; Roman 1973; Galdikas 1978). The restriction of competition for resources from resident adult males may maximise the survival opportunities of infants the male has sired within the region. In addition the resident male's presence restricts the utilisation of food resources by other adult males (Galdikas 1978; Rodman 1977).

In periods of scarcity the greater mobility of the adult male allows him to exploit distance resources away from his home ranges, possibly leaving the area entirely. In the opposite case when resources are plentiful, there is often an influx of nomadic males into the area (Galdikas 1978, 1979; Rodman 1977; Rijksen 1978). Adult males eat more animal protein (such as ants and termites), are less selective and spend far more time foraging on the ground than adult females. The exploitation of slightly different ecological nichés again reduces competition and effectively reduces the time adult males and females can associate with each other without reducing their foraging efficiency (Rodman 1977; Galdikas 1978, 1979). Adult males may leave their resident ranges for a few years when all the females in their range have infants. This also removes pressure on female resources.

Researchers disagree about the effect of predators on orang utan reproductive and survival strategy. Mackinnon (1974) suggests there was an increased group size in Sumatra due to the larger number and variety of predators than in Borneo. Rijksen (1978) suggested that hunting by humans has increased the orang utan's solitary and arboreal behaviour, while Horr (1972), Rodman (1973) and Galdikas (1978) discount any influence of predation on the orang utan's social adaptation. The reason proposed for increased group size is the more clumped nature of fruit trees in the Sumatran rainforest. This results in the larger temporary groupings sometimes seen in large fruiting trees (Rijksen 1978).

1.2 Orang utans in Captivity

Galdikas (1995) has estimated that, in the wild, infant mortality is low and that the majority of orang utans live for at least 40 years. Because of their size and strength their exhibits are usually expensive to build. Therefore the exhibits usually need to be designed for a very long life. The most important design question that should be asked of a designer is will the design meet the needs of the animals and the zoo over the life of the exhibit? Therefore the design of an orang utan exhibit must not only meets the needs of the current orang utans at a zoo, but for often up to 20 years ahead. Therefore the design will need to incorporate possible room for expansion, as well as the change in numbers, changes in individuals of varying temperament and the changing age and sex structure of the colony. It may also be prudent to consider the changing priorities of *ex situ* conservation, changes in public attitudes and changes in the goals of captive management of orang utans, which are expected over the life of the exhibit.

This document is designed to be a tool for designers and managers of orang utans exhibits, in the form a checklist of relevant points, which they may want to consider.

2.0 Enclosure Design

2.1 Internal Structure of the Exhibit

Galdikas' (1978) study showed adult female orang utans have a core range of two to three km². (The core area is an area a female orang utan nests in and uses more intensively and to the exclusion of any other female). The adult female's home range is between 5-6km². This home range overlaps with home ranges of other females and provides sufficient food resources for a year-round supply for her and up to two dependent offspring (Rijksen 1978; Rodman 1973; MacKinnon 1974; Horr 1977). Because daughters move out gradually into adjacent ranges to their mothers, the neighbouring females in any given area are usually related.

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It is normally accepted that providing the correct social environment for animals in captivity is one of the major necessity for their well being. There is also a large variation in potential orang utan sociability according to age and sex. Juveniles and sub-adults are naturally far more social than adults. For example sub-adult males, which are naturally the most social orang utans, as adults become the least social of orang utans (See Appendix for definition of life stages of orang utans). Captive orang utans, especially if they are hand-raised are capable of being more social than they are in the wild, but their capacity to modify their behaviour is not totally plastic. There is also a large variation in sociability between individual animals. With such individual, life history, sex and demographic variation, there is the risk that characteristics of a few individuals can over influence the design of exhibits, which may out last the stay of the inhabitants. It is therefore wise to design the exhibit to be able to provide the inhabitants with social contact comparable to wild orang utans for their age and sex. This may be done by designing of placement of future internal barriers in the exhibit such as walls or vegetation protected by electric fences.

Female orang utans are very territorial. To the extent that recent evidence suggest female orang utans are so fearful to roam the forest outside their normal boundaries, because of potential confrontation with the resident, when their territory is degraded by logging they remain in the area eventually to die (van Schaik 2000). It is therefore important that adult female orang utans are allowed to set up their own territories and other adult females are not allowed to enter the area, even if the female temporarily vacates the area. Although the rotation of orang utans through various enclosures does have the potential of behavioural enriching the orang utans through novelty, the stress of this movement out weighs any benefit. Markham (1990) observed captive orang utans take on average two months after an exhibit move until signs of stress were reduced to pre-movement levels. Wild orang utan females tend to set up territories next to their dams. This relationship between females in a given area reduces friction between adult females when exploiting resources on the boundaries of the

territories. In captivity, the housing of related females in a zoo, also has the potential to reduce friction between adult females.

