ASSOCIATION OF ZOOS & AQUARIUMS

ORANGUTAN SPECIES SURVIVAL PLAN

ORANGUTAN
(*Pongo*)
CARE MANUAL

CREATED BY THE
AZA Ape Taxon Advisory Group
& Orangutan Species Survival Plan®
IN ASSOCIATION WITH THE
AZA Animal Welfare Committee

Orangutan (*Pongo*) Care Manual

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Disclaimer: This manual presents a compilation of knowledge provided by recognized animal experts based on the current science, practice, and technology of animal management. The manual assembles basic requirements, best practices, and animal care recommendations to maximize capacity for excellence in animal care and welfare. The manual should be considered a work in progress, since practices continue to evolve through advances in scientific knowledge. The use of information within this manual should be in accordance with all local, state, and federal laws and regulations concerning the care of animals. While some government laws and regulations may be referenced in this manual, these are not all-inclusive nor is this manual intended to serve as an evaluation tool for those agencies. The recommendations included are not meant to be exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Commercial entities and media identified are not necessarily endorsed by AZA. The statements presented throughout the body of the manual do not represent AZA standards of care unless specifically identified as such in clearly marked sidebar boxes.

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Introduction

Preamble

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (http://www.aza.org), which might not be included in this manual.

Taxonomic Classification

Table 1. Taxonomic classification for orangutans.

Classification	Taxonomy
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Suborder	Haplorhini
Family	Hominidae

Genus, Species, and Status

Table 2. Genus, species, and status information for orangutans.

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
Pongo	*pygmaeus*	Bornean Orangutan	Endangered	Critically Endangered	Green SSP
Pongo	*abelii*	Sumatran Orangutan	Not Listed Separately	Critically Endangered	Green SSP
Pongo	*pygmaeus x abelii*	Hybrid Orangutan	Not Listed Separately	Not Listed	Red SSP

General Information

The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), AZA Species Survival Plan® Programs (SSPs), biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers (visit the AZA Animal Program page to contact these individuals). It is based on the most current science, practices, and technologies used in animal care and management and is a valuable resource that enhances animal welfare by providing information about the basic requirements needed and best practices known for caring for *ex situ* orangutan populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for orangutans must comply with all relevant local, state, and federal wildlife laws and/or regulations;

AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and/or regulations. In these cases the AZA standard must be met.

AZA accreditation standards that are more stringent than these laws and/or regulations must be met (AZA Accreditation Standard 1.1.1).

The ultimate goal of this ACM is to facilitate excellent orangutan management and care, which will ensure superior orangutan welfare at AZA-accredited institutions. Ultimately, success in our orangutan management and care will allow AZA-accredited institutions to contribute to orangutan conservation, and ensure that orangutans are in our future for generations to come.

Physical description: Orangutans are large-bodied apes with thin, shaggy hair, ranging from reddish-orange to brown in color. They are the world's largest arboreal animal and have long and flexible arms to support their tree-living lifestyle. Orangutan arms are one and a half times longer than their legs, but they also have very flexible, fully-rotating hips. Their feet are hand-like, enabling them to be exceptional climbers. Orangutans have long fingers and opposable thumbs. Like all apes, they lack a tail. They are sexually dimorphic, with distinct differences in appearance between sexually mature males and females. Males are nearly twice the size of females. Only adult male orangutans develop cheek pads (flanges) made of subcutaneous fibrous tissue, although not all adult males develop flanges. Although both males and females have a sac hanging from their throat, the male sac is larger and may be used to propel vocalizations across long ranges in dense jungle habitat. Both sexes are typically bearded. Orangutans have 32 teeth and both males and females have powerful jaws capable of processing tough foods. Their dexterous lips help them to detect food textures before eating.

Some differences have been noticed between Sumatran and Bornean orangutans' physical appearance and are listed in Table 3. The differences are generally most apparent in adult males. Because of the considerable degree of individual variation in phenotype expression, the only way to definitively determine an orangutan's genetic classification is through genetic testing.

Table 3. Physical Characteristics of Bornean and Sumatran Orangutans*

Characteristic	**Bornean (*Pongo pygmaeus*)**	**Sumatran (*Pongo abelii*)**
Flanges	Jutting cheek pads, tend to curve forward	Lie flat against the face
Throat Sacs	Larger and more pendulous	Smaller and less pendulous
Hair Color	Tends to be darker in general	Tends to be lighter in general
Hair Length/Texture	Tends to be shorter/less dense	Tends to be longer/more dense
Facial Hair	Beard tends to be less noticeable	Beard tends to be more noticeable
Jaws	More robust jaws	Less robust jaws

*Adapted from: Bemmel, 1968; Jones, 1969; Groves, 1971; Mackinnon, 1975; Mallinson, 1978; Courtenay et al., 1988; Delgado & van Schaik, 2000; Taylor, 2006

Male Bornean Orangutan (Photo - Max Block)

Male Sumatran Orangutan (Photo – Angie Selzer)

Natural history: In the distant past, orangutans were likely to have roamed throughout Southeast and mainland Asia, but are currently only found in Northern Sumatra and in Borneo (Goossens et al., 2009). For many years, a debate about whether orangutans living on these two islands (which have been separated for more than 8,000 years (Harrison et al., 2006)) were subspecies or more genetically distinct and classifiable as separate species. Currently, most evidence suggests that there are two distinct species – *Pongo pygmaeus* (Bornean orangutan) and *Pongo abelii* (Sumatran orangutan) (Goossens et al., 2009) – while the Bornean species exists in three subspecies (*P. p. morio, P. p. pygmaeus, P. p. wurmbii*) (Groves, 2002).

Orangutans are predominantly arboreal and live in the rainforests of Sumatra and Borneo. Their range is restricted to a small area of northern Sumatra, and although they are more widespread across Borneo, they exist primarily in areas of geographical isolation. Orangutans are diurnal, and the activity period typically begins around sunrise and ends around sunset. Orangutan behavior and diet can vary considerably depending on the specific habitat that they occupy, but in general, orangutans spend about half of their day feeding. Orangutans are frugivorous, preferring fruit, but also eating flowers and insects and falling back on leaves, non-leafy vegetation, and inner bark (Bastian et al., 2010).

Females show wide variation in home range size, with differences ranging from around 60 hectares to over 850 hectares (summary in Singleton et al., 2009). Type of forest, quality of habitat, and food availability are variables that affect home range size. Female home ranges overlap with those of other females, and there is no obvious territoriality, although mutual avoidance is a commonly employed strategy to avoid conflict (Knott et al., 2008). Although orangutans are often considered to be the most solitary of the apes, evidence from several field sites suggests that females form clusters where several females' home ranges overlap. These females are often relatives, and show preferential association and reproductive synchrony (Singleton & van Schaik, 2002). Male home range sizes are more difficult to study because they are often larger than the size of a study area, but they are generally larger than those of females. A rough estimate is that male ranges are 3–5 times the size of female ranges within the same population of orangutans (Atmoko et al., 2009).

Male ranges may also overlap, but encounters between adult, flanged (having cheek pads) males are rare and potentially dangerous when they do occur. Presence of females may affect the probability of aggressive encounters when flanged males come in contact. Flanged and unflanged males will tolerate one another and unflanged males often stay near flanged males, especially during consortships, but at a relatively safe distance. If a flanged male is aggressive toward an unflanged male, it is unlikely to be very violent. As a group, unflanged males tend to associate more than other males and may even travel together and associate with females (Bastian, 2008; Atmoko et al., 2009). In general, conflicts between males are rare because long calls mediate spacing among males (Mitani, 1985). In contrast, females approach long calls (Mitra Setia & van Schaik, 2007).

Orangutans show an interest in sex at a young age, and may experiment with sexual activity before they are sexually mature. However, in general, flanged males advertise their location and availability to females by giving long calls and females travel in the appropriate direction. Females often prefer mating with the dominant flanged male. Unflanged males are left to roam the forests looking for potential reproductive partners, and may resort to forced copulations with females. This generally happens when other males are not around. The fact that forced matings happen when other males are not around and the fact that females travel in the direction of preferred males suggests that females often choose their reproductive partners, and most often cooperatively mate with the male of their choice (Atmoko et al., 2009).

Although orangutans may be the least gregarious of diurnal primates, they are not as solitary as once believed. Instead, evidence suggests that orangutans form loose communities organized around a dominant male that is the favored mating partner of multiple females. Females are likely to form clusters with related females where interactions are relatively frequent. The females tend to avoid associations with unflanged and non-dominant flanged males and remain within audible range of the dominant male. This may be a strategy to avoid harassment from other males. Beyond this, groups of orangutans have been seen congregating in large fruit trees at many study sites. It is also fairly common to see groups of mothers and immatures together, or unflanged males associating with other unflanged males or nulliparous females (Mitra Setia et al., 2009). The amount of sociality seen in managed groups of orangutans provides additional evidence that orangutans are capable of being social, but there are ecological pressures that prevent more frequent sociality in the wild.

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

Animal collections within AZA-accredited institutions must be protected or provided accommodation from weather and any adverse conditions detrimental to their health or welfare (AZA Accreditation Standard 1.5.7). Animals not normally exposed to cold weather/water temperatures should be provided heated enclosures/pool water. Likewise, protection from excessive cold weather/water temperatures should be provided to those animals normally living in warmer climates/water temperatures.

> **AZA Accreditation Standard**
>
> **(1.5.7)** The animals must be protected or provided accommodation from weather or other conditions clearly known to be detrimental to their health or welfare.

Before the 1930s, orangutans were often kept in high temperatures and humidity designed to reflect their tropical homeland (Ulmer, 1957; Hediger, 1970). However, this produced ideal conditions for bacterial diseases, which in combination with infectious contact with humans usually reduced the life span of managed orangutans to only 4 to 5 years (Ulmer, 1957). Orangutans readily acclimate to regional conditions. With heated night holding areas in cold climates and shelter and shade provided, orangutans are usually adaptable to most environments (Brambell, 1975). The combination of low temperatures and high humidity has also been linked to health problems in orangutans (McManamon & Bruner, 1990).

Orangutans 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 behavioral enrichment or source of stimulation that can be controlled by the orangutans (Ross, 2006; Ross et al. 2009).

Temperature and light are close correlates in nature. High, bright, basking perches can provide supplemental heat, while darker areas can be cooler. Individual facilities are recommended to use a variety of components to determine temperature guidelines. Minimum recommended average temperatures are 18 °C (55 °F), with maximum temperatures of 28 °C (84 °F). Temperature limits can vary with other ambient conditions (e.g., 10 °C (50 °F) may be acceptable depending on sun/wind/precipitation conditions). Outdoor areas must be provided with shelter from sun, rain, and chilling winds. Institutions should base their exhibit guidelines on these recommendations. A sufficient number of shelters must be provided to prevent dominant animals from denying access to other animals (Coe & LaRue, 1997).

Humidity levels should range between 30%–70%. McManamon and Bruner (1990) state that orangutans are vulnerable to conditions of low temperature and high humidity. Humidity is strongly affected by temperature and should be considered together with ventilation to provide a comfortable environment. In a rainforest, humidity levels vary widely from hour to hour and location to location. For example, humidity levels are much lower in the tree tops exposed to full sun than they are on the forest floor. These gradients should be considered and emulated to the extent possible when designing large indoor activity areas.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available. Warning mechanisms and backup systems must be tested periodically (AZA Accreditation Standard 10.2.1).

> **AZA Accreditation Standard**
>
> **(10.2.1)** Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. Warning mechanisms and emergency backup systems must be tested

Systems should be backed up by double redundancy in case of equipment failure. Maintenance should be scheduled as recommended by the manufacturer. Systems should be equipped with alarms to monitor hazardous chemical or gas leaks, fire and smoke, and failure of system and temperature range indicators. Alarms should be set to dial out to specified, trained personnel for appropriate response.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums. Illumination standards recommend that illumination be uniformly diffused throughout the facility (AWR, 2005; NIH, 1972). A more naturalistic solution would be to provide a two-part lighting system. Light levels should vary following a natural model; bright near the top of the space, darker at floor level. An override utility light system can take care of cleaning and surveillance needs during the relatively short period of time each day when keepers are present. NIH (1972) recommends at least 30 foot candles 1.0 m (3.3 ft.) above the floor. Mount fixtures in waterproof and shatterproof enclosures (Coe & LaRue, 1997).

Access to natural sunlight is strongly recommended and should be a basic design component. O'Neill (1989) recommends viewing windows as a source of behavioral enrichment. Skylights or windows are recommended to facilitate natural light cycles and gradual changes on a daily basis, such as dawn and dusk. Fluorescent or natural spectrum bulbs are required when the animals do not have access to natural sunlight. There are some health concerns associated with long-term exposure to artificial light, and particular care should be given to the implications of unnatural light on primate health (Coe & LaRue, 1997).

1.3 Water and Air Quality

Air quality: Ventilation should be adequate to eliminate dampness and odor. Ventilation can be unequally distributed, with greater flow near the floor to encourage evaporation and at high elevations to mimic an arboreal breeze. Ten to fifteen air changes per hour are recommended for small areas that contain high numbers of animals. This same level is used for areas of potential contamination such as sterile surgical areas, necropsy rooms, and waste storage areas (NIH, 1972). Air entering animal rooms should be fresh and exhausted without recirculation (100% air exchange in animal rooms or equivalent if possible). Separate zoning of air systems to prevent cross contamination should be a part of any non-human primate facility (McManamon & Brunner, 1990). Besch (1980) suggests that ventilation requirements should be based upon a rate per animal. Woods et al*.* (1975) agrees with this approach and found it an energy-efficient means to provide an odor-free environment. It is often wise to design a multi-stage ventilation system, which can be run at low or high settings depending upon the animal occupancy levels of the areas at a given time (Coe & LaRue, 1997).

All duct-work should be protected from the animals. No insulating material over duct work should be within an animal's reach (including accessibility with browse or other objects that can be used as tools to extend the animal's reach) or near areas to be hosed, unless waterproofed (Coe & LaRue, 1997).

Water quality: Orangutans should have access to a constant supply of fresh clean water (Yerkes & Yerkes, 1929; Brambell, 1975). In addition to using water for drinking, both wild and managed orangutans often use water for play activities. Water troughs that refill automatically, waterfalls, shallow pools or streams can provide sufficient water for drinking and play, without the risk of drowning (Brambell, 1975; Maple, 1980; Jones, 1982).

Water should be fresh, potable and of human drinking quality. The most efficient way to offer drinking water is through a nipple drinker, push-button, or other automatic system (e.g., Lixit®), though some animals plug drinking lines up with straw, insert objects to cause continual operation, or dismantle them (Coe & LaRue, 1997).

Drains, including trench drains, should be located outside of the enclosure in keeper aisles for ease of cleaning. Drain covers should have small holes to prevent hay and food from clogging the drain. A basket in the drain will also help. A minimum sanitary drain pipe size is 15 cm (6 in.). Large pipe size does not prevent clogging. Pitch, water velocity, and maintenance practice should also be considered. Frequent clean-out points are helpful. Drain-traps are required by the USDA (1991) to prevent the back-flow of gases and sewage (Coe & LaRue, 1997).

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquariums. Acoustic environments in a zoo setting are much different than a natural environment. Mechanical equipment required to move large volumes of air can be a major source of indoor noise pollution and appropriate noise dampening techniques should be incorporated into the design of building mechanical systems. Unfortunately, most noise absorbent materials are not waterproof. The following can be used to reduce noise levels: resilient flooring; nylon or polypropylene glides; cover plates; animal gates; deep bedding; electronic noise neutralizing devices; environmental sounds; and music. Ideally, the animals could have the option to choose the sounds to which they want to listen (Coe & LaRue, 1997).

Orangutans hear a frequency of sounds similar to humans and thus are susceptible to noise and vibratory annoyances that would also bother us. Indoor exhibits should particularly be monitored for noise or vibrations that could potentially disturb the animals. Many exhibits are built to be easily cleaned, but this may have the side effect of amplifying noises. A good rule of thumb is to try to mimic an environment that the animals would experience in the wild. While they would definitely hear a cacophony of noise from birds and insects, they would not hear the clanging of metal, the rumble of engines, or the screaming of children.

Potential sources of sound: There are several possible sources of sound in and around orangutan enclosures in zoos:

- Construction either in or adjacent to the orangutan area, including the humans involved in the actual construction work.
- Mechanical equipment including heating and cooling equipment, air handlers, motors, water pipes, automatic watering devices, any type of fans, cage washing machines, water feature equipment such as pumps, filters, etc., horticultural equipment such as blowers, chain saws, lawn mowers, etc.
- Humans including staff and public.
- Caging doors opening and closing.
- Enclosure concrete or gunite flooring and/or walls.
- Other orangutans or other species in nearby exhibits.
- Outside urban sounds including sirens, airplanes, trains, highway traffic, etc.
- Miscellaneous noise from radios, TVs, loudspeakers, zoo amusement rides, telephones, computers, video monitors, carts, etc.

Addressing and controlling sound: Construction should be scheduled around the orangutans and scheduled at times when the orangutans can be properly housed as far as possible from construction activities. For example, schedule necessary construction indoors during spring and summer so that orangutans can be outdoors when the work occurs. All construction work should be dependent on the orangutans' movements. That is, construction work begins when animals are moved to other areas and ends when orangutans should be moved back into the original area.

Mechanical equipment should be housed in rooms with appropriate doors and walls such that noise from the equipment is greatly reduced. Soundproofing equipment can be used on the doors to minimize noise and the doors should be kept closed at all times. Sound dampening products such as blankets or membranes can also be hung on walls and/or around equipment safely to reduce noise levels. Vents coming from mechanical rooms should also be evaluated for the amount of noise coming through. Any pipes, fans, etc., throughout the orangutan holding area should be monitored and evaluated routinely for rattling, squeaking, scraping, etc. Insulating all pipes will reduce rattling noises, but extra wrapping may be necessary in areas where pipes cross each other and may knock together. Regular preventive maintenance on all equipment reduces mechanical noise such as belt squeaking, unbalanced fans and noisy ducts.

Humans working with or around the orangutans on a daily basis should be sensitive to the noise they inadvertently add to the animals' environment. Much of the noise that the orangutans are exposed to daily will be created by care staff in the course of their routine work. Noise from hosing, raking, two-way radios, AM/FM radios and other music players, opening and closing enclosures, opening and closing doors, equipment such as pressure washers and power tools, telephones, loud talking, and yelling should be minimized. Recognition of the benefits of auditory stimulation in human well-being has prompted recent research into the value of "sound enrichment," including natural (species-typical) sounds of either conspecifics, natural environments, or other sounds not typically found in the wild (e.g., music) (see Wells, 2009 for review). Although formal research has not been carried out with orangutans, radio broadcasts, a source of complex and variable auditory stimuli, have been shown to reduce aggression and agitation, and increase social affiliations in laboratory-raised chimpanzees (Howell et al., 2003). This type of enrichment, especially if it is controlled by the orangutans, may also be beneficial for them. Further research should be done to examine what types of sound enrichment are most beneficial for orangutans, but it is likely that similar results will be found. Staff should be conscious about using sound enrichment by choosing sounds that are likely not to be abrasive, and give the animals the choice to turn the sounds off.

Staff should be encouraged to view the orangutan enclosures as the orangutans' home rather than simply a work space, and this seems to help humans be more conscious of their own noise levels. Staff should also be encouraged to remain calm while working with orangutans, even when the animals themselves can be quite loud. Work with loud tools should be performed when the orangutans are not in the immediate area and/or sound dampening blankets can be used if doing noisy work close by is unavoidable.

In a study that manipulated the noise level of crowds viewing orangutans, the orangutans were found to react more to loud crowds (Birke, 2002). Infants approached adults more frequently, and the orangutans stared at the public more in the loud condition than when quiet groups were in front of the exhibit. Although this does not necessarily indicate that orangutans are bothered by large crowds, it is best to give them the option of a place to retreat in the event of loud crowds, especially if infants are in the exhibit.

Finally, it is important to remember that, like humans, orangutans vary by individual. Some orangutans may be more tolerant of loud, repetitive, or unusual noises than others. It is important to continually observe orangutans and take note of any unusual behavior or demonstrations of annoyance that may be due to sound.

Future research: We need more research to understand the effects of sound on managed animals in general. For orangutans, it would be beneficial to explore how different types of sound enrichment affect behavior and stress physiology. We also should undertake further research that explores the effects of various crowd sizes and noise levels on orangutan welfare. We should scientifically explore if construction or other environmental noises negatively affect welfare, and the limits within which animals can tolerate such noises before experiencing diminished welfare.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

Careful consideration should be given to exhibit design so that all areas meet the physical, social, behavioral, and psychological needs of the species. Animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design (AZA Accreditation Standard 1.5.1). All animals must be housed in safe enclosures that meet their physical and psychological needs, as well as their social needs (AZA Accreditation Standards 1.5.2, 1.5.2.1, 1.5.2.2).

> **AZA Accreditation Standard**
>
> **(1.5.1)** All animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' welfare requirements with aesthetic and educational considerations.

> **AZA Accreditation Standard**
>
> **(1.5.2)** All animals must be housed in enclosures which are safe for the animals and meet their physical and psychological needs.

> **AZA Accreditation Standard**
>
> **(1.5.2.1)** All animals must be kept in appropriate groupings which meet their social and welfare needs.

> **AZA Accreditation Standard**
>
> **(1.5.2.2)** All animals should be provided the opportunity to choose among a variety of conditions within their environment.

Orangutans have evolved in a vertically-oriented, highly complex environment for millions of years and have lived in managed, horizontally-oriented animal care facilities for only a few score years. We often tend to build new exhibits by first looking to existing exhibits at other zoos, but we should begin by considering the orangutans' tropical rainforest home, orangutan physical and psychological needs, orangutan health, human safety and ease of use in conjunction with previous exhibit models before undertaking new construction.

In the wild, orangutans primarily move through the canopy using both their arms and legs. One of the most important aspects of the managed physical environment is the amount of arboreal space available for both rest and locomotion (Maple, 1979; Maple & Stine, 1982; Jones, 1982). Horizontal arboreal pathways and nesting/resting platforms are the main elements of the natural physical environment for orangutans (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 feces often become more common, especially if there are no other stimulating objects in the enclosure (Hill, 1966; Maple, 1980).

Resting platforms are necessary for orangutans to fully utilize climbing structures. There should be a sufficient number of platforms so that dominant animals don't exclude subordinates in the group. The climbing structures also need to be designed to prevent subordinate animals from being trapped at a dead-end. Platforms should be large enough for the orangutans to build nests for resting. The appropriate size will vary with the size of the individual orangutans; critically, platforms must be sturdy enough to support the weight of the orangutans as well as their nesting materials, which can at times be substantial.

Many orangutans have hung themselves by accidentally draping loose ropes around their necks. For this reason care should be taken to ensure ropes or artificial vines do not have small enough diameters or sufficient slack to be firmly secured around an orangutan's neck. We recommend the use of fire hose over rope in orangutan enclosures whenever possible. Fire hose is often available free of charge from local fire departments.