The question with orang utans is not are they solitary or gregarious, but what is the appropriate level of social contact they require. Due to the large variation in the appropriate level of social contact between sex/age groups and individuals, it is seldom possible to provide all individuals their preferred level of social contact. In the wild orang utans have the capacity to space themselves from each other and even the most subordinate animals can choose the level of social contact they desire. Neither keeping single orang utans, or small groups of orang utans isolated from even visual contact with other orang utans, or the formation of groups dependant only on numbers of orang utans at a zoo, are desirable management options.

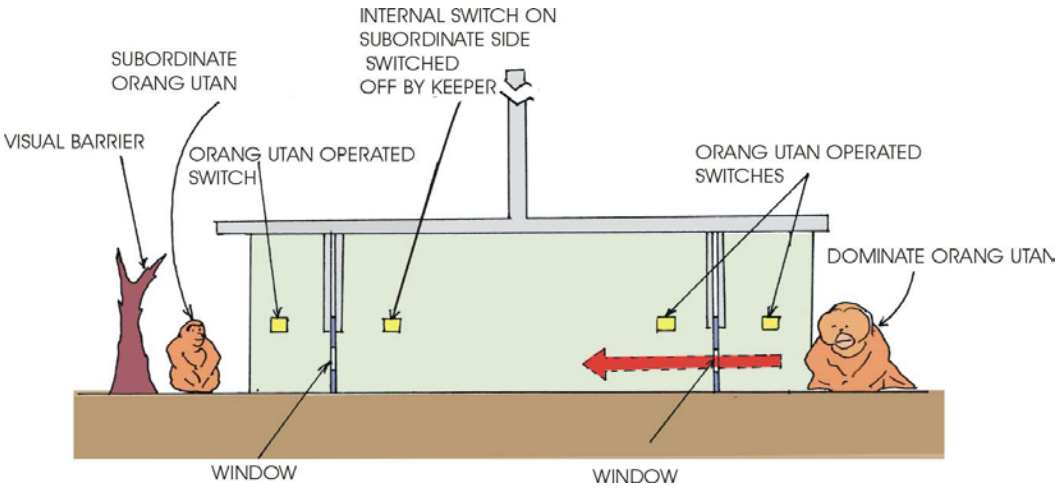
The problem in captivity where orang utans are confined to small areas is that choice by a dominant orang utan rarely coincides with that of the subordinate orang utan. Therefore in captivity the choosing of the appropriate level of social contact is usually decided by the keepers and restricted by the design of the exhibit.

There are potentially three methods of dealing with social contact.

1.Put all orang utans in one area and provide a level of choice through a diverse and complex environment, with multiple internal visual barriers, allowing even subordinate orang utans to choose their level of contact with cage mates. In addition ensure all desirable areas and facilities are offered to the orang utans are in abundance. The level of success with this approach is highly dependent on the size of the exhibit. The larger exhibit the more choice. Areas to some extent can be made effectively larger by increasing the functional complexity of the internal environment.

2. Place the orang utans in strictly defined natural population units (i.e. Adult female and up to two offspring, Solitary adult males, Juveniles and sub-adults in groups or twos or threes) and allow the keepers regulate the level of physical contact between groups according to individual temperament and known wild parameters. This is often the only effective method available to zoo managers when exhibit space is highly restrictive.

Fig. 2 Suggested Design of Contact Corridors



3. As in method two, place the orang utans in strictly defined natural population units, but allow transfer between groups in adjacent territories according to mutual choice of orang

utans. This can be achieved through the placement of corridors between enclosures (See Fig. 2). In this situation the keeper closes the slides and separates the two individuals/groups each night. The slides may be opened each day by sensor-switches operated by the orang utans, with the exception of the inside switch closest to the subordinate animal's enclosure. This switch has its orang utan-operation mode turned off by the keeper. If the dominant orang utan wants to have social contact it raises the slides and enters the corridor. The subordinate animal may view the dominant animal through the slide's window. If the subordinate agrees with the contact it must open the slide for the dominant animal. If the subordinate orang utan makes the first move it can open all the slides to the dominant animal's enclosure. Alternatively, the movement both ways can be made to occur by mutual consent only. There is a visual barrier placed near the slide windows to prevent any unwanted visual contact between individuals. As well the keeper may close the slides at any time of his/her discretion.