Orangutan activity is maximized by small diameter climbing structures, which can be used for various types of movement. To further stimulate activity, the climbing structures should also have a high degree of movability (e.g., firehose and sway poles) and be appropriately spaced (about 2 m [6.5 ft.] apart). Orangutans are adapted for an arboreal lifestyle, yet because of their supreme dexterity and strength, they are usually provided with few climbing opportunities. In the wild, orangutans often move themselves by causing branches, vines and small trees to sway in the desired direction until they can reach a new handhold, transfer to a new perch and repeat the process. For this reason, sway poles are often a good choice to promote arboreal locomotion. Resilient nests made from small branches and broad crotches in larger trees provide rest areas. Most of the orangutan's usable world is made of things that they can move (Coe & LaRue, 1997). By contrast, most environments made for managed orangutans provide fixed furnishings. Large diameter ropes and cargo nets have been used successfully to add the important dimension of movement. Artificial vines made from synthetic fiber rope thinly coated with epoxy have proven to hold up under heavy use and can satisfy aesthetic requirements for a natural appearance. However, these vines may need to be repaired frequently. Ensure that high safety standards are employed when using these materials to reduce the risk of injury.

Artificial trees made of steel-reinforced concrete, although stoutly built, have sometimes been broken by orangutans. As a lower cost alternative, many zoos have installed natural dead trees as climbing structures. Appropriate species of healthy living trees cut for this purpose should be used. Trees that are partly dead when cut are already greatly weakened by wood decay and will not last long. Also, it is advised to remember that natural trees cannot be expected to last longer than 5 to 7 years before becoming weakened. Crane access should be maintained to allow for tree replacement and should be considered in determining maintenance budgets (Coe & LaRue, 1997). Heavy timbers treated with preservatives will last longer than untreated ones, but types of preservatives vary widely in their toxicity to mammals. Institutions should determine that preservatives used pose no hazard to the animals.

Design of exhibit features allowing food enrichment, resting platforms, and functional arboreal pathways to be provided high in climbing structures may encourage much greater activity among orangutans of all ages. One unique approach to keeping animals arboreal is to design an exhibit where the floor is flooded so that animals prefer remaining on their elevated structures (Hebert & Bard, 2000).

Most orangutan exhibits tend to be circular, oval, or square with little opportunity to move about. Wild orangutans, by contrast, cover wide areas in search of food, following well defined aerial pathways. Ideally, orangutan exhibits would more closely follow this natural model, being linear or perhaps even forming circuits, with continuous overhead pathways. Elevated foraging areas should be provided along the way to encourage use. One AZA institution has connected orangutan exhibits at different sides of the zoo by providing an arboreal cable pathway that crosses the zoo (Coe & Dykstra, 2010). This ensures that the orangutans are able to experience locomotion as they would in the wild. Several other zoos have since incorporated similar arboreal cable pathways into new or refurbished enclosures. Long, narrow exhibits allow large trees to grow on both sides, out of reach of the orangutans. These can provide desirable shade, backdrop and ambience.

Recommendations:

- Useable arboreal space should be one of the major parameters used to measure the relative value of different designs.
- Maximum bar/rope width 75 mm (3 in.).
- Ideal reach distance (e.g., bars and ropes) is 2 m (6.56 ft.). This should also include routes for young animals with smaller arm spans.
- Structures should be designed to prevent subordinate animals from being trapped by dominant animals by including escape routes.
- Climbing structures should be at least 4 m (13 ft.) from the top of external walls or fences and 2 m (6.56 ft.) from the base of the wall.
- There should be several resting/sitting areas for every orangutan housed in an exhibit to avoid monopolization.
- Ropes should be of sufficient diameter or have limited movement (e.g., fixed tightly at both ends) to prevent accidental hangings. Large knots should be tied every 45.72 cm (18 in.) to prevent hanging even if wrapped around an orangutan's neck. Firehose is a recommended safer alternative to rope.
- Care should be taken to monitor rope or fire hose condition; as rope/fire hose begins to fray, it can catch apes' fingers and toes, as well become a hanging hazard.

Foraging: Orangutans spend 40% to 60% of their activity budget in the wild foraging for food depending on resource availability (Delgado & van Schaik, 2000; Bastian 2008). It is a good idea to design foraging opportunities into the exhibit. Places to forage at an elevated level are advised. Trees designed with special holes to encourage tool use, or other puzzle-feeder devices, greatly improve exhibit complexity for orangutans. It is also beneficial to design elevated feeding devices that can be moved periodically to promote novelty. When designing and placing arboreal feeding locations in an orangutan enclosure, ensure that they can be readily accessed by staff for cleaning and other maintenance.

Resting and sleeping: Nest building is an important part of the orangutan's behavioral repertoire. Wild orangutans build exclusively arboreal nests, but managed individuals are known to sleep in ground nests. It is important to provide elevated platforms so that orangutans have the opportunity to build elevated nests both in their daytime exhibit and evening holding area. Wild orangutans build both daytime and nighttime nests for resting and sleeping. A variety of materials should be provided to promote nest building, such as hay, wood wool, straw, burlap, blankets, and branches. It is recommended to provide enough nesting material so that each orangutan in the group can build a nest that is comfortable for resting/sleeping. What defines as comfortable will vary depending on nesting material, location of nest and size/physical state of the individual, but wild orangutans on average build nests that are 19.6 cm (7.72 in.) deep (van Casteren et al., 2012).

Social considerations: It is normally accepted that providing the correct social environment for managed animals is one of the major necessities for their wellbeing. There is also a large variation in potential orangutan sociability according to age and sex. Juveniles and sub-adults are naturally more social than are adults. Zoo-living orangutans may be more social than wild individuals, but there is large variation in sociability between individual animals in both environments. With such individual, life history, sex and demographic variation, it is important to design exhibits that will be suitable for a wide range of sociality among residents. This may be done by designing numerous flexible spaces that can be joined together for larger group access, or divided (via gates or panels) to accommodate numerous smaller social groups. In the wild, adult females establish individual home range territories. Although these ranges may overlap with other familiar females, there is little overlap with unfamiliar and unrelated females. Orangutans seem to go to great lengths to avoid these meetings. Given this, it is a good idea to provide room for cohabiting females to establish individual territories. In addition, housing of related females has the potential to reduce friction between adult females.

The question with orangutans is not the extent to which they are solitary or gregarious, but rather what level of social contact they require. It is seldom possible to provide all individuals with their preferred level of social contact, due to the large variation in the typical level of social contact among sex/age classes, as well as among individuals.

One option could be to house all orangutans in one area and provide a level of choice through a diverse and complex environment, with multiple internal visual barriers. Smaller areas to some extent can be made effectively larger by increasing the functional complexity of the internal environment. Another option may be to house the orangutans in more natural social units (i.e., adult female with up to two dependent offspring and solitary adult males and sub-adults of both sexes), and allow the keepers to regulate the level of physical contact between groups according to individual temperament, taking animal behavioral cues and safety into account. There are as many options as there are individual orangutan preferences.

Numbers of orangutans: The more orangutans each zoo holds, the more zoos can contribute to genetic diversity in the AZA Orangutan Species Survival Plan®. This, of course, has resource implications for zoos. There are at least two factors that need to be considered when deciding the number of orangutans to hold. The first is whether or not there are adequate facilities for the zoo to hold a minimum of a breeding pair and associated offspring. The second is whether the zoo is equipped to keep offspring of both sexes long enough to ensure that maternal behaviors and other key species-specific behaviors are passed down from one generation to the next. Although orangutans are often described as solitary, this ignores the fact that they have a rich social system. Although contact between individuals is less frequent and less physical than in other great ape species, social contact is just as important for their psychological well-being as it is for the African great apes. This is especially true in relation to the mother-infant relationship. Rejection of the infant by the mother is particularly harmful to zoo-living orangutans who are hand-reared. Hand-rearing infants can increase physical and psychological problems and also increases the likelihood that hand-reared females will, upon attaining adulthood, reject their own infants (Cocks, 1998).

Additional features: To provide the best possible environment for managed orangutans, there are several other accommodations that will maximize health and welfare for the animals:

- Weigh stations
- Urine collection areas
- Overhead mesh chutes (to allow choice of travel destination)
- Medical treatment areas that allow procedures to be done without moving orangutans from the building
- Restraint devices that orangutans are trained to comfortably enter to reduce the need for anesthesia during medical procedures
- Specialized research observation areas to enhance data collection, which should be an integral part of the management plan
- Caregiver service areas that allow for optimal levels of management, observation, and interaction
- Introduction areas with "howdy" areas with mesh barriers for visual, tactile and olfactory contact between adjacent spaces
- Access ports to allow connection of a blood sleeve or facilitate ultrasound procedures
- Numerous attachment points for furniture/structures to ensure flexibility when changing the enclosure layout

Exhibit complexity: An integral consideration for zoo and aquarium environments is complexity of design. This refers to the overall variation in the environment (e.g., topography, trees, shade, sunny areas, climbing structures, puzzle feeders, tall grass, swampy areas, streams, pools, large rocks, smooth areas, rough areas, and various sights and sounds). Designing features that mimic the complexity and variety of experiences that wild orangutans have will greatly aid the promotion of species-appropriate behaviors and development.

<u>Enrichment:</u> It is a USDA requirement that behavioral and environmental enrichment be provided (and documented) to all non-human primates on a regular basis to promote the psychological well-being of the animals (AWR, 2005). Providing enrichment during periods of confinement indoors is essential. Lack of appropriate enrichment has been associated with an increase in social aggression and abnormal behaviors in apes (Maple, 1979; Clarke et al., 1982; Maple & Hoff, 1982). Holding areas should be able to accommodate a variety of enrichment items, and to allow for frequent rotation of the items. This will ensure a high degree of novelty that helps to promote psychological well-being. Multiple attachment points for ropes, vines, and other hanging enrichment (such as feeders and puzzles) will facilitate these changes. Attention should also be given to safety and toxicity concerns when providing any type of enrichment. See Chapter 9, section 9.2 of this manual for further enrichment ideas.

<u>Control:</u> In the wild, orangutans have substantial control over their environment. There is a growing understanding that providing managed animals with increased control over their environment is essential for maximizing welfare. Elements of control might include being able to choose social partners or microenvironments (e.g., access to outdoors, shade, or preferred locations), but can range to more complex forms of control such as controlling heaters, water spritzers, music, lights, curtains separating them from the public, and food-scattering devices. Additionally, hiding places should be provided so that orangutans can withdraw from the public's view when desired (Hebert & Bard, 2000).

<u>Outdoor access:</u> Access to outdoor exhibit space is highly recommended.

Horticulture: Orangutans in outdoor exhibits are commonly kept on grass. When growing grass, a rapidly-draining growing medium prevents the formation of muddy areas, but increases the need for fertilization. In order for this to be successful, an adjacent space for the animals to live in while the plantings are established is recommended. This works best in larger exhibits (Coe & LaRue, 1997). Electrified wire plant protection systems work well with many individual orangutans and are worth using, but are not totally orangutan-proof. Some animals are adept at short-circuiting the systems, while others seem to enjoy grasping the wires.

Fiberglass or epoxy has been used to make realistic artificial bark structures, which protect the trunks of larger trees in exhibits. Electrified aerial roots or other hot wire configurations at the top of these 4 m (12 ft. to 13 ft.) structures discourage climbing. This allows the animals free access to the base of the protected tree, providing much needed shade.

Exhibit substrates: Exhibit designers may want to consider the bio-floor as night-quarters 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 orangutans. Deep bedding, if feasible, works best in areas where it is contained by walls or curbs and where provisions are made for easy removal and replacement (Coe & LaRue, 1997). Chamove et al. (1982) have shown that deep bedding facilitates behavioral enrichment and inhibits bacterial growth over time. There are examples of zoos that have successfully used bio-floors. Observed problems have been reduced opportunity to collect urine samples and wood frames rotting. Some recommendations when using bio-floor are:

- Depth: minimum 40 cm (15 in.), optimum 50 cm (19 in.)
- 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, the floor should be flooded with water

Wall, ceiling and floor materials/surfaces: Walls are usually constructed of poured concrete, concrete masonry units (CMU), or fired clay tiles or blocks. Where hollow units are used, walls should be fully reinforced and the interior voids filled with grout to form solid walls to prevent the animals from breaking through the surface, scratching away the mortar or removing blocks. Solid walls should also provide support for a wide variety of surface-mounted structures and equipment. Pipes and conduits are often built into walls where they cannot be reached by the animals. Pipe and duct wall penetrations must be sealed (Coe & LaRue, 1997).

Wall surfaces should be cleanable with no small irregularities or pits where fecal material can collect. The following are the most common types:

- Concrete walls that are plastered with a waterproof Portland cement plaster and painted with an epoxy-based paint.
- Masonry walls, which have joints struck flush and are treated with a block-filler to remove pits and painted.
- Glazed masonry units may be used, making sure to use grout between the tiles (Coe & LaRue, 1997).

Exhibit size: There is no rule for exhibit size except to acknowledge that there is no way a zoo can provide a space that 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 cannot be provided for in any other way: the bigger the better.

The same careful consideration regarding exhibit size and complexity and its relationship to the orangutan's overall well-being must be given to the design and size of all enclosures, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3). Sufficient shade must be provided by natural or artificial means when sunlight is likely to cause overheating or discomfort to the animals (AZA Accreditation Standard 10.3.4).

AZA Accreditation Standard

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

AZA Accreditation Standard

(10.3.4) When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

Indoor areas: The requirements of holding areas can vary according to the type of husbandry use intended, the number of animals expected to use it concurrently, and the amount of time they are expected to occupy the space. Of course, most spaces will be used for a variety of functions (Coe & LaRue, 1997).

Shift rooms: Shift rooms would normally be used by up to two compatible animals for a few hours or less while other areas are cleaned or during transfer operations.

Day rooms: Day rooms, also known as community rooms or exercise rooms, are larger. The minimum desirable size room to consider is 3.66 m long x 6.10 m wide x 6.10 m high (12 ft. x 20 ft. x 20 ft.). A minimum guideline of 200 cubic meters per individual is suggested, with the caveat that this recommendation will be suitable for some groups, but may not be enough space for others.

A much taller space is desirable to accommodate the orangutans' vertical space orientation. Day rooms should provide opportunities for enrichment with multiple opportunities for climbing, perching, feeding, exploration, manipulation or other physically and mentally stimulating activities. Day rooms should be complex enough to allow individuals to separate themselves from others if they wish. Many of the recommendations made previously regarding orangutan climbing structures apply to the furnishing of the day rooms. *Ad lib* access to water is also advised (Coe & LaRue, 1997).

Day rooms can be used for positive reinforcement training sessions, so locking ports where materials can be transferred back and forth may be useful. A 'howdy' wall or gate is needed for this purpose. This is a double mesh barrier through which animals can touch each other without full physical contact (Coe & LaRue, 1997). In many zoos, day rooms may also be public exhibits. In facilities with larger collections, day rooms provide exercise opportunities for animals that are not on public exhibit.

Quarantine areas: Quarantine areas are used to isolate animals that are ill or undergoing health screening. Waste drainage should be separate from other holding areas to prevent cross-contamination (McManamon & Bruner, 1990; USDA, 1991). These enclosures are similar to night rooms and day rooms, but are isolated from other animal zones and have negative air pressure relative to the surrounding areas. Quarantine areas should ideally connect to the outside service area so that new animals can be brought in without contaminating other holding areas (Coe & LaRue, 1997). There should also be separate HVAC systems for quarantine areas. Medical areas should include the following features as recommended by McManamon and Bruner (1990):

- An examination room for taking blood samples, suturing wounds, and other minor surgical procedures. This room should be able to hold veterinary equipment and supplies.
- Emergency equipment including oxygen, electrocardiogram machine, heat lamps, intravenous fluids, anesthetics, and immobilization equipment.
- A radiograph unit should be available for fractures (if animals are young, a portable unit may be sufficient).
- A small laboratory with a microscope for examination of fecal samples. Other laboratory analyses, such as blood tests, can be performed on-site or at another facility.
- A separate necropsy room with its own entrance if other facilities do not exist within a reasonable distance; cooler or refrigerator and storage or incinerator.
- A sterile surgical area.

Night quarters/holding enclosures: Night quarters, night rooms or holding enclosures should be no smaller than 2.4 m wide x 3.5 m deep x 2.4 m high (8 ft. x 12 ft. x 8 ft.). Night quarters usually have elevated sleeping platforms or nesting provisions and *ad lib* access to water. Flexible provisions for behavioral enrichment are suggested, and animals should be given as much control as possible over their environment (Coe & LaRue, 1997). When orangutans are shifted for cleaning, training, or enrichment, this is an opportunity to monitor their health and collect urine and fecal samples.

Ideally, there should be space for each adult orangutan (or adult female with a dependent infant) to have its own individual night quarter/holding enclosure for the eventuality where such separation may be needed. 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. Orangutans should be able to be housed comfortably in these enclosures for extended periods of time. This will allow for appropriate animal holding space when exhibit repairs/modifications need to be made or when there are health issues that require orangutans to be held off exhibit. Be sure to include enough enclosure space to shift animals to adjacent enclosures for cleaning if off exhibit areas are at capacity. 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 incoming animals. 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 orangutans move through them on a daily basis.

Some other recommendations for this space are:

- The area should be rodent- and pest-resistant.
- Adequate lighting should be provided for orangutans in these areas for routine husbandry and keeper observation of the animals (minimum of 30 foot candles, 1 m [3.3 ft.] above the floor is suggested). A proper day/night light cycle should be maintained for orangutans who are housed in these areas. Twelve hours of light followed by 12 hours of darkness is suggested and can be maintained via programmable light timers.
- Public or other noise around the orangutans should be eliminated, or at least reduced to a minimum.
- Night quarter/holding enclosures should provide arboreal nesting sites. Suitable nesting materials should always be provided on a daily basis.
- Drainage should be outside of the enclosure and flow into adequately-sized gutters/sanitary drains.
- Floors should slope to the drain and be covered with epoxy-based paint.
- Walls should be coated with a durable, smooth, and easily cleanable surface such as epoxy-based paint.
- Enclosure ceiling should ideally allow for arboreal locomotion. This can be accomplished via a mesh enclosure ceiling or by installing attachment points in the ceiling so that arboreal enclosure furnishings can be installed.
- Food hoppers should be incorporated to provide more flexibility in feeding.
- Steel bars are not recommended as they allow possible dangerous contact between the orangutan and keeper.
- Suggested maximum gaps between doors and other adjacent structural features are 3 cm (1 in.).
- Doors should open into the night quarters/holding enclosures.
- All night quarters should be connected with shift doors to enable orangutans to move throughout as allowable.
- Horizontal shift doors should be pushed to open in order to reduce injury to the keeper from the handle if the orangutan throws the door open. Ratcheted shift door handles or doors that can be opened to adjustable sizes (“creeped”) are also beneficial from a safety standpoint as well as being effective for animal management.
- The ability to attach a crate for animal transport and crate training prior to transport is strongly recommended. This could be accomplished by having an interchangeable night quarter/holding enclosure door with an opening for the attachment of a transport crate or by having crate attachment points built into the enclosure. Ensure that when the crate is in place it is secure enough to prevent an orangutan from escaping.

Cleaning: Maintaining a clean and safe living environment helps to prevent disease transfer. The Animal Welfare Act requires that indoor primary enclosures be cleaned at least daily (AWR, 2005). Enclosure disinfection can be accomplished by application of a phenolic disinfectant, sodium hypochlorite, or quaternary ammonium disinfectant. All surfaces that the orangutans come in contact with (including transfer crates and restraint equipment) should be scrubbed manually, and thoroughly rinsed and dried with a squeegee. If possible, high-pressure water or steam-cleaning twice monthly will help remove buildup of organic material on surfaces (Lee & Guhad, 2001). When doing this, orangutans should be shifted into a separate air space and staff should wear appropriate personal protective equipment (PPE).

Indoor enclosures: The indoor surfaces that the orangutans come into contact with should be designed with cleaning protocols in mind. Many surfaces can be smooth and impervious to debris and moisture so that cleaning and disinfecting is possible. Some indoor areas may have bedding as well, and cleaning protocols will depend on the specific substrate that is present. Sharp edges should be avoided in the design of indoor enclosures, and rough surfaces may make cleaning more labor-intensive. Construction should be of durable material to withstand regular cleaning and disinfection, as well as rough handling by the orangutans. Surfaces that the orangutans come into contact with should be free of rust and free of peeling or chipped paint. Wood is an acceptable material for climbing structures and though it cannot be sanitized, it can be replaced when it is overly soiled.

Outdoor enclosures: The method for cleaning outdoor exhibits will vary with the type of substrate. Natural indoor or outdoor exhibits with dirt or other absorbent substrates should be spot-cleaned on a regular basis. This will ensure that the animal can avoid contact with feces and food waste, which reduces the number of pathogens and pests. The use of biotic substrates, such as mulch floors, will help control bacteria levels. The frequency of cleaning will depend on the size of the exhibit and the number of animals.

2.2 Safety and Containment

Animals housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3). It is not recommended that orangutans be housed in free-ranging environments.

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). All animal exhibit and holding area air and water inflows and outflows must also be securely protected to prevent animal injury or egress (AZA Accreditation standard 1.5.15). Pest control methods must be administered so there is no threat to the animals, staff, public, and wildlife (AZA Accreditation Standard 2.8.1). Exhibit design should be considered carefully to ensure that all areas are secure and particular attention should be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction. The use of sign boards and public announcement (PA) systems by staff for communicating animal containment and movement, as well as closed circuit video systems for animal monitoring may additionally improve the safety of work areas.

Orangutans should be considered potentially dangerous animals. Therefore, safety and security are important elements of facility design. Security design has two main goals: to keep unqualified people away from the animals, and to contain the animals and prevent their escape. Since safety is clearly linked to knowledge and experience, a well-designed animal care facility can be thought of as a series of security zones granting greater degrees of access based upon qualification to interact with the animals (Coe & LaRue, 1997). Institution-wide security is usually a fence or other barrier whose characteristics are governed by the USDA or other standards. Its purpose is to keep out unwanted people and stray dogs, and it may serve as a back-up containment barrier. General service areas are usually accessible to any staff or delivery person. It is essential that these areas be well separated from animal areas. Outdoor areas include service drives and yards and planting areas. Indoor areas include staff and food preparation areas and mechanical equipment rooms (Coe & LaRue, 1997).

Secondary animal security areas are those areas immediately adjoining areas containing animals. Since these are the first areas into which any animal escapes occur, they should be designed to

AZA Accreditation Standard

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to either the institution's animals, the free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully monitored, and treated humanely at all times.

AZA Accreditation Standard

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

AZA Accreditation Standard

(1.5.15) All animal exhibit and holding area air and water inflows and outflows must be securely protected to prevent animal injury or egress.

AZA Accreditation Standard

(2.8.1) Pest control management programs must be administered in such a manner that the animals, paid and unpaid staff, the public, and wildlife are not threatened by the pests, contamination from pests, or the control methods used.

be as “orangutan-proof” as possible. It is essential that staff have complete visibility of these areas before entering. ”Blind spots” should be avoided. Some facilities use parabolic mirrors to compensate for these problems, but it is better to eliminate such areas altogether. Where corridors change direction and blind spots are unavoidable, careful placement of an additional mesh barrier and security doors can provide an additional security zone with good visibility (Coe & LaRue, 1997). Darting portals or other means to shift an animal without entering the space are very useful in emergency situations and should be considered in the design process. Installing surveillance cameras in orangutan areas can also be a very useful tool for routine observations as well as for emergencies.

Primary animal security areas are those areas normally occupied by the animals and those areas occasionally occupied by unrestrained animals such as shift areas and transfer chutes. It is essential that staff in secondary animal security zones have excellent visibility into primary security areas so that staff can verify that rooms are empty and secure before they enter (Coe & LaRue, 1997).

Where secondary security areas provide access into large complex indoor or outdoor exercise or display areas, it may not be possible to ensure complete visibility of the area before entering. Therefore, the following two precautions are essential: 1) Excellent visibility of the animal area immediately beyond the door, including overhead space, and 2) The ability for staff to quickly account for the location of all animals to determine that no animals are present prior to opening the door. Provisions should be made to ensure that animals will not be released into any area that is already occupied by another staff member (Coe & LaRue, 1997).

Enclosure and gate materials (adapted from Coe & LaRue, 1997): **“**Orangutans are highly intelligent, extremely persistent, patient, strong and skilled at dismantling equipment. They have been known to use their fingernails as highly effective ‘screwdrivers’” (McManamon & Bruner, 1990). Other examples include using their fingers to loosen bolts and nuts tightened with automatic wrenches, and opening locks with pieces of wire and other items they have hidden under their tongues and lips.

Hot-dipped galvanized steel is the most commonly used material for enclosure construction. Stainless steel is preferred, but is much more expensive. For the enclosure front, many new facilities have used 6 mm (1/4 in.) x 5 cm (2 in.) x 5 cm (2 in.) crimped steel mesh. This is preferred over welded wire mesh because the welds can be broken by orangutans. Spiral weave (chain-link) mesh has been used, although some animals have unwoven it. Steel bars are not recommended as they allow the animals to reach through the barrier more readily than mesh.

Gates between adjacent holding areas should be located near the enclosure front to facilitate animal visibility and prevent animal injury during transfer. Two well-separated gates into major animal activity areas should be included so that a dominant animal cannot block other animals from entering or exiting the area. The size of animal gate opening in orangutan facilities ranges from 81 cm^2 (31.9 $in.^2$) to 102 cm^2 (40.2 $in.^2$).

Factors to consider in selecting a gate movement system include: 1) Frequency of operation; 2) Cost of construction; 3) Frequency of maintenance; 4) Back-up system requirements; and 5) Staff experience. Plastic materials have the advantage of being better thermal insulators for outside gates and allow some light penetration. They are also lighter in weight, quieter than steel, do not rust and reduce the amount of friction during operation.

Gate closure systems vary widely. Hydraulic gates are used and provide excellent operator control, considerable power, and can be fixed in any location. If the orangutans could conceivably gain access to the hydraulic hose, non-toxic hydraulic fluid such as water or vegetable oil should be used. Electric powered gates have also been used. These operate smoothly, lock in any position, but are slow. Both of these systems require back-up in case of power failure.

Manually operated gates include vertical (guillotine) and horizontal (sliding) gates. Swing (hinged) gates are not recommended. Guillotine and sliding gates with a single operating cable have been developed using spring or counter weight-powered throw bolts to lock the gate in a variety of positions. While these gates operate well under ideal conditions, experience has shown that they require frequent adjustment and that debris in the bottom track can prevent closure. Guillotine gates with a continuous steel cable or chain drive have been effective. It can be locked in a variety of positions by securing the operating wheel. Horizontal sliding gates can be operated by any of the above systems or by the use of a push/pull bar. This is the simplest and most cost-effective form of gate operating systems. Placement of the gate will determine whether pushing or pulling on the handle opens the gate. Pushing to open the gate is safer for the keeper operating it. If the animal forcibly opens the gate, the push rod is thrown away from rather than toward the keeper.

All gates should have a highly visible and unambiguous locking device, to allow staff to immediately confirm that the gate is secure. Gate control points should provide a clear view of the gates being operated with good view of both sides of each gate while being located well out of reach of the animals. A lock should not be used to hold any slide, gate, or door closed. Locks are not intended as the mechanical securing mechanism.

Positive reinforcement training should be used to condition the animals to transfer. No mechanical system can compensate for problems with animal transfer procedures. For example, the smallest orangutan can effectively block the most powerful gate closure mechanism by simply putting a hand or foot in the opening, thus preventing the gate from closing. Using rapidly moving gates is dangerous and may discourage reliable animal transfers in the future.

Keeper access doors: Normal human access doors are usually 0.9 m (3 ft.) x 2 m (6.6 ft.). Wider and/or taller doors should be provided where access is required for replacing deep bedding, browse or exhibit furnishings. Doors into animal areas should provide good visibility. When glass view-ports are used, they should be made of an adequate thickness of laminated safety glass. Access doors at barrier walls should be constructed so the animals can't climb them.

Hinged doors should swing into the animal area and be designed so they cannot be opened into the keeper area. They should be latched at both top and bottom, not just in the middle. Sliding doors are also satisfactory provided that they are continuously supported on both top and bottom.

Exhibits in which the visiting public is not intended to have contact with animals must have a barrier of sufficient strength and/or design to deter such contact (AZA Accreditation Standard 11.3.6). The public visitor zone is the area used by zoo guests. Barriers between the public and areas into which animals can reach are generally 1.07 m (3.5 ft.) high with openings no greater than 10.16 cm (4 in.) in any direction. There should be no horizontal members, which could form a ladder. When this barrier is not an exhibit viewing area and is hidden by vegetation, many facilities have used 1.22 m (4 ft.) or higher steel mesh fencing. Each facility should verify the appropriate height for public security barriers based upon local government ordinances (Coe & LaRue, 1997). Inside buildings, the public is generally separated from staff and animal areas by locked doors.

AZA Accreditation Standard

(11.3.6) There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.

Barriers to contain orangutans: There are essentially seven kinds of barriers used to confine orangutans. They are dry moats, glass barriers, electric barriers, mesh enclosures, deep water moats, wall/fences, towers, or a combination of these barriers.

<u>Glass barriers</u>: Glass barriers are effective against the transmission of human diseases (Maple, 1979). The thickness of the glass varies with the size of the opening and should be determined by a glass specialist. Unshaded glass barriers are used by many zoos as outdoor barriers. If the intent is to create an invisible barrier, reflections quickly give it away. Reflections also make viewing through unprotected glass nearly impossible under certain viewing conditions. To minimize reflections, viewing glass should be covered such that the viewing area is much darker than the area viewed (Coe & LaRue, 1997). Orangutans can easily break glass if they have access to hard objects such as stones or steel. Annealed or tempered laminated glass with PVB inner layer and glass with intermediate acrylic layers will remain intact if broken, but the damage is done. Acrylic and other glass substitutes are unbreakable, but can easily be scratched. Glass and acrylic of sufficient strength to contain orangutans is also very expensive (Coe & LaRue, 1997).

<u>Electric barriers:</u> Electric barriers are regularly neutralized by orangutans and are therefore not acceptable as a primary means of constraint. Electric barriers can serve a function as secondary barriers. For example, these may be useful for protecting the vegetation inside an exhibit. If electric barriers are used inside an exhibit they should be of sufficient height and contain a sufficient number of strands to

prevent orangutans scaling the fence or shorting out all the wire too frequently. Placement height is critical as to avoid any use of behavioral enrichment by the orangutans to neutralize the hot wires. The suggested minimum height for electric barriers is 3 m (10 ft.) from substrate, with a minimum distance between wires of 10 cm (4 in.). The first 1.5 m (5 ft.) should all be positive wires, and the top 1.5 m (5 ft.) can alternate between positive and negative wires. The suggested maximum strength is 6,000 volts, with a minimum of 3,300 volts. The suggested peak current is 6.4 amps. Electric barriers should only be used as secondary barriers to contain orangutans.

Mesh enclosures: Mesh exhibits are the most secure of the barriers used to contain orangutans. They have the advantage of maximizing the amount of arboreal space per area, while allowing for behavioral enrichment and enclosure furniture to be attached throughout. It is challenging to make mesh enclosures visually appealing. Orangutans can dig into the ground; therefore the mesh of the enclosure should be extended four feet under the ground and angled back into the exhibit at depth. There are also, other options available such as 2 feet of concrete below the mesh.

Steel mesh enclosures vary from highly visible rigid frame structures to the very light and diaphanous cable-supported type. Mesh size and type can vary from the 6.4 mm (0.25 in.) diameter x 5.08 cm (2 in.) x 5.08 cm (2 in.) crimped wire used in holding area enclosures to the new 2.4 mm (0.09 in.) diameter 5.1 cm (2 in.) x 5.1 cm (2 in.) woven stainless steel cable mesh. The mesh should extend at least 50 cm (2 ft. 4 in.) under the ground.

The mesh enclosure makes it much more difficult for objects to be thrown either into or out of the exhibit area. However, orangutans are still adept at manipulating items through the mesh to reach outside of their enclosure. Mesh may be a more cost-effective option than moats for smaller exhibits, although the price varies depending upon the type of construction and material. Another form of mesh enclosure is a fence with a 3.05 m (10 ft.) smooth, solid overhang or vertical extension which animals can’t climb.

Dry moats & smooth walls: Smooth walls 3.66 m (12 ft.) high have been used to contain orangutans. It is important to ensure that no potential finger holes are present and that the angle at which walls join does not enable orangutans to brace against one side to scale the seam. This eliminates all but the smoothest artificial rockwork or requires an overhang at least 3.05 m (10 ft.) wide which animals can’t climb. Smooth walls tend to be unattractive in naturalistic exhibit areas and it is best to design the facility so that smooth walls are not visible to the public. The advantage of smooth walls is that little space is needed and that it is only moderately expensive compared to other alternatives. Disadvantages include the possibility that the orangutans may improvise a ladder and escape. Wall height should be sufficient to prevent escape by use of stray objects thrown or fallen into the exhibit or objects otherwise obtained by the orangutans, plus allow orangutans to have a wide range of enrichment material. As with mesh enclosures, the wall or fence needs to be extended under the ground or angled back into the exhibit to prevent digging under. The fence or wall should be extended at least 50 cm (19.7 in.) under the ground.

Dry moats are nearly invisible when perpendicular to view. However, when moats are parallel to view they may be fully exposed and unattractive. It is possible to use plantings or other features to screen public views down into moats, or to paint the walls. Allowing orangutans access into the moat may provide them with opportunities to hide; such access may present enrichment opportunities for the orangutans, but should be considered in terms of exhibit requirements. Advantages of dry moats include their near invisibility when well placed. Disadvantages include high relative cost and unsuitability in areas with high water tables or shallow bedrock. Like smooth walls, they can be compromised by animals using improvised ladders. Moats take up a lot of space in smaller exhibits (Coe & LaRue, 1997). The suggested minimum moat depth is 4.5 m (14.8 ft.).

Deep water moats: Orangutans 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 orangutans 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. Orangutans have been observed wading up to their necks in both the wild and *ex situ* environments. Some zoos use electric wires to try to prevent orangutans from entering 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 orangutans are usually very skilled at using vegetation or sticks to by-pass or destroy electric wires. Deep water moats should be avoided as barriers for orangutans (Unknown, 2008).

Towers: Towers can be used to allow the orangutans to traverse areas outside of their primary enclosure. The towers should be of sufficient height that the orangutans will not risk jumping in all but the most extreme situations. They should also be designed to prevent the orangutan from descending them. 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 orangutan from gripping the surface. The suggested minimum drop height for a structure over a non-secured area is 8 m (26 ft.).

Pest control: Pest control should be considered as an important factor during exhibit design. Pests such as mice and cockroaches seek tight dark areas. Small openings, such as between steel barrier frames and masonry walls, or penetrations into tubular steel frames, should be sealed. Mounting counters, cabinets, or shelves away from walls, as well as maintaining open space around furnishings, gives pest species nowhere to hide. The use of open shelving made of wire mesh also limits hiding places. Drain covers with tight fitting mesh drain baskets help to prevent the movement of insects and rodents through the sewer systems. Many enclosure features contribute to the creation of rodent habitat, both indoors and outdoors. Food availability is probably the most critical factor. Fly and mosquito control programs should be considered for animals with outdoor access. A routine, integrated pest control program should be part of standard animal management practices.

AZA Accreditation Standard

(11.2.4) All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

Emergency Procedures: All emergency safety procedures must be clearly written, provided to appropriate paid and unpaid staff, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.4). Fire alarm systems are recommended. Alarms should automatically call the Fire Department and appropriate orangutan care and management personnel. Plans should include training in emergency protocols to overnight personnel who do not regularly access the building to ensure orangutan safety, as these people will presumably be first on the scene in the event of a fire during hours in which animal care staff is not present. All orangutan personnel should be trained to properly use fire extinguishers and fire extinguishers should be kept and maintained around the area.

A severe weather plan should be developed to address the various weather scenarios that are specific to the geographic location. Be sure to include plans for addressing power and water needs when affected by severe weather. A disaster supply kit (see list below) should be assembled and kept in the building and checked and assessed quarterly. Orangutan holding facility buildings are typically constructed of thick, concrete walls with few entrances or large windows, making them ideal safe places during extreme weather events such as hurricanes or tornadoes. High ceilings and existing drains also increase the possibility that the building is safe during severe weather.

Preparations for hurricanes in orangutan housing should be similar to human hurricane preparation. All orangutans should be locked inside and preparations made to provide both the humans who stay with the orangutans, and the orangutans themselves, fresh food and water for several days. Preparations for severe thunderstorms or tornadoes in orangutan housing should be similar to human preparation for these events. All orangutans should be locked inside. Care should be taken to move animals into areas away from large sheets of glass that might shatter during high winds. After the severe weather passes:

- Watch out for fallen power lines and stay out of the damaged area.
- Assess roofs and outdoor spaces for damage and potential escape routes.
- Listen to a radio for information and instructions.
- Use a flashlight to inspect buildings for damage.

A flood and earthquake response plan should be developed if the institution has the potential for either of these events. Emergency relocation plans should be included for floods in case high water levels dictate relocation. Keep a Disaster Supply Kit on hand, along with food and water for all orangutans and caregivers.

Disaster Supply Kit (www.redcross.org)**:**

- Canned food and can opener
- Bags of dry chow (one week's supply)
- At least 3 gallons of water per individual per day (humans and orangutans)
- Protective clothing, bedding, or sleeping bags (for both humans and orangutans)
- Battery-powered radio, flashlight, and extra batteries
- Special items for infant, elderly, or disabled individuals
- Written instructions on how to turn off electricity, gas, and water if authorities advise this action (a professional should turn natural gas service back on)
- Store supplies in a waterproof, easy-to-carry container, such as a plastic tub with handles
- Generator for back-up heat/cooling source
- Sufficient bedding for one week
- Cleaning supplies

Staff training for emergencies must be undertaken and records of such training maintained. Security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2).

Emergency drills must be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6). Such communication systems can include phone trees or centrally monitored alert systems. A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (AZA Accreditation Standard 11.2.0).

AZA-accredited institutions must also ensure that written protocols define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.7). Institutions holding orangutans should have agreements with their local fire, police and other emergency personnel regarding dangerous animal escapes which will include the orangutan. Institutions can define acceptable parameters of responsibility for the escape. For example, within the zoo perimeter zoo personnel are responsible, but outside zoo perimeter fences, the city and/or

AZA Accreditation Standard

(11.6.2) Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

AZA Accreditation Standard

(11.2.5) Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified. (See 11.7.4 for other required drills).

AZA Accreditation Standard

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

AZA Accreditation Standard

(11.2.0) A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (see 11.2.5, 11.5.2, and 11.7.4).

AZA Accreditation Standard

(11.2.7) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

county emergency response personnel have authority. Training for outside personnel and the documentation of this training should mirror what is provided to zoo staff.

Escape precautions: Many escapes can be attributed to one of two causes: human error or design flaw. It is impossible to provide more than a few guidelines for handling escapes, as each facility and animal is different. Many factors will influence choices to be made, and there may be several strategies with a high probability of success. Escapes are best handled through prevention. Common sense, attention to shifting, locking and securing enclosures, knowledge of animal behavior, and maintenance needs of facilities will go a long way in eliminating the risk of an escape. It is strongly advised to always work carefully and attentively and “Think Safety!” It is important to focus on the task at hand and avoid carelessness, inattention or hurrying in locking enclosures and shifting animals. Always double-check locks, tugging on them firmly to be sure they are securely locked. Most orangutans are very aware of locks and will check and test them. Volunteers, curators, veterinarians, maintenance workers and fellow caregivers should be made aware that distracting orangutan caregivers from their normal routine can be hazardous to caregiver and animal safety. Be sure the location of each animal in the group is known before entering an enclosure. Don’t assume an enclosure is empty because no orangutans are seen. Count off or name each individual in the group, making positive visual contact with each animal before unlocking the presumed empty area. If more than one caregiver is working in an area, stay in close contact and make sure that everyone clearly understands their assignments. Check on each other often and be sure to avoid potentially disastrous situations. If Dick is working orangutan night dens and Jane is working the on-exhibit areas, they should both be present during shifting. If Jane allows the plumbers into the night dens to unstop a drain while Dick is at lunch, she should stand by until they are finished and the area is secure. Think through actions to their likely conclusion. Diagramming a complicated shifting routine or writing down or reciting aloud each step can help anticipate problems. This also aids in the communication process so that each individual knows clearly what will happen and who will do what. Thinking aloud is a good way for senior caregivers to teach new caregivers how to anticipate the animals’ responses and to be sure all alternatives have been considered.

Escape response: In spite of all cautions and anticipation, escapes happen. Each institution should have its own escape protocol, outlining the appropriate methods of communication, containment, areas of responsibility and evacuation procedures. Caregivers should be familiar with all aspects of an escape plan. A yearly drill should be scheduled to practice escape procedures. It is recommended that a variety of scenarios be modeled during drills, including scenarios that address an institution’s specific animal(s) and facility. Drills should include animals escape scenarios into secured and non-secured areas as well as escapes outside of zoo boundaries.

These situations can be modeled by the use of volunteers posing as escaped orangutans. Such volunteers should be familiar with orangutan behavior to accurately model potential situations in real time. These “mock orangutans” should be clearly marked as such for the drill. All drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures.

<u>Communication:</u> Where is the command center (security, curator’s office, etc.)? Is it the same place at night and on weekends? Who is responsible for staffing the command center?

- How to report escape information and communication during an escape
- Zoo's radio code to indicate an escape
- What specific information should be broadcast to other respondents
- Familiarity with the chain of command for escape emergencies
- The location of the escape command center including where to report for after-hours responses
- The procedure for securing staff in safe locations during a dangerous animal escape
- Updated telephone list of essential personnel posted in appropriate locations
- Institutional media policy for animal escapes and emergencies
- Post-escape review process

<u>Containment:</u>

- Follow institutional guidelines for recapture and containment of the escaped animal(s). Typically, the Scene Commander will determine a recapture strategy to communicate to staff and emergency responders.
- Remain calm. Staff actions should minimize stress and danger of injury to the animal, staff and guests. Remain in a secure location until assistance arrives and never attempt to capture an escaped orangutan alone.
- Orangutans can be very dangerous animals. Even when a staff member has a good relationship with an individual animal, the orangutan should always be assumed to be dangerous.
- Keeping the animal in a familiar location or routine may help resolve the situation quickly and safely.
- If chemical immobilization is necessary, the animal should be darted in a location where it will not be injured and so it can be safely monitored as anesthesia is taking effect.

Evaluation:

- Immediately following the recovery of an escaped animal, a debriefing meeting should be held with all staff and responders that were involved in the capture/recovery of the animal. During this meeting, discussion on how and why the escape happened should take place so that corrective measures can be taken and improvements can be made to better respond to future situations.
- Written documentation should be included in the evaluation process.

AZA-accredited institutions which care for potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Animal attack emergency response procedures must be defined and personnel must be trained for these protocols (AZA Accreditation Standard 11.5.3). As intelligent animals that can be much stronger than humans, orangutans should be considered potentially dangerous. It is recommended that caregivers have only protected contact with orangutans. An exception would be in the case of an infant who is being temporarily hand-reared prior to reintroduction to the dam or introduction to a surrogate (see guidelines Section 8.5).

New orangutan caregivers should be thoroughly trained in orangutan behavior, as well as learning the preferences and personalities of each individual orangutan they will be working with; it should be stressed that it takes time to build a trusting relationship with an orangutan and each individual person and orangutan will develop that relationship at his or her own pace. The progression of the training of new staff depends on both the orangutans' and the keepers' comfort level. If keepers are uncomfortable being near, feeding, or shifting orangutans it can create a potentially dangerous situation for the person, and this factor should always be carefully considered during staff training. Supervisors who are familiar with the orangutans should always be available to answer questions and provide guidance.

AZA Accreditation Standard

(11.5.3) Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

Animal attack emergency drills should be conducted at least once annually to ensure that the institution's staff know their duties and responsibilities and know how to handle emergencies properly when they occur. All drills need to be recorded and evaluated to ensure that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation 11.5.3).

If an animal attack occurs and injuries result from the incident, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident (AZA Accreditation Standard 11.5.3).

Chapter 3. Records

3.1 Definitions

In the zoo and aquarium world, animal records are defined as "data, regardless of physical form or medium, providing information about individual animals, samples or parts thereof, or groups of animals". Most animals in zoo and aquarium collections are recorded as (referred to as) individuals, though some types of animals are recorded as (referred to as) groups or colonies of animals, particularly with invertebrates and in aquariums (see Appendix B for definitions and Recordkeeping Guidelines for Group Accessions). The decision about how to record its animals usually resides with each institution, but in certain cases, the AZA Animal Program Leader (i.e., TAG Chair, SSP Coordinator, or Studbook Keeper) may request that animals be recorded in a certain manner, whether as individuals or as groups. The AZA Orangutan SSP identifies animals at the individual level and requires all participating institutions to do the same.

3.2 Types of Records

There are many types of records kept for the animals in our care, including but not limited to, veterinary, husbandry, behavior, enrichment, nutrition and collection management. These types of records may be kept as separate records as logs in separate locations or as part of the collection records and some may be required by regulation agencies (e.g., primate enrichment records) or per AZA Accreditation Standards (e.g., emergency drill records).