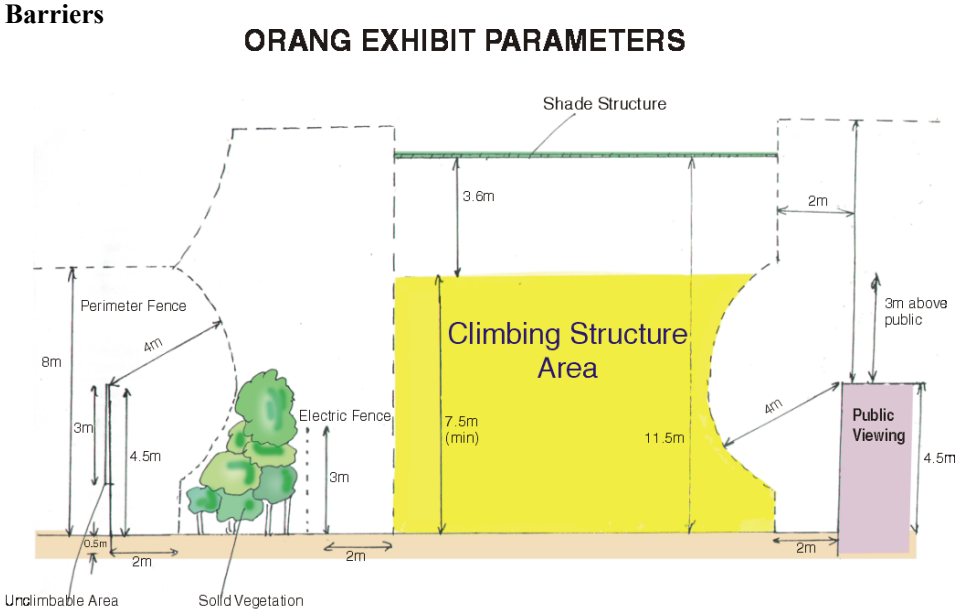
Recommendations

- Where possible all adult females in an exhibit should be related.
- With the exception of between adult males, all orang utans should have the possibility of visual contact between all other individuals.
- Exhibits must be designed to have the potential to house a complete orang utan social group.
- Exhibits must be designed to have the potential to house orang utans in natural population units within the social group.
- Population units housed separately should not regularly exchange territories.
- Population units of orang utans must be able to have visual escape from other units.
- Zoos should consider designs, which allow the level of social contact to be mediated by the orang utans.
- There should be provision to house animals seperately.

2.2 Barriers

There are essentially seven kinds of barriers used to confine orang utans. They are Dry Moats, Glass Barriers, Electric Barriers, Mesh Cages, Deep Water Moats, Wall/Fences and Un-descendible Poles.

Fig. 1 Cross Section of an Orang utan Exhibit Design showing the Use of Various Barriers



2.2.1 Dry Moats and Glass Barriers

Orang utan's susceptibility to most human diseases has caused major health problems for them in captivity. Glass barriers and wide dry moats have proven to be effective against the transmission of human diseases (Maple 1979). Unfortunately in small enclosures glass barriers can violate the orang utan's natural minimum flight distance (See 2.6.0).

Recommendations

- Minimum moat depth is 4.5m.
- Glass Barriers should be avoided in small exhibits.

2.2.2 Electric Barriers

Electric Barriers are regularly neutralised by orang utans and therefore are not recommended as a primary means of constraint. Electric barriers can serve a function as secondary barriers. For example protecting the vegetation inside an exhibit. If Electric Barriers are used to protect vegetation or separate orang utans inside an exhibit they must be of sufficient height and contain a sufficient number of strands to prevent orang utans scaling the fence or shorting out all the wire too frequently. Concern is expressed that in response to orang utans manipulating electric wires, with various objects the manipulative objects are no longer made available. This compromises environmental enrichment, an essential component of orang utans captive management.

Recommendations

- Electric Barriers: Minimum height 3m, minimum distance between wire 10cm, first 1.5m all positive wires, top 1.5m alternate positive and negative wires. Maximum 6,000 volts, minimum 3,300 volts. Peak current 6.4 amps (See Fig. 1).
- Electric Barriers should only be used as secondary barriers to contain orang utans.

2.2.3 Mesh Cages

Mesh Cage exhibits are the most secure of the barriers used to contain orang utans. They also have the advantage of maximising the amount of arboreal space per area, plus allow for unlimited play objects without fear of escape. They unfortunately are difficult to make visually appealing. Weave mesh is a lot safer as orang utans have been known to unpick weld mesh. Orang utans can dig into the ground, therefore the mesh of the cage needs to be extended under the ground or angled back into the exhibit.

Recommendations

- Mesh Wire: 5mm diameter (NSW Agriculture 1995), 5cm x 5cm.
- Woven Steel Cable Mesh: 2mm diameter, 5cm x 5cm weave.
- The mesh should extend at least 50cm under the ground.