Recordkeeping is an important element of animal care and ensures that information about individual animals or groups of animals is always available. The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information (AZA Accreditation Standard 1.4.0). These records contain important information about an individual animal or group of animals, including but not limited to taxonomic name, transaction history, parentage, identifiers, gender, weights, enclosure locations and moves, and reproductive status (see Appendix C for Guidelines for Creating and Sharing Animal and Collection Records). Due to their frequent participation in research projects and positive reinforcement training programs, it is recommended that detailed records of orangutan involvement in these programs be recorded. In relation to positive reinforcement training, video records of trained behaviors may be most useful, especially when animals are transferred between institutions. Additional records of preferred and potentially hazardous enrichment, dietary restrictions, personality and temperament are also useful.

A designated staff member must be responsible for maintaining the animal record-keeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and current (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4) and at least one set of historical records safely stored and protected (AZA Accreditation Standard 1.4.5). AZA member institutions must inventory their orangutan population at least annually and document all orangutan acquisitions, transfers,

AZA Accreditation Standard

(1.4.0) The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information.

AZA Accreditation Standard

(1.4.6) A paid staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all paid and unpaid animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

AZA Accreditation Standard

(1.4.7) Animal records must be kept current.

AZA Accreditation Standard

(1.4.4) Animal records, whether in electronic or paper form, must be duplicated and stored in a separate location. Animal records are defined as data, regardless of physical form or medium, providing information about individual animals, or samples or parts thereof, or groups of animals.

AZA Accreditation Standard

(1.4.5) At least one set of the institution's historical animal and veterinary records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

deaths, releases, and reintroductions (AZA Accreditation Standard 1.4.1). All species owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2). Orangutans are typically transferred as a donation or breeding loan. Holding institutions should notify the owning institutions of any births, transfers, deaths, injuries, medical procedures, and respond to annual surveys. All AZA-accredited institutions must abide by the AZA Policy on Responsible Population Management (Appendix D) and the long-term welfare of animals should be considered in all acquisition, transfer, and transition decisions.

AZA Accreditation Standard

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisition, transfer, euthanasia, release, and reintroduction.

AZA Accreditation Standard

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution.

3.3 Permit Considerations

The orangutan is regulated by federal and/or state governments under the USFWS Endangered Species Act. Therefore, possession and/or specific activities involving these species usually require a permit(s) issued by the regulating agency, granting permission for possession and/or the specific activities. Depending on the agency involved, the application and approval process may take a few days to many months. These permits must be received by the applicant before the proposed possession or activity can occur. At the federal level, the USDA oversees the regulation of zoos under the Animal Welfare Act. Environmental and behavioral enrichment records must be current and made available upon request. Individual states also maintain their own regulatory processes, details of which are beyond the scope of this manual. Consideration of individual state permitting is especially important when transporting animals across state lines. For more information on state permitting processes, have the zoo registrar, or those in charge of recordkeeping for your institution, contact state officials.

3.4 Identification

Ensuring that orangutans are identifiable through various means increases the ability to care for individuals more effectively. All animals held at AZA facilities must be individually identifiable whenever practical, and have corresponding identification (ID) numbers. For animals maintained in colonies or groups, or other animals not considered readily identifiable, institutions must have a procedure for identification of and recording information about these groups or colonies. (AZA Accreditation Standard 1.4.3). These IDs should be included in specimen, collection and/or transaction records and veterinary records. Types of identifiers include:

AZA Accreditation Standard

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

<u>Physical identifier</u>: These include, but are not limited to, ear and/or wing tags, leg bands, tattoos, microchips/transponder and RFID devices, elastomers, ear and/or shell notches and toe clips. Permanent physical identifiers are often required when a species is regulated by a government agency and to distinguish separate animals in studbooks. Common methods of individual orangutan identification include radio frequency identification (RFID) implants (aka "microchips") with unique identification numbers and tattoos. Permanent physical features, scars, and other unique external characteristics may also aid in identification of individual orangutans. Like many primates, orangutans can also be identified by facial features. The use of physical identification features can begin immediately after birth and should be regularly updated as the individual ages. The use of RFID implants or tattoos should be implemented at the discretion of the overseeing veterinarian but are generally implemented before the individual's first birthday.

<u>Intangible identifiers (called 'logical identifiers' in the Zoological Information Management System [ZIMS]):</u> These include, but are not limited to, institutional accession number, house name, public name, studbook number, and ZIMS Global Accession Number. The International Studbook for orangutans uses three primary identifiers: (a) Studbook number: assigned by the Studbook Keeper; (b) local ID number assigned

by the holding institution; and (c) House name. Only the first of these three is assured to be consistent through the lifetime of the orangutans and as such, is the most reliable method of identification.

Chapter 4. Transport

4.1 Preparations

Animal transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). All temporary, seasonal, and traveling live animal exhibits must meet the same accreditation standards as the institution's permanent resident animals, with foremost attention to animal welfare considerations (AZA Accreditation Standard 1.5.10). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order. Include copies of appropriate permits and authorizations in transport documentation. If the animal is not owned by the shipping institution, permission is to be obtained from the owner well in advance of the move.

> **AZA Accreditation Standard**
>
> **(1.5.11)** Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

> **AZA Accreditation Standard**
>
> **(1.5.10)** Temporary, seasonal and traveling live animal exhibits, programs, or presentations (regardless of ownership or contractual arrangements) must be maintained at the same level of care as the institution's permanent resident animals, with foremost attention to animal welfare considerations, both onsite and at the location where the animals are permanently housed.

Crate size and design: Determining the size and design of the shipping crate is a critical part of assuring a safe and successful transfer of the animal. The crate's inside dimensions should allow the animal to turn around and sit upright without its head touching the crate ceiling. Remember to take into account the depth of any bedding that may be included in the crate with the animal. There are governmental and transport-company regulations on the types of bedding that can be used during shipment; this is an especially important consideration in international shipments. Types of wood used in crate construction are also sometimes included in regulations. The crate should be constructed of materials that are strong enough to contain the specific animal to be shipped, taking into account the gender, age and size of the orangutan. Orangutans can be skilled dismantlers, so aluminum, heavy-grade plywood and steel can all be used in various combinations to construct a strong, safe crate. All nuts and bolts on the crates should be checked to ensure they are tight and will not come loose during the transport. The design should allow for ease and safety in handling the crate. It is very important that the size and weight restrictions for the intended method of transport be taken into account (USDA Subpart D Sections 3.87-3.92; www.usda.gov) for specific requirements for crate construction and transit activity. Also, refer to the latest edition of the International Animal Transport Associations Live Animal Regulations (www.IATA.org) for the crate design approved for air transport for great apes.

Other factors to be considered when determining crate size include: corner turning space into the holding enclosures, dimensions of service corridors and doors, specifications of all truck trays, truckload ratings, and airplane cargo door dimensions. It is important to check with the receiving institution to ensure the shipping crate can fit into their quarantine area for unloading. The method in which the crate door opens and closes needs to be taken into consideration to ensure a smooth unloading process. When measuring an enclosure door to determine if a crate can fit through the door, make sure to include the width of the crate, including any side/carrying handles to ensure a proper fit.

The equipment should provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s). Items to bring may include:

- 2 gallons of water per orangutan per 24 hour period
- Treats that will fit through bars/mesh of crate
- Produce (check government and transport regulations on permissible produce)
- Biscuits that will fit through bars/mesh of crate
- Juice
- Blankets
- Medications and medications sheet
- Cups
- Pill crusher and pill splitter
- Emergency kit

- Vet box
- Soap/hand sanitizer
- Personal protective equipment (latex gloves, masks, Tyvek suit)
- Baby monitor
- Thermometer to measure air temperature
- USDA transfer form
- Health certificate
- Health records
- State import permit
- Credit card/cash
- Road atlas
- Important phone numbers
- Vehicle registration and insurance card
- Cell phone car charger
- Extra vehicle keys
- Lug wrench and jack
- Spare tires for vehicle (and trailer if trailer used)
- Jumper cables
- Oil and coolant
- Ramp for onloading and offloading crate if necessary
- Emergency heating/cooling equipment
- Fire extinguisher

Safe transport also requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

Staff involvement: Having someone familiar with the animal accompany the transfer can assure a smoother transition for the animal and caregivers. It is strongly recommended that keeper staff from the receiving institution work with the orangutan at its home institution prior to shipping. This allows the animal to meet its new caregivers and allows the new caregiver to work with and observe the animal during its normal daily routine. Both the sending and receiving institutions' caregivers should accompany the animal during shipment. Many orangutans suffer depression (sometimes extreme) after being moved to a new facility. It is recommended that a familiar caregiver stay at the new facility with the orangutan until the animal is eating and showing signs of adjustment to the new routine.

The choice to transport an animal using zoo staff may be the best one for relatively short distances. Remember that driving an orangutan across country is not as easy as it sounds. Plan the best route and then have alternative routes in case of unexpected road closures, severe weather or other changes. Have a plan for dealing with any problems encountered on the road. For long road trips, make plans for backup vehicles in case of a breakdown in the primary transport vehicle. It is recommended that arrangements are made for in-transit veterinary emergencies. This can be done by contacting AZA institutions that are along the transport route to enlist an experienced veterinarian to be on call if the need arises. Ensure that adequate staff accompanies the shipment. For the sake of the orangutan caregiver and animal safety, a minimum of two people should make the trip, although it is probably best to have three. Refer to the USDA regulations for transport of non-human primates for additional information (AWR, 2005).

4.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. A pre-shipment veterinary evaluation should be done well in advance of shipment. This evaluation involves examining all the records and history of the animal. These may include: medical, animal management, APES (Ape Profile and Evaluation System), positive reinforcement training, and other records. A pre-shipment physical examination is also recommended; see the Veterinary Chapter for more information.

1. **Determine transport guidelines**
   a. The USA has adopted International Air Transport Association (IATA) Live Animal Regulations. Some airlines have specific nonhuman primate requirements or restrictions.
      - Animals should be crated for shipment to the receiving institution.
      - Animals should be trained for voluntary crating whenever possible.

- Familiar zoo staff should accompany an ape in transit whenever possible.
- Certificate of Veterinary Inspection, medical records, and appropriate permits should accompany an ape in transit.
- Animals should be shipped in a climate-controlled manner, with temperatures optimally held between 15–29 °C (60–85 °F).
- A contingency plan for transit-associated problems should be in place prior to the shipment.

2. **Develop a shipment transition plan**
   a. This plan can help the animal being shipped adjust to changes in its environment, daily routine, diet, caregivers and future social group. Some orangutans adjust well to a new location and animal management routine with little apparent stress. Other individuals can experience varying levels of stress and/or depression ranging from mild to severe. There are cases of adolescent and sub-adult orangutans who have suffered severe post-shipment stress and/or depression. In a few of the cases, the animals have lost significant amounts of weight, become reclusive, and are non-interactive with their caregivers or surroundings. Here are some recommended steps in developing a shipment transition plan:
      - Exchange animal records with the receiving institution. This will allow caregivers and animal managers the opportunity to review the animal's history. Records may include: Zims, Tracks, APES, AAZK Animal Data Transfer Form and Enrichment Data Transfer Form, diet, enrichment, and training records. A records review will help determine if any past or present behavioral or medical issues will need to be addressed prior to or after shipment. This will also help in deciding where to place the newcomer. All involved parties should be in regular communication to discuss the upcoming shipment and animal to be transported.
      - Determine the shipping timeline. This will help in the development of a transition plan. The more time to prepare the animal for transition the better.
      - Identify a shipping crate if the transition plan includes crate-training the orangutan prior to shipment. This is highly recommended if the sending facility can accommodate this type of training. Voluntary crating of an orangutan is the least stressful method.
      - Develop a separation plan. It is recommended that the animal being shipped be acclimated to increasing time lengths of voluntary separation from its present social group. This type of training helps the animal being shipped adjust to being alone while at its home institution. It also helps to desensitize the remaining animals in the social group who are not being shipped, to separate for increasing periods of time in a non-stressful situation. Separation time lengths should start very small and increase to a point at which the animal is separated from its social group for several days prior to shipment. A concerted effort to keep the experience positive for the animals involved and in their regular routine is a goal.
      - Have the nutritionist review the animal's present and future diet to determine what (if any) adjustments need to be made.
      - Determine how birth control will be altered or stay the same after the transfer.
      - Learn as much as possible in advance of the shipment about the new facility and its orangutan management routine in order to help the transition of the animal being shipped. Request copies of the receiving facility's orangutans' APES profiles.
3. **Determine the size and design of the shipping crate**
   a. This information is presented in the second paragraph of Section 4.1.
4. **Permits**
   a. The required permits will depend on the animal's destination and method of transportation. In general, a health certificate will be needed for transport in the United States. International shipments and some states require additional permits and

documentation.

5. **Locate a CDC-registered import quarantine facility for international imports**
   a. Nonhuman primates entering the US from foreign countries may need to go through quarantine at a CDC-registered facility.
   b. Note that some changes to the requirements in 2014 may minimize some of the requirement for zoo-to-zoo imports; ***contact the CDC directly for up-to-date requirements***.
6. **Plan travel arrangements as early as possible**
   a. Consider difference in climate between the two locations and try to plan for a time when weather is not too different.
   b. Decide whether the animal will be shipped by plane or by using an institutional or rented vehicle. Decide who will be accompanying the animal (at least 2 people). It is best to choose people the orangutan is comfortable with. If possible a veterinarian would accompany the animal as well. If needed, make arrangements with an animal transporter. Choose the safest and least stressful route to reach the receiving institution. Ensure that the orangutan is never exposed to dramatic shifts in weather. If flying, arrange for the keeper to have access to the tarmac to supervise animal handling during transport, if possible, in accordance with airline and airport security regulations. It is recommended that security passes be arranged well in advance with the cargo manager for both the outgoing airport and also any stopovers. Establish veterinarian contacts in stopover locations or along the driving route for ground transport.
   c. If an animal transporter is used, confirm that they have experience with orangutans and ask for references from prior orangutan transports they have done. Pre-arrange for any equipment or special requests for the transport.
   d. Develop contingency plans for any potential problems while on the road, including vehicle and/or animal-related issues. Arrange with zoos along the transport route for emergency help if needed and give list of contacts to the transporter.
7. **Transfer animal to crate and transport to new facility**
   a. The best method is to move an animal into a crate using positive reinforcement training, although sedation also works. If using crate training, start the training process well in advance of the actual shipment. Once the animal is trained, actual "mock transports" could be staged prior to the actual shipment.
   b. If the animal is sedated, great care should be taken in placing the animal in the crate so that the airway is not blocked. Maintain quick access to the animal until it starts to respond and can hold itself in an acceptable position. Do not put food or water into the crate until the animal is fully alert. The orangutan should be fully alert before it leaves the facility.
   c. All documentation should be sent well in advance of the shipment except for the health certificate and actual transport documents. Remember to bring a hard copy of all pertinent information about the animal to the receiving facility including: medical history, APES form, the American Association of Zookeepers Animal Data Transfer form, Enrichment Data Transfer Form, Training Data Transfer Form, and any institutional records pertaining to the individual orangutan. If the animal is involved in a behavioral modification program, a videotape of the animal's training sessions will help provide a smooth transition to the new trainer(s).
8. **Provide follow-up information and support to the new facility**
   a. It is worth designating specific staff at each institution to help facilitate communication regarding the orangutan post-shipment. It should be specified how frequent the updates will be and what both institutions expect for communication. After the animal has been shipped, fill out the AZA SSP Animal Transfer Survey and return it to the AZA Orangutan Husbandry Advisor.

Chapter 5. Social Environment

5.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors. Orangutans can be housed in a variety of ways: mixed age/sex groups, restricted-access groups, and solitary individuals are all potential options, depending upon individuals and circumstances. Adult male orangutans should not be housed together. Although orangutans can be housed alone, it is not recommended except under unusual circumstances. Adult males and adult females may be housed through the use of a creep door arrangement, allowing the female to choose her accessibility to the male. Individual institutions should evaluate available holding and exhibit spaces as well as the temperament and social experience of their animals when forming groups. Visual barriers and access to several holding enclosures or exhibits are an important consideration for larger social groups. Group structure should be evaluated frequently, especially when housing juvenile animals with adults, as animals' temperaments may change with the onset of sexual maturity, and adult-male tolerance of maturing males can change very suddenly.

When individuals need to be isolated from the group, every attempt should be made to retain as much visual, olfactory, and auditory contact as possible, while restricting physical contact. This can be accomplished through the use of mesh or Lexan® shift doors. Mirrors on the outside of the enclosure can be used to maintain visual contact. More information on this topic is discussed in Chapter 2.1 as "Social Considerations".

5.2 Influence of Others and Conspecifics

Animals cared for by AZA-accredited institutions are often found residing with conspecifics, but may also be found residing with animals of other species. Mixed species exhibits are valued for conserving space, providing positive and challenging stimuli to animals and for the education and entertainment aspect of a zoo's mission. The decision to house different species together should take into account the inherent problems associated with any animal introduction and management scheme but should include additional factors unique to mixed-species exhibitry. Some of the issues to be addressed when considering mixed-species exhibits include: aggression between the two species; multi-species competition for resources such as food, space, etc.; and the potential for zoonotic disease transmission, especially from high risk species such as macaques. In addition, psychological distress as the result of a mixed species situation should be considered as a potential health risk. Management of each individual species should be considered independently of the other especially with regard to cases where the mixed exhibit is not successful. Alternative plans for housing, feeding, etc., should be made prior to beginning the mixed species program.

Orangutans have been housed successfully with siamangs, various gibbon species, crab-eating macaques, and Asian small-clawed otters. Exhibits with water moats have had fish, bullfrogs, and various turtle species in them with no reports of interaction or aggression by the orangutans, even when the turtles basked on land. One report cites various Old World monkeys opportunistically and briefly getting into an orangutan exhibit with no extraordinary outcome, although zoo managers did not plan these visits. Feral animals such as domestic cats and rabbits have also been found living in orangutan exhibits.

Management considerations: Housing multiple species in an exhibit presents many management challenges. The species' natural histories, species-specific requirements, and preventing resource competition are priorities in planning a program. The following should be regarded as a basic but not exhaustive list of facility design and program considerations:

- Sufficient space in the night quarters for each species and each individual as well as appropriate physical, visual, or auditory separation where needed.
- Exhibit should be large enough to meet the minimum standards for each species plus added square footage for the addition of extra animals.
- Exhibit should be properly furnished to supply species-specific needs for each species without

competition for furniture or space made by conspecifics.

- A plan for feeding and watering to eliminate food competition or dominance over feeding/watering sites.
- Safety features in any shared living space which help protect the smaller or less dominant animals and allow them to retreat from harassment or aggressive behavior from others.
- The environmental enrichment program used for orangutans should be re-evaluated to consider the conspecifics to be housed in the exhibit. The safety and species-appropriate nature of enrichment items used in the program should ensure that the goals of enrichment are met for all of the species, in a safe and healthy manner.
- As arboreal animals, orangutans should not have to compete for arboreal living space with another arboreal species such as gibbons. The exhibit area should be large enough and sufficiently furnished such that all animals are comfortable residing in their arboreal living areas. Providing arboreal travel pathways with differing load-bearing capabilities is one way to exclude heavier animals from certain areas.
- Be sure to recognize the individual personalities of the orangutans and the other animals to be housed with them. Individual personalities can mean the difference between success and failure. A dominant personality within the group can affect the dynamics in both species.

5.3 Introductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved. For purposes of these standards, the word introduction refers to animals introduced for reproductive or social reasons within a managed setting. This document does not address reintroductions of animals to the wild.

Typically, there is a high rate of success when conducting orangutan introductions. The most challenging introductions involve infants or adult animals. Juvenile introductions have the highest success rate. Injuries commonly inflicted during introductions are bite wounds to hands, arms, feet and head, and pulled hair or fingernails. Most injuries are considered minor and few individuals require invasive wound care. Aggressive encounters have been recorded between males and females although well-planned male-to-female introductions are largely uneventful. The number of minor injuries that have been reported to occur during successful as well as unsuccessful introductions indicates that differences between individuals can be resolved. If initial introductions are not successful, all options should be reviewed before further attempts are abandoned. A different introduction location or combination of animals may be all that is required.

It should be emphasized that no two orangutans will react in the same way to every situation. Information regarding the personality and social experience of all individuals is essential prior to formulating introduction protocols. Introductions may take longer than anticipated and continual monitoring of the animals is essential. For case study information describing various age/sex combinations of introductions, see the “Introductions” chapter of the Orangutan Husbandry Manual (http://www.czs.org/Centers-of-Excellence/Center-for-Animal-Welfare/Animal-Husbandry/Orangutan-Husbandry-Manual).

Developing introduction plans: The first step in any introduction should be the development of an animal management plan. Plans should be flexible and specific to the individual animals involved. APES profiles and other records containing information on the social history of the animals involved should be reviewed. Meetings held prior to the introduction should include discussions on alternative plans of action, potential facility modifications, staff involvement and intervention equipment needed. Discussions with less experienced staff are very important in order to give them an idea of what they might see and hear during the introduction. They should follow the instructions of a more experienced staff member. Inexperienced staff should not be responsible for monitoring introductions without experienced backup.

Location and equipment: Facility design may limit the location for an introduction. It is important to conduct a facility review prior to the introduction to determine if any modifications are needed. A variety of locations can be used for an introduction including holding and exhibit enclosures. Single enclosures should be avoided.

Using as much enclosure space as possible is important when planning an introduction. Enclosures that have "dead ends" should be avoided. Animals should be provided with every opportunity to escape from each other. Restricted access enclosures (or "creeped" enclosures) should be used if your facility has them. Remember that adult orangutans can fit through a very small opening. It is highly advisable to test the animal's ability to pass through a "creeped" door prior to the introduction. When choosing an introduction location, consider staff accessibility to the animals in case an intervention is necessary. Keep in mind that an unnecessary intervention can prolong or inhibit the introduction process.

All animals involved should be given ample time to become familiar independently with any new enclosure that will be used for the introduction. This is especially important if an introduction will occur in an area that contains potential hazards such as a dry or water-filled moat. Special care should be taken when introducing one or more unflanged (sub-adult) males as this is a period of hormonal fluctuation. Groups containing individuals of this developmental stage should be monitored closely for indications of increased aggression or submissiveness by any individual. Juvenile introductions (which are uncommon) warrant a more controlled situation. They may need a longer adjustment period when being introduced to a new enclosure in order to become familiar with new surroundings prior to the introduction. Deep bedding and the use of a restricted access or "creep" door is highly recommended for this type of introduction. Juveniles should always have the choice to get away from the other animals to which they are being introduced.

Good visual access and the ability to maximize control are important factors for staff when planning an introduction. Animal control equipment that can be available during the introduction includes: water hoses, high-pressure hoses, carbon dioxide fire extinguishers and/or immobilization equipment. This type of equipment should by readily available but not visible to the animals. It is not uncommon for animals to be stressed when seeing this type of equipment.

The use of heavy bedding is strongly encouraged during an introduction; it can help minimize fall-related injuries and provide foraging opportunities. At least 10 cm (4 in.) of hay, wood wool or other substrate should be used to ensure adequate padding of the enclosure floor. Deep bedding is critical when doing introductions involving infants. Food items offered during an introduction should be plentiful enough to avoid competition between individuals. Small forage items can promote species-typical behavior while serving as a distraction. Behavioral enrichment should be provided as well. Refer to this manual's section on enrichment for additional ideas. The use of browse is highly recommended.

Progression of the introduction: Group composition including size, sex, and age of the animals involved, animal personalities, APES and social history should all be evaluated. If the introduction is to occur in phases, the behavior of all animals involved during the prior phases of the introduction should be evaluated.

Auditory, visual, and olfactory contact is the first step in an introduction. Mirrors can be used to facilitate this if the facility design does not allow for complete visual access. Mirrors can angle between individual enclosures. Limited tactile contact may follow. Fine mesh screens or grates between adjacent enclosures can be used. These can replace solid doors or be added to enclosure barriers that would otherwise allow full tactile contact. A period of limited tactile contact will enable staff to better evaluate how individuals may react when in full contact. Consideration should be given to the possibility of animals biting each other when this type of contact is allowed.

If your facility has the ability to increase tactile contact opportunities, this should be the next step. During this phase, carefully monitor all individual animal responses to their new peers. Any aggressive behavior should be evaluated prior to the full-contact phase of the introduction. Affiliative behavior can be reinforced by caregivers where appropriate.

Full contact is the final phase of the introduction process. The animals should be allowed sufficient time to integrate into their new social group. The adjustment period to a new social situation may be quick or could take an extended period of time. It is important to let the behavior of the animals involved dictate the pace of the adjustment period.

Orangutan introductions are highly variable. Aggression during introductions may occur and is not unusual. Some behaviors commonly seen during introductions include: chasing, hair pulling, slapping, wrestling, biting of toes and fingers, and ano-genital inspection. It is common to see sexual behavior and forced copulations when introducing an adult pair. Careful observations are recommended to identify encounters that could escalate and result in serious injury. Unnecessary separations should be avoided as frequent separations and subsequent reintroductions can be a factor in increasing aggression between individuals. Animals should be allowed the time and opportunity necessary to work out any differences in order to develop compatibility. Emphasis should be placed on positive interactions between individuals before moving on to the next introduction phase.

When doing any introduction, it is important for staff involved in the process to discuss how each observer involved perceived the animals' interactions at each stage of the process. This will help in planning the next step of the introduction. Staff monitoring and assessment is critical throughout the entire introductory process.

Depending on the facility's animal management routine, it may be desirable to separate individuals at certain times. Some individuals do not tolerate being housed together continually. Continual housing or restricted access housing (creep method) should be considered for a breeding pair to allow unrestricted access during the ovulation period.

Chapter 6. Nutrition

6.1 Nutritional Requirements

AZA Accreditation Standard

(2.6.2) The institution must follow a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

A formal nutrition program is required to meet the nutritional and behavioral needs of all orangutan (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the AZA Nutrition Scientific Advisory Group (NAG) feeding guidelines: (http://www.aza.org/nutrition-advisory-group/), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

Wild orangutans experience a dramatic flux in food availability due to mast synchronized fruiting of trees in Southeast Asia. Mast fruiting is rare, occurring only once every 2 to 10 years (Ashton et al., 1988). During the lower periods of fruit production, orangutans are forced to rely on other, less energy-dense foods. This phenomenon has led researchers to hypothesize that orangutans evolved to take advantage of mast fruiting by storing the excess calories as fat in order to partially rely on this energy when fruits are not available (MacKinnon, 1974a; Wheatley, 1982, 1987; Leighton, 1993; Knott, 1998a, 1999). Biomarkers from field-collected urine confirmed that wild orangutans deposit fat during high-fruit periods and metabolize fat when fruits are scarce (Vogel et al., in preparation). Recent studies have used nutritional geometry to analyze the responses of wild orangutans in Borneo to variation in the macronutrient composition of natural foods (Vogel et al., in preparation). Results showed that orangutans maintain their daily intake of protein within narrow limits, but allow non-protein energy intake to vary with variation in the macronutrient composition of available foods. Consequently, during periods of high fruit availability (masting periods) the orangutans eat similar amounts of protein but considerably higher amounts of non-protein energy and hence of energy overall, compared to outside of masting periods when high-protein foods such as leaves and cambium form the major portion of the diet.

Orangutans are often classified as frugivores, due to their preference for fruits when they are available; however, based on their digestive system physiology, Stevens & Hume (1995) classified them as arboreal folivores. Foods selected by wild orangutans have been identified by various researchers and include fruit, leaves, non-leafy vegetation, inner bark, flowers and insects (Bastian et al., 2010; Galdikas, 1988; Hamilton & Galdikas, 1994; Knott, 1998a; Knott, 1999; Leighton, 1993; MacKinnon, 1974a; Rodman, 1977). There are several reports of carnivorous activity by orangutans, including the consumption of a gibbon (Sugardjito & Nurhuda, 1981), slow lorises (Utami & van Hooff, 1997), and a rat (Knott, 1998b).

While many researchers have identified the types of foods consumed by free-ranging orangutans, very few have quantified the nutritional composition of those items. Hamilton and Galdikas (1994), Heller et al. (2002), and Knott (1998a, 1999) are among the only researchers that have analyzed free-ranging orangutan foods for protein, fat, fiber, and dry matter. The most extensive analytical research on orangutan foods has been by Knott (1998a, 1999). One of her studies focused on food availability and its effect on orangutan nutrition, energy balance, and reproduction. For this study, a complete year of Bornean orangutan food consumption was documented between November 1994 and December 1995 in Gunung Palung National Park in Indonesia. During this time period a mast fruiting event occurred, which enabled Knott to include numerous fruits in her analyses.

Knott analyzed 93 orangutan food items for structural fiber (neutral detergent fiber, acid detergent fiber, and lignin), crude protein, ash (total mineral composite), and lipids (fat). Overall, there was a wide range in nutrient composition both between and within food categories. The table below (Table 4) is a composite of information of all the food items analyzed. Note the high upper range of neutral detergent fiber concentrations identified for most food items.

Table 4. Nutrient ranges in orangutan foods (% on dry matter basis; Knott, 1999)

Item	Neutral Detergent Fiber	Crude Protein	Fat
Seeds (n=39)	9–84	2–19	0–52
Pulp (n=19)	9–77	5–13	0–18
Leaves (n=8)	21–72	12–19	1–2
Bark (n=10)	53–73	6–17	0–8
Flowers (n=3)	46–57	10–13	2–3
Whole Fruits (n=4)	50–65	4–12	0–4
Pith (n=4)	51–82	3–7	0–2

Knott approximated individual orangutan consumption using the time an individual spent eating and their average feeding rate. Based on those intake calculations, neutral detergent fiber comprised 24.1–60.8% of the consumed diet. During the non-fruiting period (June to December), the fiber concentrations of the diet were at their highest because orangutans relied on leaves and bark as main food items, both of which are extremely high in structural fiber. While concentrations of fiber changed in the diet, the overall, absolute quantity of fiber consumed did not vary significantly throughout the year. While the percentage of fiber consumed varied throughout the year, the percentage of protein remained relatively consistent, comprising 5.3–16.0% of the diet. The lipid (fat) concentration of the diet ranged between 7.2–16.8% with the higher percentages being attributed to the consumption of *Neesia* seeds, which contain 40% fat.

The target nutrient levels estimated for zoo orangutans were derived from the Nutrient Requirements of Nonhuman Primates (2003). This document was compiled by an expert panel on primate nutrition and includes data from numerous nonhuman primate nutrition research projects. The summarized estimated nutrient requirements for orangutans are listed in Table 5.

Table 5. Proposed nutrient guidelines for orangutans on a dry matter basis*

Nutrient	Proposed Nutrient Guidelines
Crude Protein, %	15–22
Neutral Detergent Fiber (NDF), %	10–30
Acid Detergent Fiber (ADF), %	5–15
Ca, %	0.8
P, %	0.6
Mg, %	0.08
K, %	0.4
Na, %	0.2
Cl, %	0.2
Fe, mg/kg (or ppm)	100
Cu, mg/kg	20
Mn, mg/kg	20
Zn, mg/kg	100
I, mg/kg	0.35
Se, mg/kg	0.3
Vitamin A, IU/kg	8,000
Vitamin D_3, IU/kg	2,500
Vitamin E, mg/kg	100
Vitamin K, mg/kg	0.5
Thiamin (B_1), mg/kg	3.0
Riboflavin (B_2), mg/kg	4.0
Pantothenic acid, mg/kg	12.0
Niacin, mg/kg	25.0
Vitamin B_6, mg/kg	4.0
Biotin, mg/kg	0.2
Folacin, mg/kg	4.0
Vitamin B12, mg/kg	0.03

Vitamin C, mg/kg	200
Choline, mg/kg	750

*Target values based on NRC (2003)

Mimicking the nutritional composition of the high fiber, low sugar diet of free-ranging orangutans will promote healthier orangutans. Feeding orangutans animal products, including dairy and eggs, is not recommended as they may promote obesity and increase cholesterol concentrations (Schmidt et al., 2006). The only exception to this would be when hand-raising orangutan infants. At those times human infant formulas supplemented with omega fatty acids are recommended for use over cow's milk.

In addition to estimating nutrient consumption, Knott estimated caloric intake and expenditure. During mast fruiting periods, caloric intake was approximated to be 8,422 kcal/day for males and 7,404 kcal/day for females, which is greater than during non-masting periods in which males consumed an estimated 3,825 kcal/day and females consumed 1,793 kcal/day (Knott, 1998a). Knott estimated energy expenditures for orangutans during fruit-rich periods to be approximately 3,400 kcal/day for males and 1,900 kcal/day for females (without maternal costs), and 2,400 kcal/day for females with maternal costs using food consumption rates and caloric content of the foods eaten.

Metabolizable energy (ME) needs of the orangutan can be estimated using the equation: ME(kcal) = $100 \times BW^{0.75}$ where BW is body weight in kilograms (King, 1978). This equation has been used to formulate diets for apes at several zoos and appears quite accurate for weight maintenance in orangutans. For example, an adult female weighing 45 kg (99 lbs.) would require approximately 1,737 kcal per day for maintenance. Ideally, orangutans should be weighed regularly to determine their individual requirements as they may require more or less than the average orangutan to maintain body condition.

The second piece of information to consider when formulating diets for animals, especially for those whose dietary needs are not well established, is the anatomy of the gastrointestinal tract. The distinctive feature of an orangutan's digestive tract is the voluminous and lengthy large intestine. Gorillas, also known for their high fiber diets, have a similar digestive tract; however, not all apes share this trait. The large intestine of the chimpanzee is smaller in volume and shorter in length than that of the orangutan. The proportionate length and volume of orangutans' large intestines reflect their ability to ferment significant quantities of fiber from which they are able to acquire energy (Figure 1).

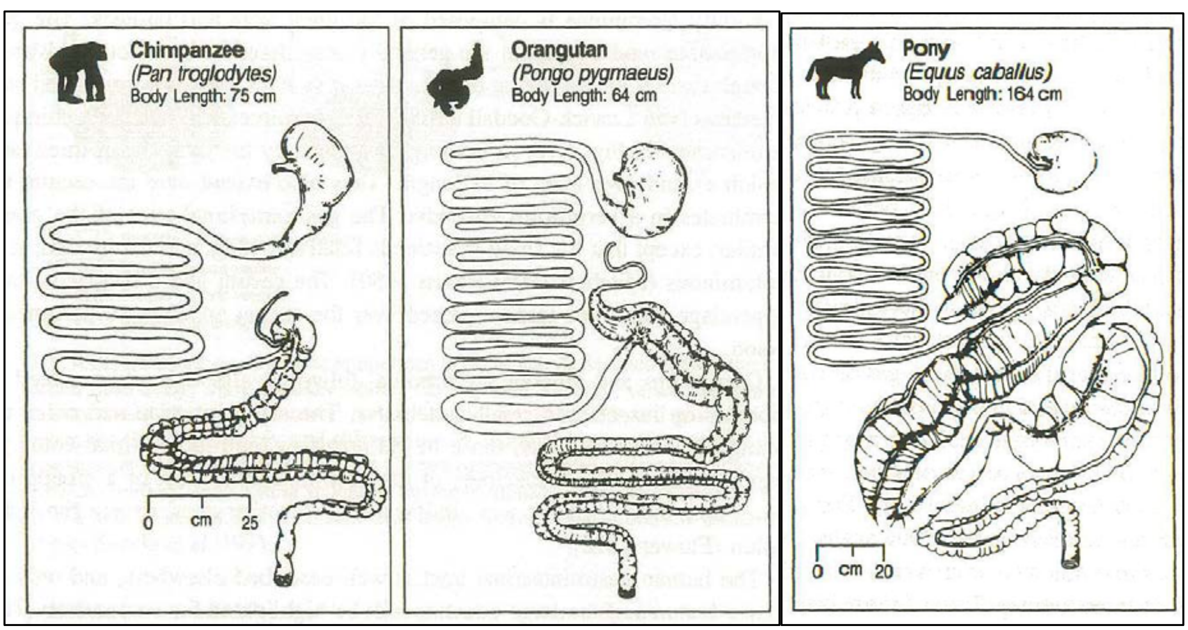

Figure 1. Gastrointestinal tracts of large hindgut-fermenting herbivores—chimpanzee, orangutan (Stevens & Hume, 1995) and pony (Stevens, 1977)—comparing length and volume of the large intestine, an indication of ability for fiber fermentation.

Fiber is a generic term used to describe a broad range of plant compounds, including hemicellulose, cellulose, lignin, gum, and pectin. Mammals do not produce the digestive enzymes necessary to degrade fiber in plants, yet herbivores have evolved to rely on plants as their primary food source. To overcome this inability, herbivores, and to a lesser degree omnivores and carnivores, have developed a symbiotic relationship with bacteria. In non-ruminant animals, including the orangutan, these bacteria reside mainly in the large intestine. Certain species of bacteria rely specifically on fiber for survival, while other bacterial species survive on undigested protein or starch particles that reach the large intestine. The fiber-degrading (fibrolytic) bacteria manufacture and secrete the specific enzymes necessary to break certain types of fiber strands into individual sugar components through a process known as fermentation. Not all types of fiber can be fermented by bacteria. The bacteria use the sugars to meet their own energy needs and excrete an end-product known as volatile fatty acids (VFAs). The herbivore absorbs the VFAs, using them for energy. The research done by Hamilton and Galdikas (1994) and Knott (1998a, 1999) revealed that foods selected by orangutans are relatively high in structural fiber. Through this symbiotic relationship with bacteria, orangutans are able to obtain energy during low fruiting periods by consuming extremely high fiber food items, such as leaves and bark. Combining the knowledge of their high fiber diets with their digestive anatomy would lead one to believe that orangutans have evolved to metabolically rely on VFAs for a significant proportion of their energy.

Even though fiber is not recognized as a “required nutrient” by classical animal nutritionists, the benefits of its presence to gastrointestinal health and metabolism cannot be ignored. In other species, the presence of fiber in the intestinal tract has been shown to enhance blood flow to the intestines, thereby promoting nutrient absorption and tissue health (Kvietys & Granger, 1981; Howard et al., 1995). The presence of VFAs, by-products of fiber fermentation, helps prevent the overgrowth of pathogenic bacteria, including *E. coli* and *Clostridia* (Hidaka et al., 1986; Izat et al., 1991). Volatile fatty acids are also believed to increase the epithelial cell population of the intestines and stop malignant cell growth, decreasing the risk of intestinal cancer (Sakata & von Engelhardt, 1993).

In addition to energy, many health benefits are obtained from including fiber in the diet of herbivores. Herbivorous animals, including the orangutan, may be physiologically dependent upon VFAs to provide a substantial proportion of their daily energy supply. Schmidt (2002) used high-fiber gel diets to evaluate the orangutans’ capacity for digesting fiber. The fiber concentration in extruded primate biscuits is maximized at 30% due to the manufacturing process. To increase the fiber concentration, ground corncobs (CC) or soybean hulls (SH) were suspended in a fiber-based gel matrix. The resulting neutral detergent fiber concentrations were 47% (CC), 64% (CC), and 53% (SH). These fiber levels were 1.5–2.0 times greater than that provided by extruded primate biscuits. Results from this study showed that orangutans were able to degrade 58-65% of the fiber in the CC gel diets and 75% of the fiber from the SH gel diet. While no other orangutan digestibility trials have been conducted for comparison, the ability of the orangutans in this study to degrade significant concentrations of fiber was remarkable. Their ability to digest these large quantities of fiber is an indication that they are capable of relying on fiber fermentation and the resulting VFA production to fulfill some of their energy needs.

There has been no specific research done on nutritional needs for reproduction or growth in orangutans. Growing primates have an increased requirement for energy when compared to the requirements of an adult for maintenance (Kerr, 1972; Nicolsi & Hunt, 1979; King, 1978; Ausman, 1995). During growth it is also important for juveniles to receive vitamins, calcium, and phosphorus in appropriate concentrations to meet the demands of bone formation and development. Vitamin D is necessary for the absorption of calcium. Of the primates that have been studied, primate milk does not contain sufficient concentrations of vitamin D, which can make nursing infants who are reared indoors susceptible to vitamin D deficiency and metabolic bone disease (NRC, 2003). Since vitamin D can be stored by the body and reach toxic concentrations, this supplementation should only occur under the guidance of a nutritionist or veterinarian. Fortunately, supplementation is rarely required if animals are given outside access, as vitamin D can also be synthesized in the skin when individuals are exposed to unfiltered sunlight during spring, summer, and fall months in the Northern Hemisphere.

The specific nutritional needs of reproducing female orangutans are not known. Extrapolating from other primate research, including information obtained on humans, no additional energy requirements are needed during the first trimester of pregnancy (NRC, 2003). However, during the second and third trimesters, it is recommended that the energy content of the diet be increased by 300–350 kcal·day^{-1} to meet metabolic energy needs for the developing fetal, placental and maternal tissues (FAO/WHO/UNU, 1985; NRC, 1989; Williams, 1997). Protein requirements of pregnant females have also not been determined. However, when maternal intakes of protein were at least 1 g·BW_{kg}^{-1}·day^{-1} the infants were of normal birth weight (Riopelle et al., 1975; Riopelle & Favret, 1977). Biscuits and a variety of feed items, including green leafy vegetables, often contain adequate nutrient levels to support females in any reproductive state, and diets can simply be increased or decreased to account for changes in energy requirements.

Lactation is the most energy-demanding physiological state for an individual. Recommendations for humans by the FAO/WHO/UNU Expert Consultation (1985) are for an additional energy allowance of 500 kcal·day^{-1} of metabolizable energy for the first 6 months of lactation. These recommendations may not be appropriate for orangutans. Energy needs can be assessed by obtaining frequent weights on individuals to detect changes in weight. If an individual gained excess weight during gestation, it may be best to let that individual use those energy reserves to meet her increased energy needs during lactation. During this time it is also imperative that the lactating females receive adequate concentrations of vitamin D, calcium, and phosphorus for milk production and body maintenance needs. These needs are typically met through primate biscuits, which are formulated in the appropriate vitamin and mineral concentrations.

As animals age, their energy requirements generally decrease (NRC, 2003). Animals also tend to be more sedentary and thus burn fewer calories. For these reasons it is important to closely monitor the individuals' intakes to ensure they are consuming a nutritionally balanced diet, yet are not consuming too many calories and risking becoming obese. An animal that has muscle wasting due to inactivity can still have excessive body fat. Well-monitored exercise programs are important to maintain good health in the geriatric animal. Daily exhibit use may require furniture adaptation to accommodate arthritic or less agile animals. Altered mental state or agility in geriatric animals may require adaptation to enrichment activities as well. With advanced age in orangutans, veterinarians and nutritionists may need to tailor diets to provide for changing nutritional needs and to maintain good body condition. Common age-related health issues in geriatric orangutans include renal disease or cardiac failure, and these may require further specific adaptations of the diet through supplements or restrictions. Poor dentition may also require special modifications to the diet to achieve adequate intake.

6.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.2). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

> **AZA Accreditation Standard**
>
> **(2.6.1)** Animal food preparation and storage must meet all applicable laws and/or regulations.

Food preparation must be performed in accordance with all relevant federal, state, or local laws and/or regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for orangutan. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

Humans that are ill should not work directly with non-human primates nor prepare their diets. When this is not possible, personal protective equipment (PPE) including face mask and barrier gloves should be worn. Frequent hand-washing and a focus on personal hygiene should be a top priority. For daily food management, HACCP methods should be instituted in the central nutrition area and individual non-human primate kitchens. This includes handling, washing, storage, preparation, and provision of foodstuffs to the animals. Respiratory and gastrointestinal illnesses are some of the most common diseases of orangutans, and prudent measures to prevent transmission of such illnesses between staff and orangutans should be followed.

There are a variety of primate biscuits that will meet the nutritional needs of orangutans. Table 6 gives examples of the biscuits that can be used to establish the base diet for orangutans.

Table 6. Sample of nutritionally complete feeds suitable for primate diets as part of an overall diet plan (values reported on an "as fed" basis).

Nutrient	**Mazuri® Primate L/S Cinnamon Biscuit 5M1S[1]**	**Mazuri® Primate Browse Biscuit 5MA4[1]**	**Mazuri® Leaf-Eater Primate Diet 5M02[1]**	**Marion Zoological© Leaf Eater Food[2]**	**ZuPreem® Primate Dry Diet[3]**	**LabDiet® Old World Primate 5LG1[1]**
Protein, %	20	18	23	23	20	21
Fat, %	6.4	5.2	6.0	6.9	5.0	5.0
NDF, %	34	26	29	21	^	20
ADF, %	22	17	18	13	^	12
Crude Fiber, %	17	15	14	7	4	10
Ca, %	1.1	1.3	1.1	1.1	^	0.9
P, %	0.7	0.7	0.7	0.7	^	0.6
Mg, %	0.2	0.1	0.2	0.2	^	0.2
K, %	1.5	0.8	1.1	0.8	^	1.1
Na, %	0.2	0.3	0.2	0.3	^	0.5
Cl, %	0.3	0.5	0.3	^	^	0.4
Fe, mg/kg (or ppm)	190	415	480	218	^	260
Cu, mg/kg	35	35	20	20	^	36
Mn, mg/kg	100	110	130	48	^	84
Zn, mg/kg	125	165	145	101	^	110
I, mg/kg	1.5	2.2	1.7	1.0	^	1.3
Se, mg/kg	0.3	0.3	0.2	0.4	^	0.2
Vitamin A, IU/kg	21,735	23,140	26,920	13,805	^	40,000
Vitamin D_3, IU/kg	4,275	3,325	2,850	3,817	^	6,600
Vitamin E, mg/kg	318	181	131	319	^	40
Vitamin K, mg/kg	2.3	2.3	2.9	3.8	^	3.0
Thiamin (B_1), mg/kg	16	13	10	7.2	^	7
Riboflavin(B_2), mg/kg	23	13	11	8.7	^	9
Pantothenic acid, mg/kg	142	66	57	24	^	57
Niacin, mg/kg	190	90	95	65	^	100
Vitamin B_6, mg/kg	33	15	12	8	^	13
Biotin, mg/kg	0.4	0.4	0.3	0.4	^	0.3
Folacin, mg/kg	13	13	9.1	5.2	^	1.3
Vitamin B12, mg/kg	0.09	0.065	0.05	0.03	^	0.02
Vitamin C, mg/kg	665	475	720	350	^	680
Choline, mg/kg	2,375	1,580	1,425	1382	^	1,200

[1]PMI Nutrition International, LLC, St. Louis, MO 63166
[2]Marion Zoological, Plymouth, MN 55441
[3]ZuPreem, Shawnee, KS 66214
^Missing values unavailable from manufacturer.