2.2.4 Deep Water Moats

Unfortunately, orang utans quickly drown if they fall in deep water moats or pools in enclosures. Infants can also drown in surprisingly shallow water. The incidence of drowning increases when orang utans are likely to enter the water to avoid aggression, retrieve objects from the enclosure or to gain objects thrown into the water by the public. Orang utans have been observed wading up to their necks in both the wild and captivity. Some zoos use electric wires to try to prevent orang utans from entering the deep-water moats. As mentioned earlier, this often results in the absence of any play objects for the animals, to prevent them from shorting out the electric wires. Even this is often not effective as orang utans are usually very skilled at using vegetation or sticks to by-pass or destroy electric wires.

Recommendation

- Deep Water Moats should be avoided as barriers for orang utans.

2.2.5 Fence/Wall Barriers

Although walls as little as 3.66m (with 26cm overhang) have been shown to successfully contain orang utans the wall height must be sufficient to prevent escape by use of stray objects thrown into the exhibit or objects otherwise obtained by the orang utans, plus allow orang utans to have a wide range of enrichment material. As with mesh cages, the wall or fence needs to be extended under the ground or angled back into the exhibit.

Recommendations

- Wall or fence height minimum 4.5m (See Fig. 1).
- It is recommended that the last 3m of a wall or fence must be un-climbable (See Fig. 1).
- The fence or wall should extend at least 50cm under the ground (See Fig. 1).

2.2.6 Un-descendible Poles

Orang utans can be prevented from escaping by use of poles, which may extend over the public area. The poles must be of sufficient height that the orang utans will not risk jumping in all but the most extreme situations. The poles must be designed to prevent the orang utan from descending the pole. This can be achieved through the use of electric wires or preferably by the placement of a smooth surface area of sufficient diameter to prevent the orang utan from gripping the surface.

Recommendations

- Minimum drop height for a structure over a non-secured area is 8m (See Fig. 1). N.B. In National Zoo (Washington DC) poles are 15m high.
- A smooth conical structure should be placed under the poles platform (minimum height 3m, minimum width 1.5m).

2.3 Climbing Structures

Orang utans are extremely strong, very intelligent and have large reaches. All these attributes need to be incorporated into exhibit designs. They are extremely adverse to jumping at heights and adult orang utans are very unlikely to jump even the smallest distances.

The most important aspect of the captive physical environment for orang utans is the amount of arboreal space available for both rest and locomotion (Maple 1979; Maple and Stine 1982; Jones 1982). Horizontal arboreal pathways and nesting/resting platforms are the main elements of the natural physical environment (Jones 1982). The lack of opportunity for arboreal locomotion promotes lethargy and contributes to obesity (Maple 1980). The combination of lethargy and living on the ground causes health hazards. Coprophagy or playing with faeces often becomes common, especially if there are no other stimulating objects in the enclosure (Hill 1966; Maple 1980). Infection by faecal bacteria causes air-sacculitis, the second most common cause of death in adult orang utans in captivity (Cambre et al. 1980). This disease is totally unknown in wild orang utans (Cocks 1999).

Orang utan activity is maximised by small diameter climbing structures, which can be used for various types of moment. To further stimulate activity the climbing structures need also to have a large percentage of movablity (e.g. ropes and sway poles) and be appropriately spaced.

Resting platforms are necessary for the orang utan to fully utilise the climbing structure. There should be a sufficient number of platforms, so that dominant animals don't exclude subordinates in the group. The climbing structure also needs to be designed to prevent subordinate animals from being trapped.

Many orang utans have hung themselves by accidentally draping loose ropes around their necks. For this reason care must be taken to ensure ropes or artificial vines do not have small enough diameters or are loose enough for them to be firmly secured around an orang utan's neck.

Recommendations

- Usable Arboreal Space: should be one of the major parameters used to measure the relative value of different designs.
- Maximum Bar/Rope width 75mm.
- Climbing structures need to have a large percentage of movablity.
- Ideal inter-structure distance (e.g. bars and ropes) is 2m.
- Structures should be designed to prevent subordinate animals being trapped by dominant animals.
- Climbing structures must be a least 4m from the top of external walls or fences ground and 2m from the base of the wall (See Fig. 1).
- There should be three platforms for every orang utan housed in an exhibit (Minimum size 1.5m x 1.5m).
- Ropes should be of sufficient diameter or have limited movement (e.g. fixed tightly at both ends) in order to prevent accidental hangings.

2.4.0 Night Quarters

The time orang utans are confined to their night quarter is a valuable time to monitor their health and collect urine and faecal samples. Each adult orang utan (or adult female with a dependent infant) should have its own individual night quarter. Even if this were not the current practice of the zoo, the variation in the groups over time and individuals would make this a sensible design parameter. This also allows food, urine, faeces and menstruation to be monitored on a regular basis. Juveniles and sub-adults should also ideally have individual night quarters, but if there is not enough room to allow this they should be kept in pairs in the night quarters. Care should be taken to choose compatible pairs of about the same size and dominance status. Except with dam and dependant offspring below eight years of age, orang utans do not readily share food. For this reason all orang utans after the age of eight should be provided their own night quarters to allow all animals to receive a balanced and monitored diet. Some zoos have overcome the difficulty of food sharing in random-group housed orang utans through positive reinforcement training, but this method is time consuming and not 100% guaranteed.