Formulating diets based on the caloric needs of the animal is recommended over feeding a food amount based on a percentage of body mass. Table 7 provides examples of diet proportions successfully fed to orangutans at four zoological institutions that have cared for and bred orangutans. Since fruits and primate biscuits are the most calorie-dense items, target feeding them to animals will help control caloric intake. The fruit portion of the diet can also be reserved for training rewards. Fruit is not an essential part of the diet and can even be eliminated if animals are severely obese. Leafy green vegetables and/or low-starch vegetables are recommended in higher proportions due to the lower calorie concentration of these items.

Table 7. Orangutan diet proportions (as fed basis) offered at four zoological parks.

Diet Item	Adult Male	Adult Female	Juvenile
Primate Biscuits	5–17 %	5–17 %	9–14 %
Fruit	4–20 %	4–17 %	7–18 %
Vegetable	4–19 %	4–19 %	9–19 %
Root/Starch	2–25 %	2–22 %	5–23 %
Leafy Green Vegetables	36–85 %	39–85 %	37–60 %

Table 8 gives examples of diet proportions based on diets from Table 7 with "added" recommendations for low concentrations of fruit and root/starch proportions. As biscuit concentrations of the diet increase, leafy green concentrations would decrease.

Table 8. Examples of orangutan diets using recommended diet proportions.

Diet Item	Low Biscuit	Medium Biscuit	High Biscuit
Primate Biscuits	5 %	11 %	17 %
Fruit	4 %	4 %	4 %
Vegetable	20 %	20 %	20 %
Root/Starch	2 %	2 %	2 %
Leafy Green Vegetables	69 %	63 %	57 %

Table 9 lists the nutrient concentrations of those example/recommended diets in Table 8. Primate biscuits were entered in the program as an average of the biscuits reported in Table 6, with the exception of ZuPreem® Primate Diet. Since the nutrient concentration of the ZuPreem® primate biscuits is not reported by the manufacturer, that option was excluded from the mix. The fruit category included apples, bananas, oranges, pears and grapes. The vegetable category contained celery, green beans, green peppers, tomatoes, cucumbers and squash. The root/starch category comprised carrots, sweet potatoes, corn, onions and green peas. The leafy green vegetable category consisted of romaine, iceberg and loose leaf lettuces, cabbage, and kale.

The diet item with the highest concentration of fiber, typically NDF and ADF, will be primate biscuits. While various types of primate biscuits are available, it is important to select a variety of those that offer high concentrations of fermentable fiber. Offering animals a rotation of these higher fiber biscuits will not only increase the variety of foods available to the animals throughout the week, but may encourage better primate biscuit consumption. A relatively new primate biscuit formulation providing a lower starch (7% vs. 19–29%), higher fiber concentration (33% NDF vs. 19-29% NDF) has been made available within the past few years and is used by several institutions with success.

As mentioned earlier in this chapter, produce items are typically much lower in NDF and ADF than free-ranging orangutans consume. Though humans are encouraged to have a plethora of produce in their daily diets, produce cultivated for human consumption does not provide the same level of fiber that orangutans consume in the wild. Browse is a great way to include higher fiber concentrations in the diet, but few zoos have a year-round source of browse (Appendix G).

Also remember that fruits are typically much higher in sugars than those that orangutans consume in the wild, so feed sparingly. Root vegetables and starchy items (e.g., peas, corn) are also high in sugar/starch and these should be offered sparingly as well. It is recommended to feed larger quantities of regular vegetables (e.g., cucumbers, peppers, squash, green beans, broccoli, etc.) and leafy green vegetables (e.g., lettuce, cabbage, kale, and greens) compared to root and fruit produce.

Table 9. Nutrient analyses of diet recommendations from Table 7 (dry matter basis).

Nutrient	Low Biscuit	Medium Biscuit	High Biscuit	Proposed Minimum Nutrient Guidelines*
Protein, %	20	21	21	15–22
Fat, %	4.2	4.6	4.7	n/a
NDF, %	18.9	22.0	23.7	10–30
ADF, %	13.5	14.8	15.6	5–15
Ca, %	0.9	1.0	1.1	0.8
P, %	0.5	0.6	0.6	0.6

Mg, %	0.17	0.18	0.2	0.08
K, %	2.2	1.9	1.7	0.4
Na, %	0.3	0.3	0.3	0.2
Cl, %	0.1	0.2	0.2	0.2
Fe, mg/kg (or ppm)	183	234	262	100
Cu, mg/kg	17	22	24	20
Mn, mg/kg	65	77	84	20
Zn, mg/kg	70	95	108	100
I, mg/kg	0.64	1.01	1.22	0.35
Se, mg/kg	0.1	0.2	0.2	0.3
Vitamin A, IU/kg	335,480	229,180	170,180	8,000
Vitamin D_3, IU/kg	1,650	2,600	3,120	2,500
Vitamin E, mg/kg	113	138	152	100
Vitamin K, mg/kg	0.9	1.4	1.7	0.5
Thiamin (B_1), mg/kg	9	10	10	3
Riboflavin(B_2), mg/kg	11	12	12	4
Pantothenic acid, mg/kg	39	51	57	12
Niacin, mg/kg	81	93	99	25
Vitamin B_6, mg/kg	15	16	16	4
Biotin, mg/kg	0.1	0.2	0.3	0.2
Folacin, mg/kg	8	8	8	4
Vitamin B_{12}, mg/kg	1.8	2.8	3.3	0.03
Vitamin C, mg/kg	2,750	1,982	1,555	200
Choline, mg/kg	631	992	1,192	750
ME Calories, kcal/g	3.08	3.06	3.04	not applicable

*Target values based on NRC (2003)

When feeding any managed animal, it is important to consider various factors that may affect an individual's diet. Issues such as animal preference, body condition, health status, and activity level should be considered when determining types and quantity of food to feed an individual. Animals housed in groups should receive enough food to meet their nutritional needs and limit aggressive encounters; however, the quantity should not allow animals to be overly selective in what they eat. For example, allowing them to consume mostly produce while avoiding primate biscuits, a nutritionally complete feed, could lead to nutrient imbalances. Animals that are fed as a group should have a small amount of food left over after the feeding period. This ensures that no individual is being deprived of food.

Produce can vary in size and the amount of water it contains. Nutritionally complete feeds also vary in density, even from lot to lot of the same product. For these reasons, it is very important to weigh food in each category rather than preparing the diet by counting food items (i.e., weigh out 250 g (8.8 oz.) of apple instead of offering one apple).

The term "produce" refers to the vast array of readily available fruits, vegetables, and leafy greens cultivated for human tastes. Many caretakers want to offer orangutans and other exotic animals more "natural diets" by using produce as the sole source of nutrients. Although orangutans are highly frugivorous in the wild, the fruits and other plant items they consume in the wild are drastically different in composition from the fruits cultivated for human consumption (Knott, 1999; Schmidt et al., 1999; Schmidt, 2002). Fruits eaten by free-ranging orangutans are much higher in structural fiber, while fruits cultivated for humans are typically lower in fiber and higher in sugar to satisfy human tastes. It is impossible to meet the average fiber levels consumed by wild orangutans using only commercially available produce. When formulating diets, it is important to remember that animals require specific nutrients, not specific dietary items.

When possible, offer produce items with the peels and cores intact. Removing these items may also remove potential sources of structural fiber. If in doubt concerning what is safe for an animal, consult with your institution's nutritionist and/or veterinarian. Cooked produce items, especially those high in starch (e.g., yams, white potatoes), contain more readily available sugars than raw produce (Pretorius, 1997). Cooked items should be used sparingly to minimize the intake of easily digested sugars. Consistently offering foods high in easily digested sugars may increase an individual's risk of becoming overweight and even obese, conditions that may contribute to secondary health issues later in life.

If dried produce items are used, they should not be offered in equivalent weights as fresh fruits. For example, if the diet calls for 100 grams of fresh bananas, you should not offer the animal 100 grams of dried banana chips instead. This would be equivalent to offering the orangutan approximately 5 servings of fresh bananas.

While nuts and seeds (e.g., sunflower seeds) are not typically thought of as "produce," they do originate from plants and are often included in managed primate diets. Nuts and seeds are often scattered in an animal's enclosure to provide the animal with a substance that encourages foraging. Both of these foods should be used in moderation, especially with overweight or obese individuals, due to their extremely high fat content. Gram per gram, fat contains twice as many calories as protein or carbohydrates.

While produce can contribute vitamins, minerals, fats, and protein to an orangutan's diet, it should not be relied upon to supply these nutrients to the animal. In other words, the orangutan's diet should be based on the nutritionally complete feeds (e.g., primate biscuits) with a variety of produce added to complement the diet. A multitude of produce items are available through vendors and every opportunity should be taken to offer the orangutans an assortment of items. Produce rotation schedules help ensure variety in the diet, make the diet more behaviorally enriching, and ensure that individuals do not repeatedly receive high sugar/starch produce items.

The way food is presented to the animals can also be enriching. Cutting produce into different sized/shaped pieces or leaving it whole allows different modes of presentation. The small pieces can be scattered or hidden in other substrates (e.g., hay, grassy areas), while the whole pieces can be placed in areas that may be more difficult to access or that would not be good for scattered items (e.g., tree forks, behind rocks). If infants are present, consider the size of the foods so they do not create a choking hazard.

Nutritionally complete feeds: The term "nutritionally complete" means that the product contains the correct proportions of the recommended vitamins, minerals, protein, and fats for the species for which it was formulated. Primate biscuits, which are manufactured by multiple companies, come in a variety of shapes, sizes, and colors.

Primate feeds formulated for New World primates should be avoided when feeding orangutans. These formulas contain significantly higher concentrations of vitamin D than are required by Old World primate species, which can be harmful to orangutans. Be sure to select feeds that will reliably be consumed. It may help to rotate types of biscuits offered throughout the week to create variety.

Vitamin and mineral supplementation: Nutritionally complete feeds contain the necessary and correct proportions of vitamins and minerals for primates. Adding supplemental vitamins and minerals prophylactically can actually harm an animal if the individual is consuming a nutritionally balanced diet. The body is able to store certain fat-soluble vitamins (e.g., vitamins A, D, E) and minerals, which can reach toxic levels. Prenatal vitamins for pregnant animals may be one exception to this rule. Nursing infants, who do not have access to natural, unfiltered sunlight, may also benefit from a supplemental dose of vitamin D to enhance appropriate bone growth and development (Holick & Chen, 2008).

Animal products: Some institutions use dairy products (e.g., yogurt, milk) as a vehicle for medication or as a food enrichment item. Orangutans do not have a dietary need for dairy products and may experience symptoms associated with lactose intolerance, including bloating and diarrhea. If dairy products are fed, it is recommended that no-fat or low-fat products be used and only in moderation.

Orangutans are typically thought of as frugivores, but have been seen to eat animal matter in the wild (Sugardjito & Nurhuda, 1981; Utami & van Hooff, 1997). If managed orangutans are consuming their nutritionally complete feeds, they will be meeting their dietary requirements for protein. Feeding managed orangutans meat products to fulfill their protein needs is not necessary, nor is it encouraged (Dierenfeld, 1990, 1997).

Giving specific recommendations on the amount of food to offer an individual is not practical due to differences in life stages (e.g., growth, lactation, and pregnancy), body condition, activity levels, and acceptance of the nutritionally complete feeds. Body weight and condition should be monitored to allow for dietary modifications depending on life stage (growing, maintenance, and senescence), activity level and reproductive status (pregnancy, lactation).

Food preparation must be performed in accordance with all relevant federal, state, or local laws and/or regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for orangutans. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise, and dispose of per USDA guidelines.

AZA Accreditation Standard

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

If browse plants (Appendix G) are used within the animal's diet or for enrichment, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program must be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.3). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the species. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available.

AZA Accreditation Standard

(2.6.3) The institution must assign at least one paid or unpaid staff member to oversee appropriate browse material for the animals (including aquatic animals).

The Orangutan Husbandry Manual http://www.czs.org/Centers-of-Excellence/Center-for-Animal-Welfare/Animal-Husbandry/Orangutan-Husbandry-Manual) contains a chapter with a browse list of over 285 plants that were gathered through a survey of various institutions that house orangutans. A list of plants that were provided by three or more institutions can be found in Appendix G. Plants are listed in alphabetical order by common name, followed by the scientific name. Remember that any plant under consideration as animal browse should first be approved by an institution's veterinary and nutrition staff.

6.3 Nutritional Evaluations

Excessive weight gain can influence a multitude of health-related problems. These include increased occurrences of mortality, high blood pressure, heart disease, cancer, degenerative arthritis, respiratory problems, diabetes, and liver disease (fatty liver) (Hensrud, 2002). In the wild, on average, male orangutans weigh 86.3 kg (190 lbs.) while females weigh 38.7 kg (85 lbs.) (Markham & Groves, 1990). Loomis (2003) reported weight ranges for males as 75–189 kg (165–417 lbs.) and 40–81 kg (88–179 lbs.) for females; these weights include those of managed individuals. The lower weights from Loomis correspond to the free-ranging orangutan weights reported by Markham and Groves (1990). However, the upper-end weights are double those of the free-ranging weights and were most likely obtained from extremely obese managed animals. In humans, obesity is defined as having reached a weight 20% (males) to 25% (females) above one's maximum target weight. Orangutans exhibit the same pattern of macronutrient regulation that has also been observed in humans (Gosby et al., 2013; Raubenheimer et al., 2014), and is thought to be responsible for the rise in obesity over recent years as the human diet has become more consistently protein-dilute (the "protein leverage hypothesis"). This suggests that, like humans, orangutans are adapted to alternating periods of fruit (high energy) and leaves (low energy) in the wild, and continual access to high energy fruit, as is provided in managed diets, predisposes them to obesity (Vogel et al., in preparation). Diet and activity levels are the two most critical components to maintaining animals at appropriate weights. It is recommended that frequent weights be obtained on individuals to prevent undetected, rapid weight changes.

Many managed adult orangutans have been classified as overweight and even obese (Jones, 1982). As mentioned above, obesity is often associated with an increased risk of diabetes. There have been numerous anecdotal claims that managed orangutans are prone to encountering problems with diabetes mellitus. Wells et al. (1990) conducted a medical management survey on orangutans housed in North American zoos. They reported that while endocrine system disorders were rare, the most common endocrine disorder reported was diabetes. Six animals out of 249 individuals on whom responses were received were diagnosed as diabetic. The full extent to which diabetes affects the managed population has not yet been documented in the literature. Glucose tolerance tests that determine if an individual is at risk for developing diabetes were given to 30 managed orangutans, and results showed that these animals had a propensity for developing diabetes (Gresl et al., 2000).

Though great apes are genetically similar to humans, they develop a very different type of cardiovascular disease. Apes do not get atherosclerotic coronary artery disease, which is typically seen in humans; instead they are diagnosed with fibrosing cardiomyopathy at necropsy (Schulman et al., 1995; Varki, 2009; MacManamon & Lowenstine, 2012). Mortality reports cite cardiovascular disease as the cause of death in 20% of orangutans (*Pongo pygmaeus, Pongo abelii*; Lowenstine et al., 2008). It is also being reported as a premature cause of death in young apes (GAHP, 2012).

Chapter 7. Veterinary Care

7.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian is recommended, however, in cases where this is not necessary, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and to attend any emergencies (AZA Accreditation Standard 2.1.1). In some instances, because of their size or nature, exceptions may be made to the twice-monthly inspection requirement for certain institutions (e.g., insects only, etc.). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV), available at the AAZV website under "Publications", at http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839 (AZA Accreditation Standard 2.0.1). To contact the AZA Orangutan SSP Veterinary Advisors, visit the AZA Animal Programs page of the AZA website.

AZA Accreditation Standard

(2.1.1) A full-time staff veterinarian is recommended. In cases where such is not necessary because of the number and/or nature of the animals residing there, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

AZA Accreditation Standard

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals 24 hours a day, 7 days a week.

AZA Accreditation Standard

(2.0.1) The institution should adopt the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals,* and policies developed or supported by the American Association of Zoo Veterinarians (AAZV). The most recent edition of the medical programs and hospitals booklet is available at the AAZV website, under "Publications", at http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839, and can also be obtained in PDF format by contacting AZA staff.

AZA Accreditation Standard

(2.2.1) Written, formal procedures must be available to paid and unpaid animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

Additional resources: See the "Veterinary Medical Management" section of the Orangutan Husbandry Manual and "Medical Management of the Orangutan" (Wells et al., 1990) for additional information. Veterinary advisors are available for consultation for more updated information where available.

Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to paid and unpaid animal care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure.

The similar size and physiology of great apes and humans makes human formularies and medical texts excellent resources for dosage recommendations for orangutans and other apes. In the United States, because no medications are specifically approved for use in orangutans, all veterinary or human pharmaceuticals are therefore prescribed for them in an "extra label" fashion. Veterinarians in the United States may legally utilize any human or animal drug that is FDA-approved for use in animals or humans, although these medications have not been formally evaluated for scientific evidence of safety or efficacy in exotic animals.

Veterinary recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining accurate animal veterinary record keeping. Ensuring that orangutans are identifiable through various means increases the ability to care for individuals more effectively. Animal records should include animal weights, current record of the animals' health, previous health issues and the subsequent treatments, any and all diagnostic tests performed and their corresponding results, and records of immobilization procedures and anesthesia dosing.

7.2 Transfer Examination and Diagnostic Testing Recommendations

The transfer of animals between AZA-accredited institutions or certified related facilities due to AZA Animal Program recommendations occurs often as part of a concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered.

Prior to transfer from one institution to another, it is important to determine the health status of the orangutan to ensure that it is fit to endure the stress of relocation and to minimize the transmission of infectious diseases from one institution to another. This can be accomplished through a review of the individual orangutan's medical history, a review of the medical history of the conspecifics at the sending institution, a thorough physical exam, and additional diagnostic testing. The focus of the exam and diagnostic testing should include the same baseline data obtained during the quarantine period (see Appendix H for physiological reference ranges for orangutans) with emphasis on infectious diseases that might pose a risk to the other animals at the receiving institution. Due to the high incidence of respiratory and cardiac disease in orangutans and their typical subclinical nature, it is strongly recommended that individuals over 25 years of age have a thorough cardiac exam including echocardiography and all orangutans have a thorough evaluation of their respiratory health prior to transfer.

7.3 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare (AZA Accreditation Standard 2.7.1). All quarantine, hospital, and isolation areas should be in compliance with AZA standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix E). All quarantine procedures should be supervised by a veterinarian, formally written and available to paid and unpaid staff working with quarantined animals (AZA Accreditation Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

Quarantine facilities should be able to safely house orangutans for the duration of their quarantine period. All safety and health requirements of regular housing should be maintained in quarantine quarters but because of the short-term duration of an orangutan's stay, the available space may be smaller. As such, extra attention should be paid to creating a stimulating environment for the orangutan, especially if that individual is housed alone. In some cases, when appropriate and safe quarantine facilities are not available at the receiving institutions, quarantine may be conducted at a nearby institution with appropriate coordination of the veterinary staffs of the sending, receiving, and intermediary facilities.

AZA Accreditation Standard

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare.

AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839.

AZA Accreditation Standard

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all paid and unpaid staff working with quarantined animals.

Quarantine protocols: The purpose of quarantine is protection of the existing animals and their personnel from the introduction of infectious agents from the newly arriving animal(s). The quarantine period (30-60 days) is accomplished by separation of the new animals from the existing group, and screening them for known diseases. The depth of this screening will vary with the previous history of the individual animal and its collection source. In situations where minimal prior screening has been accomplished, it is important to consider longer quarantine intervals (60-90 days), and for those animals from private facilities or the wild, this extension can be increased to 90-120 days. Federal regulations may require a minimum quarantine duration for primates imported from other countries.

AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers should care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Care should be taken to ensure that these keepers are “decontaminated” before caring for the healthy resident animals again. Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items should be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with resident animals.

AZA Accreditation Standard

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

Use of personal protective equipment, including disposable gloves, surgical masks, gowns, or surgical scrubs worn only in the quarantine area, and a footbath placed for use upon entering and leaving the quarantine area, should be used to help reduce the transmission of zoonotic diseases. Disinfection techniques for equipment and devices are similar to recommendations for all other nonhuman primates.

During periods of illness or during the quarantine period, it may be necessary to house individuals in isolation from other orangutans. While the orangutan is a social species, individuals do spend long periods of time alone in the wild, and do not have the same permanent social groupings typical of the other great ape species. However, this does not mean that isolation will not have a negative impact on an individual. Factors such as age, previous social groupings, and personality traits can have a significant impact on how an individual will react to isolation. During isolation, the orangutan should be monitored for signs of stress. Stress may be manifested as abnormal behavior, stereotypic behavior, inactivity/lethargy, decreased appetite, weight loss, and soft/loose stool. Stress also has a negative impact on immune function, and may result in exacerbation of disease or recrudescence of subclinical disease. Efforts to minimize stress should be employed.

Stress can be reduced in a variety of ways. While an orangutan is in isolation, it is important that its environment be as large and enriching as possible. Food should be presented in a manner that promotes foraging and problem-solving, unless such a presentation has a negative impact on appetite. Enclosure size and design should encourage natural behaviors such as climbing, swinging, and nesting. Other forms of environmental enrichment that stimulate any of the senses should be provided on a rotating basis. Training and interaction with personnel may also provide enrichment, depending on the individual orangutan. However, it is important that such activities do not contribute to the overall stress of the individual during isolation. In cases of stress following a transfer, the temporary relocation of a previous caretaker to the receiving institution has been employed successfully to create familiarity and routine in the new location.

As part of the quarantine evaluation, the group that the quarantined animal will enter should have known status for the infectious agents of concern. This is managed through routine physical examinations and documented in their medical history. For the new animal, quarantine begins with a thorough review of the medical records and social history of the individual, its source group, and collection history. Medical records for each animal should be accurately maintained and easily available during the quarantine period. Prior to departure from the sending institution, the orangutan should receive a complete examination that should also be reviewed by the receiving institution's veterinarian and curator before departure. Within the quarantine period at the new facility, the orangutan should be immobilized for a repeated physical examination to identify occult health issues that may have been triggered by the stress of transfer. When health issues are identified during quarantine, appropriate treatment regimens should be prescribed.