Data analysis indicates that there are certain high hazard events in the life of a captive orang utan (Cocks and Collier 1998). These include during or shortly after transportation between zoos. One in 20 die within one month of arrival and one in eight die within the first year. With increased cooperation between zoos and the regional management of breeding, the transportation of orang utans is likely to become increasingly common. Therefore it is important to come up with exhibit designs to minimise the risk of mortality associated with

transportation. The provision of an interchangeable night quarter door with an opening for the attachment of a transport crate allows for crate training of out-going animals and the quick release of in-coming animals.

Recommendations

- Each adult orang utan (or adult female with a dependent infant) should have its own individual night quarter.
- Minimum size 2.4m width x 3.5m depth x 2.4m high.
- Unless the zoo already has a quarantine area suitable for orang utans, one should be incorporated into exhibit design, including a separate drainage system.
- Although metabolic squeeze cages are used less frequently with the increased use of Positive Reinforcement Training squeeze cages can provide an additional management tool. They are usually most effective when they are placed in areas where the orang utans moves through them on a daily basis.
- The area must be rodent proof.
- Adequate lighting needs to be provided for orang utans occasionally confined during the day and inspection of the animals by the keeper (minimum 30 foot candles, 1m above the floor).
- Public or other noise especially above the orang utans should be eliminated, or at least reduced to a minimum.
- Night quarter need to provide arboreal nesting sites as well as suitable nesting materials.
- Drainage is recommended to be outside of the night quarters and flow into a large industrial sized grease trap. All surfaces must slope towards this point.
- Behavioural enrichment options need to be provided for orang utans confined to night quarters.
- Floors should slope to the drain and be covered with epoxy-based paint.
- Walls should be also coated with a smooth easily cleanable and durable surface such as epoxy-based paint.
- Roof ideally should allow for arboreal locomotion, i.e. mesh roof.
- Food hoppers should be incorporated to provide more flexibility in feeding orang utans.
- Steel Bars are not recommended as they allow possible dangerous amount of contact between orang utan and keeper.
- Maximum gaps between doors, etc: 3cm
- For strength doors should open into the night quarters.
- All night quarters should be connected for the orang utans with slides.
- A safety race should be provided.
- Horizontal gates should be pushed to open, so to reduce injury to the keeper from the handle if the orang utan throws open the slide.
- The provision of an interchangeable night quarter door with a opening for the attachment of a transport crate.

2.4.1 Bio-Floors

Exhibit designers may want to consider the bio-floor, a new night quarter floor surface. This floor uses a deep litter system on top of a drainage membrane. It has been shown to be time efficient, hygienic and more stimulating for the orang utans. Examples of zoos, which successfully use Bio-Floors, are Apenhuel and Zurich. Observed problems have been reduced opportunity to collect urine samples and wood frames rotting.

Recommendations

- Depth: minimum 40cm, optimum 50cm.
- Coat concrete first
- Use natural soaps only
- Never remove substrate

- Check pH twice a year (Low pH is below 7)
- If vermin get in the substrate should be flood with water

2.5.0 Climate Control

Before the 1930's, orang utans were often kept in high temperatures and humidity made to reflect their tropical homeland (Ulmer 1957; Hediger 1970). This produced ideal conditions for bacterial diseases, which in combination with infectious contact with humans usually reduced the life span of captive orang utans to only four to five years (Ulmer 1957). Orang utans readily acclimatise to regional conditions. With heated night dens in cold climates, shelter and shade provided, orang utans are usually adaptable to most environments (Brambell 1975). The combination of low temperatures and high humidity has also been linked to health problems in orang utans.

Orang utans require the ability to control their environment by moving to and from different microenvironments within the exhibit. This is not only a physical need, but the variations within the exhibit can be considered a form of behavioural enrichment or source of stimuli, which can be controlled by the orang utans. To allow these variations to be controlled by the orang utan they need to be accessible to all the animals in the exhibit.

Recommendations

- Shelters must provide protection from rain, sun and wind.
- *Sufficient amount of shelters must be provided to prevent dominant animals from denying access to the subordinate animals.*
- Shade structures at least 3.6m above orang utans climbing structure ground (See Fig.1).
- Recommended minimum temperature: 18 degrees Celsius
- Recommended maximum temperature: 28 degrees Celsius
- Recommended minimum ventilation: 15 air changes per hour, without re-circulation.
- Recommended humidity: 30 to 70%

2.6.0 Visual Escape and Flight Distance

Orang utans are basically solitary, using distant visual monitoring as their main type of social contact. In the wild, their native rainforest enables the orang utans to space themselves, hide from and avoid conflict with each other. Maple (1982) and Maple and Stine (1982) suggest increased available spatial volume and increased complexity of the environment and visual barriers to provide escape routes can reduce social stress in captivity. Maple (1979) observed that in small enclosures, glass barriers could violate the orang utan's natural minimum flight distance, which he observed to be six metres. He suggested that enclosures be made much deeper to allow the orang utans to establish their own minimum flight distance. Stress in arboreal primates is reduced if they are allowed to be higher than the public (Chamove et al 1988). In addition public viewing from multiple directions can reduce the perception of security for orang utans.

Recommendations

- With the exception of dam-infant groups, orang utans must be able to have visual escape from conspecifics.
- Orang utans must have visual escape from the public.
- Public viewing should only be from one direction.

- The majority of the climbing structures must be 6 meters from the public (10m optimum).
- Orang utans must be able to get higher than the public.

2.7.0 Enclosure Size

Every captive management goal should be aimed at providing as close as possible the conditions the animal experiences in the wild. There is no rule for this parameter accept that there is no way a zoo can provide the space which comes close to wild parameters. Although functional complexity and shape of an exhibit can decrease some of the adverse effects of small exhibits, designers should take into account that certain benefits of volume and surface area can not be provided for in any other way. In addition, the changing public views on captive great apes need to be considered.

Recommendation

- The bigger the better.

2.8.0 Water

Orang utans need access to a constant supply of fresh clean water daily (Yerkes & Yerkes 1929; Brambell 1975). As well as drinking water both wild and captive orang utans often use water for play activities. Water troughs, which refill automatically, waterfalls, shallow pools or streams, can provide sufficient water for drinking and play, without the chance of drowning (Brambell 1975; Maple 1980; Jones 1982).

Recommendations

- Water should be of human drinking quality.
- Shallow self-filling water should be provided to the orang utans at all times.

3.0 Captive Management Issues

3.1 Activity Patterns and Behavioural Enrichment

Orang utans rise between 6am and 9am (Davenport 1967; Horr 1972; MacKinnon 1974; Rijksen 1978). They start foraging near the night nest and then travel slowly away during the morning, resting and foraging until approximately 12 noon, when they sleep or rest for up to two hours. In the afternoon they travel faster, eating as they move, travelling greater distances than in their morning activity. A night nest is built just before sunset and they remain there until after sunrise.

The daily routine of the orang utan is not affected by light rain, but in very heavy rain all activity ceases as it takes shelter or makes a 'rain-nest'. During these days they build their night nest earlier and sleep longer (MacKinnon 1974). On dry days their midday resting time is increased, but their early morning and early evening activity becomes more intense (MacKinnon 1974).

Daily routines have been quantitatively assessed by five field workers (Davenport 1967 and Galdikas 1978). Galdikas (1978) gives data for 14 individuals (See Table 1).

Table 1: Activity Budget for Wild Orang utans

Activity	% Daily Activity Time	Range for 14 individuals
Foraging	60.1	41.4 - 72.3
Resting	18.2	7.1 - 31.0
Moving	18.7	11.9 - 25.6
Copulating	0.1	0.0 - 0.6
Long-calling	0.3	0.0 - 0.8
Agonistic Display (at researcher)	1.3	0.0 - 5.3
Nest Building	1.1	0.8 - 1.4
Foraging Index*	3.2	1.8 - 6.5

* The foraging Index measures the ratio of foraging time to travelling time and acts as a guide to the efficiency of individuals and density of food supplies in study areas (Rodman 1973).

Until recently, the design of the captive environment has taken very little account of the daily activity patterns of wild orang utans (Maple 1980). This has led many zoo managers to believe orang utans to be naturally lethargic and obese (Yerkes & Yerkes 1929; Harrison 1962). The mid 1970s marked the beginning of a growing awareness, in the zoo world, of the need to improve the captive environment of primates to stimulate species-specific natural behaviour and increase activity levels. Unfortunately, very little quantitative or qualitative evaluation of the effect of any improvements in the captive environment has been carried out and even less has been published (Markham 1990). One study was conducted by Wilson (1982) who investigated the activity levels of 68 groups of orang utans in 41 European zoos in relation to the captive environment. The environmental factors recorded were useable surface area and the number of fixed, moveable and temporary objects. Wilson concluded the environmental complexity, such as fixed moveable and temporary objects, were more important to orang utans than the size of the enclosure, the frequency of feeding or the available surface area.