During the quarantine period, specific diagnostic tests should be conducted with each animal (see Table 10). A complete physical exam, including a dental examination, should be performed. Animals should be evaluated for ectoparasites and treated accordingly. Blood should be collected, analyzed, and the sera banked in either a -80 ºC (-112 ºF) freezer or a frost-free -20 ºC (-4 ºF) freezer for retrospective evaluation. Serosurveillance for viral pathogens is a standard practice in primate medicine. The results help with the understanding of the biology of viruses within great apes. Individual and group histories and impact on conspecifics and adjacent species should be considered with interpretation of the results. Fecal samples should be collected and analyzed for gastrointestinal parasites and the animals should be treated accordingly. Vaccinations should be updated as appropriate, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations. See Section 7.4 (Preventive Medicine) for more details on vaccinations. Collection of biomaterial samples for AZA SSP-approved research projects should also be considered during the quarantine exam when possible. Animals should be permanently identified by their natural markings or, if necessary, marked when anesthetized or restrained (e.g., tattoo, RFID, etc.). Medical records for each animal should be accurately maintained and easily available during the quarantine period.

Quarantine should last a minimum of 30 days (unless otherwise directed by the staff veterinarian). If additional mammals, birds, reptiles, amphibians or fish of the same order are introduced into their corresponding quarantine areas, the minimum quarantine period would begin over again. However, the addition of mammals of a different order to those already in quarantine will not require the re-initiation of the quarantine period.

Table 10. Recommended disease surveillance and baseline medical data.

Procedure	**Comments**
Physical examination	Includes a complete review of all body systems.
Dental examination	Includes a thorough assessment of all teeth and oral soft tissue. Dental prophylaxis should be performed if needed.
Body weight	Weight should be obtained at the start and end of quarantine as well as during the physical exam.
Verify permanent identification	Includes transponder, tattoo, unique physical characteristics, etc.
Fecal parasite exam	Includes direct and concentrating techniques (flotation, centrifugation, sedimentation). Additional diagnostics targeting parasites of concern for orangutans include *Giardia* and *Cryptosporidium* screening (e.g. IFA, ELISA, PCR), and Baermann technique for identification of *Strongyloides* spp.
Fecal bacterial pathogen screening	Screening should include tests for *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., pathogenic *E. coli* strains, and *Yersinia* spp.
Blood collection	--Complete blood count (CBC) --Serum biochemistry profile --Lipid panel (includes cholesterol, triglycerides, HDL, LDL, VLDL) --Blood typing (if unknown) --Serum banking --Consider cardiac biomarkers (CRP, BNP), cholecalciferol (vitamin D), vitamin B12, and folate testing
Viral screening	Full panel recommended once per lifetime or during quarantine with subsequent testing according to potential exposure --Simian Immunodeficiency Virus (SIV) --Simian Foamy Virus (SFV) --Cytomegalovirus (CMV) --Herpes simplex virus 1 and 2 (HSV-1, HSV-2) --Influenza A and B (Flu A, Flu B) --Parainfluenza 1, 2, and 3 --Respiratory Syncitial Virus (RSV) --Simian Adenovirus (SA-8) --Measles --Human Varicella Zoster (HVZ) --Epstein Barr Virus (EBV) --Hepatitis A, B, and C
Immunizations	Immunization history should be reviewed and vaccines administered as needed according to the preventive medicine guidelines (section 6.5).

Imaging	--Thoracic, abdominal, and dental radiography --Abdominal ultrasonography considered for adults --Computed tomography (CT) imaging of sinuses, air sacs, and thorax recommended when feasible to screen for respiratory infections.
Mycobacterial testing	Mycobacterial testing results from orangutans are challenging to interpret and many tests have not been validated (see Section 6.5 for more details). Testing that has been performed includes: --Intradermal skin testing --Culture of lavage fluid (gastric, tracheal, or bronchoalveolar) --Gamma interferon testing (e.g. Primagam®) --PCR antigen testing --ELISA antibody test (e.g. ChemBio®)
Cardiac disease screening	Cardiac data should be submitted to the Great Ape Heart Project when collected. Although normal reference ranges are not established for orangutans, the following should be performed on individuals to screen for cardiac disease and to help establish a database to determine normals: --Echocardiography --Blood pressure --Electrocardiogram (EKG) --Cardiac biomarkers (e.g. BNP, CRP)

Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test to yearly repetitions of diagnostic tests as determined by the veterinarian. Release from quarantine should be contingent upon normal results from diagnostic testing and two negative fecal tests that are spaced a minimum of two weeks apart.

If an animal should die in quarantine, a necropsy should be performed on it to determine cause of death in order to strengthen the program of veterinary care and meet SSP-related requests (AZA Accreditation Standard 2.5.1). The institution should have an area dedicated to performing necropsies, and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standards 2.5.2 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner's wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination (see Chapter 7.6 Necropsy).

AZA Accreditation Standard

(2.5.1) Deceased animals should be necropsied to determine the cause of death for tracking morbidity and mortality trends to strengthen the program of veterinary care and meet SSP-related requests.

AZA Accreditation Standard

(2.5.2) The institution should have an area dedicated to performing necropsies.

AZA Accreditation Standard

(2.5.3) Cadavers must be kept in a dedicated storage area before and after necropsy. Remains must be disposed of in accordance with local/federal laws.

7.4 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.0.2). AZA institutions should be aware of and prepared for periodic disease outbreaks in other animal populations that might affect the institution's animals, and should develop plans to protect the institution's animals in these situations (AZA Accreditation Standard 2.0.3). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals: (www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf).

AZA Accreditation Standard

(2.0.2) The veterinary care program must emphasize disease prevention.

AZA Accreditation Standard

(2.0.3) Institutions should be aware of and prepared for periodic disease outbreaks in wild or other domestic or exotic animal populations that might affect the institution's animals (ex – Avian Influenza, Eastern Equine Encephalitis Virus, etc.). Plans should be developed that outline steps to be taken to protect the institution's animals in these situations.

An appropriate orangutan health care program includes proper animal husbandry and veterinary care based on these current professional standards, and addresses the complete physical and behavioral well-being of the animals. Since orangutans have a close taxonomic relationship to humans, they are susceptible to many human diseases. Close contact between people and orangutans in the zoo setting may lead to inadvertent exposure to disease for either group. Sub-clinical infectious disease can occur in orangutan groups and can be transmitted not only to naïve conspecifics, but also human caregivers. A successful preventive medicine program therefore addresses the health of both the orangutans and the animal care staff. Veterinary care with a strong preventive medicine program will minimize the need for acute and emergency medical care. Caregivers should monitor the individual health of each orangutan to facilitate a healthy environment. The basic components of a sound program include: 1) cleaning and disinfection protocols, 2) pest control, 3) an adequate nutrition and feeding program, 4) zoonotic disease prevention, 5) pre-shipment and quarantine testing, 6) routine exams and disease screening, 7) immunizations and other prophylactic measures, and 8) complete necropsies.

Daily observations of orangutan health and behavior are critical to maintaining good orangutan health on a daily basis. Careful inspections of each individual, how it relates to its conspecifics, appetite, eliminations, and detecting signs of injury or disease should be made by keepers – preferably multiple times or by multiple keepers – each day. To complete this process, a written record should document these observations, and should be provided to the veterinarians. Operant conditioning programs could be implemented to include behaviors associated with daily management routines and veterinary procedures, such as weighing, body part inspections, oral inspection, injection presentation, venipuncture, and auscultation.

It is recommended that each orangutan receive a complete physical examination at least every three years. Four or more years between exams may be too infrequent to identify and address common health problems. The frequency of exams should be based on the age, concurrent disease, and individual ape risk factors. Most institutions immobilize their orangutans every one to three years. The ability to perform exams and certain diagnostics utilizing operant conditioning can reduce the frequency of immobilizations, but should not completely replace them. For example, exams may be reduced to every three years instead of annually. Advanced age alone should not be considered a contraindication to immobilization, as geriatric individuals are the ones most likely to benefit from the findings of the exam and diagnostics. More frequent examination allows anesthetic protocols to be safely fine-tuned for the individual, and evaluation of potential health issues (e.g. dental and periodontal disease, heart disease, respiratory disease, degenerative arthritis), without waiting for potentially catastrophic illness. Risk-versus-benefit assessments are essential for each individual animal, and case-by-case individual exemptions may be judged necessary by the attending veterinarians.

Recommended disease surveillance and baseline medical data performed during routine exams can be found in Table 10. A thorough physical exam is best performed under general anesthesia. Although exams utilizing operant conditioning are an excellent supplement to the preventive medicine program, the quality of the exam and diagnostics performed are often substandard compared to those performed under anesthesia. Additionally, the routine immobilization of a healthy individual allows the veterinarian to fine-tune the most appropriate anesthetic protocol for that individual such that staff are better prepared for emergency immobilizations.

The physical exam should consist of a thorough, systematic review of all body systems. In general, a weight should be obtained and body condition assessed with a body condition score (BCS) assigned. Using the standard nine-point scale, a BCS of one would indicate an emaciated animal with decreased muscle mass and no fat stores, a BCS of five would indicate an ideal amount of muscling and fat stores, and a BCS of nine would indicate a morbidly obese animal with excessive fat stores. An orangutan-specific BCS system is not currently available at this time. A crown–to-rump length may help in determining a correlation between weight and BCS. Identifiers such as tattoos and microchips should be confirmed. An ophthalmic exam should be performed using an ophthalmoscope or slit lamp. A fundic exam should also be considered when possible. Ears should be evaluated using an otoscope. Nasal cavities can be examined using a light source and nasal speculum. The oral cavity should be evaluated, with attention to gingiva, other soft tissues, oropharynx, and dentition. A thorough dental exam, including subgingival probing, should be performed to identify subclinical dental disease. If needed, prophylactic dental scaling and polishing should be performed. Regular tooth brushing and flossing through operant conditioning has been utilized to decrease the frequency of dental prophylactic cleaning. The thorax should be auscultated to listen for lung sounds in all lung fields, as well as to assess the heart for signs of murmurs or arrhythmias. The air sac should be thoroughly palpated for evidence of fluid, thickening, or masses. The abdomen should be palpated to check for masses, fluid, or organomegaly. In larger individuals, abdominal ultrasonography is more effective at assessing abdominal organs. Peripheral lymph nodes should be palpated to check for enlargement or masses. The skin should be thoroughly investigated to check for skin lesions, external parasites, or wounds hidden by the hair. Extremities should be evaluated by palpating all long bones and joints and extending and flexing all joints to assess proper range of motion. Crepitus or decreased range of motion may indicate prior trauma or degenerative disease and should be followed up with imaging to better assess the problem. External genitalia should be evaluated to check for lesions, discharge, testicular size/shape, signs of estrus, etc. Testes should be palpated to assess symmetry and check for masses. A speculum can be used to perform a more thorough vaginal and cervical exam in females. A rectal exam can assist with evaluating the pelvic structures, including the prostate in males.

The animal's weight should be determined at every opportunity and body condition assessed. Scales built into the orangutan holding area are recommended, as orangutans are readily trained for voluntary weight measurement. Regular, frequent body weight measurements helps greatly with nutrition and health management. Currently, there is no formal body condition scoring system in place for orangutans. *Ex situ* orangutans can easily become obese, with 46% of institutions reporting diagnosis of obesity in orangutans over the past 10 years (Smith et al., 2012). Obesity should be avoided as it can contribute to diabetes, heart disease, osteoarthritis, and other problems. Conversely, unexplained weight loss is always cause for concern. Objective measurements for determining body condition scoring in orangutans have not yet been validated, but are under development and will assist with weight management in the future.

Dental examination can be facilitated by consultation with a dental specialist. Human dental charts can assist with monitoring long-term problems or routine dental health. Dental cleaning can be opportunistically coordinated with the routine physical examination, and supplemented by operant conditioning that includes tooth brushing and flossing. Gingival tissues should be closely monitored for development of periodontal disease. Low-dose, daily doxycycline has provided effective assistance in resolution of this condition in humans, and is documented in great apes. Broken teeth or teeth with exposed root canals should be evaluated for extraction or endodontic treatment (root canal) by a dental specialist. Tooth extraction or modification is not an acceptable tool for social management and reduction of conspecific aggression in the orangutan.

Blood is routinely collected from the femoral, brachial, or posterior tibial veins. The femoral vein is located medial to the palpable femoral artery located in the inguinal region with the leg extended caudally. Holding off this vessel to facilitate venipuncture is rarely required. Pressure should be applied afterward to prevent hematoma formation. The brachial vein (ventral surface of the forearm) and posterior tibial vein (caudal surface of the distal rear limb) are alternative sites for venipuncture and are the preferred sites for IV catheters. Closed collection systems (e.g., BD Vacutainer® brand) are recommended for venipuncture to reduce the risk of human exposure to blood. Needles should *not* be recapped prior to disposal in a sharps container to reduce the risk of accidental needle sticks. Orangutans can be trained to insert their arm into specialized arm sleeves to allow for venipuncture of the brachial vein while awake using operant conditioning. Blood is used for complete blood count (CBC), serum chemistry panel, viral serology, blood typing, and serum banking for all ages. For animals greater than 25 years of age, glucose and lipid profiles, and cardiac biomarkers should be considered. Thyroid testing has not been validated in orangutans. Results using human or veterinary assays appear to give questionable results, making interpretation challenging. Additional research is needed before routine thyroid testing can be recommended in orangutans.

Renal disease is one of the top causes of mortality in adult orangutans. Urinalysis can be important in the assessment of kidney and bladder health and disease. Samples can be obtained via cystocentesis during routine exams or collected noninvasively through operant conditioning training or from the enclosure. The results are often highly complementary to the CBC and serum biochemistry profiles with respect to providing information about urinary tract infections, kidney function, and diabetes.

Fecal samples or rectal swabs should be collected routinely to screen for *Shigella* spp., *Salmonella* spp., and *Campylobacter* spp. For cases of diarrhea or other gastrointestinal disease, screening for additional pathogens such as pathogenic *E. coli* strains, *Clostridium* spp. toxins, and *Yersinia* spp. should be considered.

Radiographs of the thorax and abdomen should be taken, using both the lateral and dorsoventral/anteroposterior views. The forelimbs should be extended from the view. Any skeletal areas of concern or prior injury should be imaged. Abdominal ultrasound should be routinely performed, with rectal ultrasound or other advanced imaging scheduled when needed diagnostically.

Cardiac disease caused by myocardial fibrosis is a leading cause of death of orangutans (Lowenstine et al., 2008). A complete cardiac assessment is important in early detection and treatment of this disease, and should include echocardiography, EKG, and blood pressure measurement. Recording of these dynamic imaging procedures will be helpful for long-term monitoring. Echocardiography should be performed by an experienced echo technician using a machine capable of performing the appropriate measurements. The frequency of echo exams is based on the age and clinical status of the individual (Table 11). The Great Ape Heart Project (www.greatapeheartproject.org) maintains updated recommendations for cardiac evaluation as well as a network of specialists available for consultation. It is strongly encouraged that data obtained from cardiac evaluations of orangutans be submitted to the database maintained by the Great Ape Heart Project.

Table 11. Echocardiography recommendations for orangutans.

Age/Status	Frequency of Exam	Comments
Neonate	Once	During opportunistic neonatal exam to detect congenital defects
9 years	Once	Baseline exam
10–20 years	Every 3–5 years	
>20 years	Every 2–3 years	
Cardiac disease present	Case-based	As needed to monitor and guide treatment

Respiratory infections are a leading cause of morbidity and mortality in managed orangutans. In a survey of zoo clinicians, respiratory disease was identified as the top most serious health problem faced by managed orangutans. Many cases of chronic respiratory disease in orangutans can be subclinical and persist for years without any visible clinical signs. The high frequency of respiratory infections in orangutans makes diagnostic imaging of the sinuses, upper airways, air sacs, and lungs important for screening for this disorder. Sinuses and upper airways can be evaluated using CT imaging and radiographs. A Water's view position improves radiographic evaluation of sinuses in humans and is recommended for orangutans if CT imaging is not an option. The air sac can be evaluated using CT imaging, transdermal endoscopy, and ultrasonography. The lower airways can be evaluated using CT imaging, radiographs, and bronchoscopy. CT imaging has proven to be the most sensitive imaging modality for detecting changes throughout the respiratory tract, including those not readily visible on survey radiographs. Since early detection is key to managing respiratory disease, medical imaging of the respiratory tract is recommended at each routine examination.

Vaccination: An AZA Orangutan SSP-recommended immunization schedule is a common request to the AZA SSP veterinary advisors. Unfortunately, there is no “one-size-fits-all” schedule. Many variables factor into the decision of when to vaccinate an orangutan and against which diseases. These variables include:

- Accessibility to infants, juveniles and adults
- Tolerance of a dam to allow intervention with offspring
- Frequency of routine hands-on medical evaluations
- Infectious disease prevalence in the human population of the geographic area
- Philosophy of the veterinarian and animal managers

- Institutional commitment to training for infant and body part presentation and intramuscular injection
- The design of the exhibit and an evaluation of the exposure risk (i.e., can the public throw things to the orangutans?)
- The biosecurity protocols in place with the primate keeper staff (i.e., are staff all required to be vaccinated? Are staff required to not work with apes if the staff have an infection?)
- Cost of vaccines

Rather than following a blanket vaccination schedule, institutions are recommended to evaluate each of the above factors and create a vaccine schedule that is achievable and that is based on the diseases of greatest exposure risk to that institution's orangutans. Consultation with a local pediatrician and the local public health officials can assist in this process. For example, an institution does not have a training program. It has strong staff biosecurity protocols, but the exhibit is open air and the public regularly throws things to the animals. The local pediatrician tells you that there has not been a case of polio in your city in over 30 years, but there is a high incidence of *Haemophilus influenzae* in the elementary age population and the incidence of pertussis is on the increase. Given this set of variables, the institution may choose to vaccinate against infections that could be "thrown" to the orangutans on food/objects by the public, especially those diseases that are being seen regularly by local physicians and public health authorities. The institution could forgo vaccination against blood-borne pathogens as well as those diseases rarely seen in their geographic area. This is one example to demonstrate the thought process and decision tree.

It helps to begin the decision tree with a review of the recommended human vaccination schedule. Please refer to Table 12 below for the American Academy of Pediatrics recommended immunization schedule. This table and the AAP website (http://www2.aap.org/immunization/izschedule.html) are excellent references for immunization information. The website provides product and administration information, precautions, and a "catch-up" schedule for patients that have not received the full list of recommended vaccines. Human guidelines should be followed when considering questions such as immunization during pregnancy, adverse reactions, etc. Whenever possible, killed vaccination products should be utilized when vaccinating orangutans, rather than modified-live (MLV) products.

Vaccines that are strongly recommended for all orangutan collections include annual seasonal influenza, tetanus toxoid every 5–10 years, and *Haemophilus influenzae* Type B for youngsters. A one-time pneumococcus vaccine is also recommended. Immunization against rabies is not routinely done in humans, but should be considered in orangutans based on exposure risk in the exhibits.

Following the AAP immunization recommendations for all orangutan infants may not be practical or appropriate for each situation. Hand-reared infants present a special situation where the infant is readily accessible for frequent vaccination and has the highest risk of exposure to human diseases due to increased direct exposure to human caregivers. Following the complete AAP immunization recommendation should be considered in hand-rearing situations. The AZA Orangutan SSP does not recommend repeated chemical immobilization of the dam in order to gain access to an infant solely for vaccine administration unless there is an immediate threat of exposure. Institutions are encouraged to adopt training programs and facility modifications that permit access of animal care staff to infants and juveniles. Vaccination programs should be targeted to the collection's risk-analysis as described above.

Table 12. The recommended human immunization schedule* which may be adapted for use in some orangutans based on the individual risk assessment.

Immunization	Abbreviation	Dosing Schedule
Hepatitis B	Hep B	Birth; 1–2 mon; 6–18 mon
Rotavirus	RV	2 mon; 4 mon
Diphtheria, tetanus, pertussis	DTaP	2 mon; 4 mon; 6 mon; 15–18 mon; 4–6 yrs.; every 10 yr.
Haemophilus influenzae type b	Hib	2 mon; 4 mon; 12–15 mon
Pneumococcal	PCV	2 mon; 4 mon; 6 mon; 12–15 mon

Inactivated poliovirus	IPV	2 mon; 4 mon; 6–18 mon; 4–6 yrs.
Influenza	influenza	Annually
Measles, mumps, rubella	MMR	12–15 mon; 4–6 yrs.
Varicella	Varicella	12–15 mon; 4–6 yrs.
Hepatitis A	Hep A	12–24 mon; 2nd dose 6–18 mon later
Meningococcal	meningococcal	11–12 yrs.; 16 yrs.
Human papillomavirus	HPV	3-dose series, beginning at age 11–12 yrs.

* from the American Academy of Pediatrics 2014 Immunization schedule, www.aap.org

Parasite control: Routine monitoring for endoparasites by fecal flotation should be performed at least twice yearly to monitor seasonal variation. Evaluations should include concentration techniques (e.g. flotation, centrifugation, and/or sedimentation), direct fecal smears, and a Baerman's sedimentation for detection of *Strongyloides* spp. larvae. During quarantine periods, at least three fecal samples, taken at weekly intervals, should be evaluated. Based on these results, and the baseline history of the group and collection, specific antiparasitic treatment and management practices can be employed. Removal of fecal material from enclosures, regular replacement of naturalistic substrates, disinfection of impervious surfaces, and other husbandry practices can help reduce the environmental loads of parasites and assist with disease management. As orangutans can be prone to coprophagy, daily removal of fecal material is strongly recommended, and increased provision of environmental enrichment can assist with reduced completion of parasite life cycles. When treating with antiparasitic drugs, references for human infections are the preferred information source for treatment regimens. It is important to use effective doses, ensure complete compliance by selection of appropriate vehicles, and repeat the dose at appropriate intervals. Post-treatment monitoring is necessary to determine long-term treatment needs. Over-treatment or ineffective treatment regimens can contribute to persistent parasite infections and possible drug resistance. Note that complete elimination of endoparasites is often not the expected goal, but rather control of clinical signs and reduction of endoparasitic numbers.

Parasites commonly found in managed orangutans include *Balantidium coli*, *Strongyloides* spp., *Entamoeba coli*, *Giardia* spp., coccidia, and oxyurids. *Strongyloides* spp. are a leading cause of mortality of juvenile orangutans, but their significance is underappreciated by many zoo clinicians.