The environmental enrichment of orang utan exhibits is often restricted by the zoo manager's desire to display a naturalistic environment for the orang utans. Artificial objects and climbing structures, which are some times the most stimulating, may be absent in exhibits to provide for a 'naturalistic display'. Jones (1982) recommends that any safe manipulable objects, which can increase activity and natural behaviour should be encouraged. The periodic variation of the objects presented to orang utans is of benefit, to allow an additional increase in activity associated with their novelty (Maple 1979). The introduction of new habitats, objects or activities, however, should be done gradually and with caution, especially with older animals not subjected to change in the past, because of the conservative nature of this species (Maple 1979).

Recommendations

- Orang utans should be provided behavioural enrichment to meet levels of activity of wild counterparts.
- Captive orang utan activity patterns should broadly reflect the patterns of wild orang utans.

3.2 Conditioning

Orang utans are highly intelligent animals. This makes them very susceptible to boredom-induced stress. It has long been noted by zoo keepers that in the case of chimpanzees, ex-circus animals have a greater success in breeding than zoo chimpanzees raised in inappropriate conditions. It is believed that the amount of mental stimulation is more important than whether the mental stimulation is 'natural'. Morris (1959) as cited by Maple (1980, p. 225) wrote:

"Far from being overworked, exhausted chimpanzees, these demonstration chimps are by far the healthiest, most intelligent, and most alert that I have ever seen in captivity. They obviously benefit tremendously from their varied and complicated activities and one is immediately struck by the need for introducing some similar kind of occupational therapy for adult chimpanzees and for other primates."

There may be no reason why zoos should be shy of using circus techniques. These may result in healthier animals and greater subsequent breeding success and zoos should embrace them as valuable management aid. It is only very recently that zoos, have seriously looked at the benefits of orang utan training. Animals being mentally and physically healthier if they have 'work' to do (Maple 1980). In Brookfield Zoo an incompetent orang utan mother was trained to nurse her own baby. At Perth Zoo a diabetic orang utan named 'Hsing Hsing' was trained to take insulin injections and blood samples (personal observation). These two examples indicate how the training of great apes has additional benefits in the areas of maternal behaviour and medical treatment.

Recommendation

- Positive reinforcement training should be considered as management tool for orang utans.

3.3 Numbers of Orang utans

The more orang utans each zoo holds, the more zoos can contribute to the species survival. This of course has resource implications for the zoos. Besides these there are two factors, which need to be considered when, deciding the number of orang utans to hold:

- Are there enough animals for the zoo to hold a complete orang utan social unit (i.e. at least one adult male and two or more related adult females with offspring)?
- Is there enough breeding occurring to pass on maternal behaviour from one generation to the next?

Although orang utans are often described as solitary this often ignores the fact that they have a rich social system, which although contact between individuals are less frequent and less physical than in other great ape species, is just as necessary for psychological well being.

The psychological well being of an orang utan is highly dependent on its experience as an infant. The extreme result of inappropriate infant experience is hand-raising. Hand-raising reduces longevity, increases presence of stereotyped behaviour and increases occurrence of infant rejection by females (Cocks 1998). The quality of maternal care a female provides her infant is highly dependant on the amount and quality of maternal experience she experiences from either her dam, or another adult female, during her juvenile and subadult years (For definitions of life stages see Appendix). Therefore the births of infants should be spaced in the group to allow juvenile or subadult females to gain appropriate experience before being allowed to reproduce. Wild adult females on average have their first infants at 15 years with an eight year inter birth interval (Galdikas 1978). The reduction of these periods in captivity significantly reduces a females longevity (Cocks 1998). By maintaining a natural breeding timetable a zoo conservatively requires four adult females, or liberally three adult females (with some risk of too many male babies interrupting the time-table), to maintain the transference of maternal behaviour between generations. It is possible to maintain maternal behaviour between zoos through the transference of adult females, but due to the high risk associated with transportation of orang utans these transfers should be kept to a minimum (Cocks & Collier 1998).

Recommendations

- Zoos should hold at least one adult male and at least two or more related adult females with offspring.
- To maintain maternal behaviour and reduce the cost and risk of transportation between zoos, a zoo should hold at least three, preferably for adult females.
- The births of infants should be spaced to allow juvenile or subadult females to gain appropriate experience before being allowed to reproduce.
- When possible females should not be bred before age fifteen.

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Appendix: Life Stages

The following is the description of the life stages of the orang utan as described by Markham (1990a, p.25). Markham's description is a revision of the life stages from wild studies by MacKinnon (1974) and Rijksen (1978) based on her observations of captive individuals.

(a) Infant Stage (birth to 3 years)

Males:	average weight:	1.9 - 15 kg	(birth to three years)
	average height:	400-800 mm	(birth to three years)
Females:	average weight:	1.6 - 12 kg	(birth to three years)
	average height:	400-750 mm	(birth to three years)

The infant clings continuously to the mother for the first five to six months. Small amounts of solid food provided by the mother starts to be ingested from six to twelve months of age. The infant sleeps in the nest with its mother, suckles and is carried by its mother throughout infancy. The infant starts to move about close to its mother at about 18 to 24 months. In time the infant takes short exploratory trips in sight of the mother at about 2½ years of age.

NB. There is some evidence to suggest that captive-born infants raised by their mothers tend to grow more quickly than wild infants. Hand-raised captive infants tend to weigh more than mother raised captive infants.

(b) Infant/Juvenile Transition Stage (3 to 5 years)

Males:	average weight:	15-20 kg	(3 to 5 years)
	average height:	800-1,000mm	(3 to 5 years)
Females:	average weight:	12-18 kg	(3 to 5 years)
	average height:	750-950mm	(3 to 5 years)

The infant starts to forage for food from three years of age, but still continue to suckle until five to six years of age. Towards the end of this stage the infant may be making its own night nests next to its mothers'.

(c) Juvenile Stage (5 to 7-8 years)

Males:	average weight:	20-35 kg	(5 to 7-8 years)
	average height:	1,000 - 1,100mm	(5 to 7-8 years)
Females:	average weight:	18-30 kg	(5 to 7-8 years)
	average height:	950mm - 1,050mm	(5 to 7-8 years)

The skin on the face, hands and feet start to darken. The juvenile will make its own night nest close to its mother. As well as playing alone, the juvenile seeks contact with its peers. The female juvenile stays close to its mother or makes daily contact with her until after the next infant is born. In contrast males gradually move away and explore new territory.

(d) Adolescent Stage (7 to 8 year)

Males:	average weight:	35 -40 kg	(7 to 8 years)
	average height:	1,100 - 1,150mm	(7 to 8 years)
Females:	average weight:	30 -35 kg	(7 to 8 years)
	average height:	1,050 - 1,100mm	(7 to 8 years)

The skin on the face, hands and feet continue to darken. Females stay close to their mother, observing the next born infant. They then start to set up a home range near the home range of their mother. Adolescent females seek contact with other adolescent females and closely related adult females as well as being sexually active with adolescent males.

Males are now independent and travel long distances into new territories. Adolescent males seek contact with adolescent males and females, but avoid contact with adults, especially adult males.

(e) Subadult Males (8 to 14-16 years)

average weight: 40-85 kg	(8 to 14-16 years)
average height: 1,150 - 1,450mm	(8 to 14-16 years)

This stage marks the start of the development of secondary sexual characteristics. The hair starts to lie flat on the head and the beard and moustache becomes fully grown. The hair on arms, shoulder and back becomes longer. The gular pouch starts to enlarge and the cheek flanges start to develop. With the development of the gular pouch the 'long call' vocalisation is developed. The skin on the face, hands and feet by this stage is the adult bluish-black.

Behavioural changes include: following and 'raping' adult females, temporary consortships with subadult females, increase in dominance behaviour and involvement in challenges with other subadult males, while still avoiding adult males. The subadult males gradually become less social and more solitary.

(f) Subadult Females (8 to 10-12 years)

average weight: 35-45 kg	(8 to 10-12 years)
average height: 1,100 - 1,160mm	(8 to 10-12 years)

As with subadult males the hair starts to lie flat on the head and the skin on the face, hand and feet become bluish-black.

During this time the females increasingly reduce their association with related females and subadult males and begin to follow adult males, showing periodic receptivity towards these males, which usually ignore them. In captivity, females usually give birth at this stage but in the wild females do not usually become pregnant in the first two years after menarche until they are at least 12 to 15 years of age (Galdikas 1978).

(g) Adult Males (14-16+ years)

average weight:	93 kg +
average height:	1,500mm

Between 15 and 20 years of age the maturation of the secondary sexual characteristics is completed. The gular pouch and cheek flanges are fully developed, the hair on the arms, shoulders and back becomes very long. The adult male uses the 'long call' vocalisation to advertise his location to adult females and to space himself from other males. Adult males try to establish home ranges or territories that overlap the territories of a number of females, or alternatively become nomadic over a large area. Except for brief (approximately 2½ days) courtships with females, the adult male is totally solitary.

(h) Adult Female (10-12+ years)

average weight:	48 kg
average height:	1,160mm

Adult females will establish a home range. They will occasionally travel with neighbouring females for short periods, but will mostly ignore them. Adult males are avoided unless the female is in oestrus. At this stage the females are usually accompanied by up to two offspring (an infant plus an adolescent daughter). They bear one infant every seven to eight years until 35 to 40 years of age. An adult female will produce only three to four living offspring over a lifetime.