- The parasite exists in free-living and parasitic forms.
- The infectious larvae penetrate the skin, migrate through the lungs and other tissues, and then localize in the intestine.
- The massive damage and hemorrhage caused by migration through the lungs and other tissues may be rapidly fatal in young animals and there is no successful treatment.
- Detection of larvae in feces of affected juveniles is uncommon as clinical disease often precedes the presence of adult worms in the gastrointestinal tract.
- Elimination of enteric infections in adults will help to prevent disease in the younger animals.
- Regular fecal examinations using the Baerman's method and anthelminthic treatments are recommended especially for pregnant, lactating and infant animals (Swenson, 1999; McManamon et al., 2007).
- Prophylactic antiparasitic treatments targeting *Strongyloides* spp. should be strongly considered, particularly in breeding groups. The most common prophylactic treatment regimen reported is monthly ivermectin. However, other drugs and other dosing intervals have been used for this purpose, and the relative efficacy of the various strategies has not been investigated. Using a rotation of different classes of antiparasitic drugs should be considered in cases where parasite drug resistance is suspected or a concern.

Balantidium coli is a frequently encountered protozoal parasite in orangutans. Most often it is a nonpathogenic commensal organism, but it can cause significant diarrhea in some situations. The organism is capable of forming cysts that are resistant to temperature extremes and routine disinfection, making environmental decontamination challenging. For this reason, treatment of the animal will reduce parasite loads when needed. Complete elimination of the parasite is not a realistic goal. Paromomycin (Humatin®), tetracycline, doxycycline, metronidazole, and iodoquinol (Yodoxin®) have been used to treat balantidiasis.

Infections with protozoa such as *Giardia* spp. and *Entamoeba coli* can result in clinical disease. Flagellated protozoa such as trichomonads are often asymptomatic, but can occasionally result in clinical signs. When indicated, protozoal infections can be treated with metronidazole, nitazoxanide (Ailinia®), iodoquinol (Yodoxin®), or paromomycin (Humatin®). Combinations of antiprotozoal drugs may have better efficacy when treating clinical disease. While coccidia and oxyurids have been reported in orangutans, their clinical significance is not fully known.

Neonatal / maternal assessments: The initial neonatal – maternal health and bonding assessment is critical, especially if there are indicators that things are not going well. Infancy is a critical period for the social, physical and sexual development of orangutans and ideally all healthy infants should be left with their natural dam. Placement with a comparable ape surrogate for social rearing if maternal rejection/neglect occurs is also an option.

Factors that influence the success of this period include maternal and/or infant health, maternal experience, and group dynamics. If there are indicators of problems, veterinary and management teams need to consider whether or not to remove the infant. There is substantial variation in mothering styles. Most orangutan mothers will hold their infants in a ventro-ventral contact position for the first few months of life, although this may be variable. Do not assume because an infant is not carried in this way initially that something is wrong. Even in the case of primiparous mothers, care should be taken not to remove infants prematurely since many mothers will improve in their mothering skills within the first few days of the infant's life.

Unstable group dynamics may add to a new mother's stress levels and/or cause immediate danger to the infant by trauma from the group or unintentionally from the stressed mother. Assessments of group dynamics should be on-going throughout the pregnancy and periparturient period by experienced personnel who know the animals in that group. Reintroductions of a dam and infant to their social group (conspecifics) need to be carefully planned once their health status is stable. Integration back into a social group may add to a new mother's stress levels and/or cause immediate danger to the infant. Infants should begin to nurse within 4 to 6 hours after birth, but in some cases it has been observed to take up to 2 days. Some indicators of potential problems with the maternal/neonate bond and/or neonate are: inappropriate maternal behavior (e.g., not cleaning the amniotic sac from the infant's face); aggression towards infant; ignoring the infant; inappropriate holding / roughness; no nursing by 72 hours. Some females, especially first time mothers, will not experience adequate milk letdown until 24-72 hours postpartum. If there are no signs of lactation (enlarged breasts and nipples, nursing) by 72 hours, pharmacological stimulation of milk letdown can be attempted with oxytocin and / or metoclopramide. The placenta should also pass fairly soon (<1 hour) after the birth. Most apes will sever the umbilical cord and eat the placenta so close monitoring may be the only way to know that this has occurred.

At 48 to 72 hours after birth, if the infant has not been observed to do any nursing at all, then discussions should include whether to intercede and evaluate the animal. At any time prior to this, if the infant appears weak, dehydrated, unresponsive, or the mother starts ignoring the infant and leaving it, action should be more immediate. Newborn orangutans are fairly hardy when healthy but may deteriorate rapidly once compromised. The goal when pulling a compromised infant should be to stabilize the infant as quickly as possible. As long as maternal neglect and trauma are not the issue, the infant should be returned to the mother as soon as possible. At any time if neonates show signs of weakness, lethargy, diarrhea, or dull eyes, they may deteriorate rapidly and should be assessed quickly, usually requiring sedation of the dam to obtain access to the infant. Consultation with hand-rearing and surrogacy guides, as well as with species experts and human neonatal care experts, is always warranted in these situations.

If infants are being mother-reared in exhibits where there is little to no exposure to natural, unfiltered sunlight, they may be at an increased risk of developing metabolic bone disease (rickets). Cholecalciferol (vitamin D3) is necessary for the absorption of calcium and proper bone development. Of the primates that have been studied, breast milk does not contain sufficient concentrations of vitamin D.

Therefore, exposure to unfiltered sunlight during warmer months can be critical to infant development. If this cannot be done, careful evaluation and supplementation of the infant with vitamin D3 may be needed.

Neonatal examinations: Routine neonatal physical examinations should include screening for congenital defects, trauma, neonatal disease, malnutrition, or maternal neglect. The timing and frequency of non-emergent neonatal physical examinations varies widely between institutions. A risk analysis can be used to determine the recommended interval between birth and neonatal examinations. This assessment may consider factors such as mother's experience and health, group dynamics, environmental factors, staff experience, and collection health and institutional history. Most examinations of neonates will have to be done after light or deep sedation / anesthesia of the mother. This carries with it the risks of accidental drug exposure or trauma to the infant, as well as increased risk to the mother and the mother-infant bond, and should not be undertaken lightly.

Indicators for "non-routine" neonatal examinations include any health risk to the infant or mother. Reasons for infant illnesses and mortalities may include hypothermia, dehydration, gastrointestinal illnesses, parasitism, nutritional imbalances (vitamin D deficiencies), congenital defects, trauma, and hypoglycemia. Orangutan birth weights range from 1,420 grams (50 oz.) to 2,040 grams (72 oz.) with an average of 1,720 grams (61 oz.,). Ape neonates have minimal body fat at parturition and may appear thin. Hypoglycemia and hypothermia can cause rapid deterioration in neonates so thermal and caloric support are immediate needs.

Initial health assessments should include body temperature, weight, quick assessments tests (consisting of a blood glucose evaluation, packed cell volume, and total solids), a protein electrophoresis, a complete blood count, and serum biochemistry. Intravenous access can be achieved by catheterizing either the cephalic or saphenous veins. Nasogastric feeding tubes are very easy to place in infants and may be the best choice for feeding infants that have weak to no suckle reflexes. These tubes need to be securely taped to the face and head to prevent the infant from pulling them.

Zoonotic disease control: Apes are unique among zoo species in that they can share nearly all of their infectious diseases with people and vice versa. Proper training of staff, procedures for handling animals and samples, proper facility design, and proper PPE (personal protective equipment) can all help to reduce the risk of ape to human and human to ape zoonotic disease transmission. Primate handling guidelines should be clearly defined for each institution. Restricted access into primate areas can reduce disease transmission. Varying levels of PPE should be clearly defined for 1) entering a primate area, 2) entering a primate enclosure, 3) having direct contact with a primate, 4) handling primate laboratory samples, 5) handling primate food and enrichment, and 6) cleaning a primate area.

Zoonotic disease control is important for both orangutans and their caretakers. It is important to monitor orangutan health regularly through a preventive medicine schedule for the safety of the conspecifics and involved humans. Recommended guidelines on non-human primate handling, developed by the AZA Animal Health Committee (AHC) and the American Association of Zoo Veterinarians (AAZV) should be reviewed for institutional application. Vaccination prophylaxis for staff in accordance with Centers for Disease Control (CDC) guidelines should be considered at each institution.

Humans that are ill should not work directly with non-human primates, or prepare their diets. When this is not possible, personal protective equipment including facemask and barrier gloves should be worn. Frequent hand-washing and a focus on personal hygiene should be a top priority. For daily food management, Hazard Analysis Critical Control Points (HACCP) methods should be instituted in the central nutrition area and individual non-human primate kitchens. This includes handling, washing, storage, preparation, and provision of foodstuffs to the animals. Respiratory and gastrointestinal illnesses are some of the most common diseases of orangutans, and prudent measures to prevent transmission of such illnesses between staff and orangutans should be followed. A death of an orangutan from apparent human herpes simplex 1 has been reported (Kik et al., 2005), so orangutan care staff who are herpes simplex virus positive should be especially cautious to prevent transmission of the virus to the orangutans in their care. There are also documented cases of *Haemophilus influenzae*, parainfluenza 3, influenza A, metapneumovirus, and pneumococcal pneumonia infections in apes in zoological collections, some of them fatal. The risk of reverse zoonosis is real and the risk should be thoughtfully mitigated through exhibit design and good personnel practices.

Staff should be encouraged to work with an occupational health provider to monitor their own health, remain vaccinated, and fully understand the risks of working with non-human primates. Staff veterinarians can provide an information source to these physicians, particularly in times of increased human risk, such as illness or during pregnancy. Veterinary care of orangutans is similar to good medical care and preventive health of a human. Routine evaluation of staff should be included in the health assessment of these primates. Facilities housing orangutans should adhere to all federal, state and other regulatory agencies that define cleaning and decontamination procedures for the institution. Care should be taken to monitor the potential toxicity level of all cleaning materials and allow appropriate ventilation and/or drying times as necessary.

Although routine practices that prevent transmission of human pathogens from laboratory samples should be equally effective with primate pathogens, many labs will not accept primate diagnostic samples due to the zoonotic disease risk, so be sure to check with the lab before shipping samples.

Animals that are taken off zoo/aquarium grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution's healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5).

A tuberculin testing and surveillance program must be established for paid and unpaid animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test, to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species.

AZA Accreditation Standard

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

AZA Accreditation Standard

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate paid and unpaid staff in order to assure the health of both the paid and unpaid staff and the animals.

All personnel who work directly with apes or who handle biomaterials collected from apes should participate in institutional health programs such as annual staff vaccination against influenza and annual staff testing for tuberculosis (TB). Staff TB testing includes skin testing for non-vaccinated individuals and interview +/- chest radiographs for TB vaccinated individuals. Personnel with positive tuberculin reactions on the skin test should follow local public health protocols for follow-up assessment. Tuberculosis infections in people in the United States occur at a rate of 3.4 per 100,000 people and serve as a source of infection for apes in zoos.

Regular tuberculosis skin testing (TST) is recommended for all primates, including orangutans, at the time of the routine exam. A tuberculin syringe with 25–27 gauge needle is used to inject 0.1 ml of mammalian old tuberculin intradermally in an atraumatic manner. The most common injection site is the upper eyelid, although other sites such as the abdomen or forearm have been reported. The site should be observed for swelling and erythema 24, 48, and 72 hours post-injection. Any swelling should be considered a suspect reaction and be followed up with additional diagnostics. Orangutans have a high incidence of false-positive reactions to the TST. Ancillary TB diagnostics performed during the initial exam may be helpful in preventing a second immobilization for orangutans.

Comparative skin testing using PPD avium tuberculin followed by skin biopsies of the test areas at 72 hours has been described. However, interpretation of these results may still be subjective and challenging, as specific charts or guidelines are not available for primates as they are for bovids and cervids. Thoracic radiographs to evaluate the ape for thoracic lymphadenopathy, pulmonary granulomas, or pulmonary mineralization may aid in achieving a diagnosis. Acid fast staining, mycobacterial PCR, and mycobacterial culture can be performed on gastric or bronchoalveolar lavage samples to test for the presence of pathogenic *Mycobacterium* spp. as well as non-pathogenic *Mycobacterium* spp. that may be causing the false-positive TST. Gamma interferon testing (e.g. Primagam®) requires fresh heparinized whole blood that is less than 24 hours old. The test is similar to a comparative skin test in that the results are interpreted by comparing reactions to a positive control, a negative control, a *Mycobacterium tuberculosis*-complex antigen, and a *Mycobacterium avium*-complex antigen. TB ELISA testing (e.g., Prima-TB Stat Pak®) has not been validated in orangutans. Initial results indicate that the addition of the ELISA to the TST does not increase the sensitivity of TB screening. Since interpretation of the result is still a challenge, this test cannot be recommended for orangutans at this time.

When presented with a positive TST, a combination of several additional diagnostics should be employed to fully assess the animal. At this time, a thorough physical exam, CBC, thoracic radiographs, gastric or bronchoalveolar lavage cytology/PCR/culture, fecal cytology/PCR/culture, and gamma interferon testing are recommended. These tests may need to be repeated. Local and state regulatory agencies may require notification, and may help by providing guidance for further diagnostics and management. Federal regulatory agencies may require additional diagnostics or other measures when importing orangutans with a positive TST.

7.5 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing an animal for normal or emergency husbandry procedures may be required. All capture equipment must be in good working order and available to authorized and trained animal care staff at all times (AZA Accreditation Standard 2.3.1).

AZA Accreditation Standard

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

Manual restraint: Minor medical procedures (injection, tuberculin testing, and phlebotomy) may be accomplished in infant orangutans using manual restraint if they are habituated to humans or trained to accept such procedures. Adult orangutans may be restrained for hand-injection with the use of a mechanical squeeze cage, and also may be trained through operant conditioning in protected contact to present body parts for injection, phlebotomy, auscultation, palpation, ultrasound, blood pressure measurement, or tuberculin testing. However, in adult animals, chemical restraint administered via intramuscular injection through operant conditioning or by remote drug delivery systems is essential for more invasive procedures.

Behavioral restraint: The use of operant conditioning to allow the orangutan to willingly take part in certain types of exams, diagnostics, and other procedures is increasing in frequency. At many institutions, orangutans are trained to present various body parts, sit on a scale for weighing, and participate in other daily observations or management procedures. In addition, orangutans are commonly trained for intramuscular injection, throat sac manipulation, abdominal ultrasonography, nebulization, blood collections, cardiac ultrasonography, and blood pressure measurements. Achieving these training goals requires institutional commitment and at times facility modifications depending on the procedure that is trained.

Chemical immobilization/anesthesia: With proper planning, knowledge, equipment, and team communication, anesthesia in orangutans can be successfully and safely performed. Ideally the orangutan should be isolated from other animals prior to anesthetic induction. This can be a challenge with orangutans. Including shifting and isolation in the routine daily training program is recommended so that isolation is not always associated with a negative event. The orangutan should be fasted from food and water for at least 12 hours prior to anesthesia. If the fasting and social isolation are unsettling to the animal, anxiolytic agents such as diazepam or midazolam can be used for stress relief. Ideally the induction enclosure is heavily bedded, quiet, and is a place where the animal spends time during its normal daily routine. For individuals that are prone to fecal ingestion and/or regurgitation, pre-medication with metoclopramide and omeprazole will help empty the stomach and reduce gastric secretions prior to anesthetic induction.

There are multiple injectable anesthetics that may be utilized for induction of anesthesia in orangutans. Early recommendations included droperidol (1.0 mg/kg IM) combined with fentanyl (0.02 mg/kg IM), or phencyclidine (0.5–1.0 mg/kg IM), which is no longer available (Goltenboth, 1982; Wallach & Boever, 1983). A recent review of anesthetic regimens used successfully in great apes lists seven different drugs or combinations of drugs that may be used (Loomis, 2003). Most drug combinations utilize either ketamine hydrochloride (either alone or combined with a tranquilizer) and/or tiletamine-zolazepam (Telazol®). Ketamine combined with tiletamine-zolazepam has also been used successfully at multiple institutions. Ketamine can also be combined with benzodiazepines (diazepam, midazolam), acepromazine, or alpha-2 agonists (medetomidine, dexmedetomidine). Advantages of alpha-2 agonists are a reduction of the ketamine dose, reversibility, and a more rapid recovery. Disadvantages of alpha-2 agonists in great apes include spontaneous arousals, which cause significant safety risks for the animal and staff, and cardiovascular effects that include peripheral vasoconstriction, increased vascular resistance, and bradycardia. Due to the cardiovascular effects of the alpha-2 drugs, they should be avoided in animals with known or suspected cardiac disease or in patients for which a cardiac evaluation is being performed. Note that the concurrent use of alpha-2 agonists with anticholinergic drugs such as atropine and glycopyrrolate is contraindicated due to the significant hypertension and cardiac load that results.

Table 13. Anesthesia protocols used in managed orangutans.

Drug	Induction Method	Dose	Notes
Telazol	IM	3–5 mg/kg	Expect induction within 5–8 minutes
Telazol/ ketamine	IM	2–4 mg/kg 1–5 mg/kg	Reliable, smooth inductions; stable cardio pulmonary function; good muscle relaxation
Ketamine alone	IM	8–12 mg/kg	Causes significant hypertension; not recommended as the sole induction agent.
Ketamine/ midazolam	IM +/- oral	5–10 mg/kg 0.1-0.2 mg/kg	Requires high doses of both drugs; duration will be shorter than with Telazol; the midazolam can be given orally ahead of time to reduce the anxiety of the procedure.
Ketamine/ medetomidine	IM	3–7 mg/kg 30–40 µg/kg	Unreliable depth of anesthesia. Spontaneous arousal can occur, resulting in risk to both the animal and the staff. Will cause cardio-pulmonary depression. This drug combination at published doses (30–50 µg/kg med) is commonly used, but is not recommended by the authors.
Ketamine/ midazolam/ medetomidine	IM	5–8 mg/kg 0.1–0.2 mg/kg 10–15 µg/kg	Better than straight Ketamine/medetomidine or ketamine/midazolam. The three-way combination with the low dose of alpha-2 can smooth out the first hour of the anesthesia. Expect bradycardia and bradypnea.

Table 14. Anesthetic maintenance protocols used in managed orangutans.

Drug	Maintenance Method	Dose	Notes
Isoflurane or sevoflurane	ET tube	To effect, 0.5–2.5%.	Both inhalants can cause a dose-dependent hypotension. Doses that provide adequate blood pressure typically do not provide adequate sedation. It can be a struggle to find the perfect balance. The hypotension can be managed with pressor agents such as ephedrine or dopamine. Or other maintenance drugs in addition to the inhalant can be used for supplementation if the depth of anesthesia is not adequate (e.g., ketamine, propofol or fentanyl)
Propofol	IV	To effect, 25–100 µg/kg/*min*	Provides smooth maintenance, especially when used in combination with low levels of inhalant. Can be bolused as needed if the animal becomes roused. Requires experience using syringe infusion pumps. Monitor blood pressure.
Fentanyl	IV	1–3 µg/kg/*hr*	Provides smooth maintenance, especially when used in combination with low levels of inhalant. A small amount of ketamine can be added to the fentanyl infusion to further reduce the need for inhalants. Requires experience using syringe infusion pumps. Monitor blood pressure.

Attention to careful positioning and maintaining an open airway is essential. Some individual orangutans (especially obese animals and some adult males) have anatomic challenges that complicate intubation. In these individuals, the flaccid soft palate and walls of the pharynx can occlude the laryngeal opening during inspiration, and adult male orangutans are especially at risk from asphyxia (Jones, 1982). An elongated soft palate and/or epiglottis, mobile larynx, excessive salivation, and a propensity for laryngospasm under ketamine anesthesia alone can make intubation difficult (Wells et al., 1990).

For longer diagnostic or surgical procedures or for individuals with respiratory disease, intubation is highly recommended. If initial injectable anesthesia is inadequate for intubation, mask induction with gas anesthetic or supplemental injectable anesthetic (e.g., ketamine, propofol) can be utilized to achieve adequate anesthesia for intubation. Ideal positioning and technique can minimize these challenges and facilitate successful intubation. The orangutan can be placed in lateral or dorsal recumbency. The head and neck should be fully extended dorsally, which may require the head to be suspended off the end of the exam table if in dorsal recumbency. The tongue should be extended and depressed using a long straight or curved laryngoscope blade to visualize the glottis. Laryngospasm may be prevented by spraying the vocal folds with 2% lidocaine or Cetacaine® spray, by administering intravenous lidocaine (0.5 mg/kg) as a bolus just prior to intubation/extubation, or by nebulizing with lidocaine. The endotracheal tube can then be inserted into the trachea. The trachea of the orangutan is surprisingly short for such a large animal, and care should be taken to avoid inserting the endotracheal tube too deeply and intubating a main-stem bronchus. Auscultation of all lung fields using positive pressure ventilation and/or thoracic radiographs should be used to confirm tube placement. If pulse oximetry readings are low during gas anesthesia in an intubated animal, the first thing to check is that the endotracheal tube is not in too far. Often, withdrawal of the endotracheal tube by a few centimeters is enough to return the blood oxygen saturation to normal.

Other rare cases of airway-related complications have been described, including spontaneous laryngospasm in unanesthetized youngsters under psychological stress, such as when the mother is being immobilized. Intravenous diazepam administration was effective in reversing the situation in these cases. Incidents of acute respiratory distress syndrome (ARDS) and pulmonary edema in orangutans have been described (Kenny et al., 2003). This syndrome is a complication occasionally seen in humans, particularly in those who experience temporary airway obstruction.

The most commonly used anesthetic maintenance agents are inhaled gases (e.g., isoflurane, sevoflurane, desflurane). Inhaled gases provide safe and reliable maintenance, though they can cause hypotension, which needs to be controlled. The goal is to find a level of inhaled gases that maintains adequate anesthetic depth without unacceptable hypotension. If hypotension occurs, it is readily managed with infusions of pressor agents such as ephedrine or dopamine. Another option is to add a second injectable maintenance drug to the protocol so the inhaled gas can be reduced. Infusion of propofol at a low rate intravenously can allow a significant reduction of the inhaled gas. Fentanyl alone or combined with a very low dosage of ketamine can be used in a similar way. Such constant rate infusions are preferred over higher levels of inhalants or frequent boluses of induction drugs. Using an inhalant/infusion combination results in smoother maintenance and more rapid, predictable recoveries.

Monitoring physiologic parameters during anesthesia is essential to successful outcomes. At a minimum, heart rate, respiratory rate and depth, and body temperature should be monitored on every anesthetized orangutan. If equipment is available, it is highly advisable to monitor oxygen saturation via pulse oximetry, blood pressure via a non-invasive cuff, and end-tidal CO_2 via capnography and serial blood gas monitoring. Placement of an intravenous catheter and maintenance rates of a multiple-electrolyte fluid for the duration of the procedure should be standard practice. This provides a port of access in an emergency, and it controls hydration and blood pressure throughout a procedure.

Apes should be recovered in an area with soft bedding to protect them from injury if they climb and fall before they are fully awake. They can be placed in lateral recumbency or in a partial sitting position. Once the patient is properly positioned, all maintenance drugs can be turned off and any reversal drugs given. Continue monitoring heart rate and respirations as long as possible.

Great apes show individual variation in their propensity to laryngospasm following extubation. Several preventive measures can be taken to reduce the chance of this potentially life-threatening complication:

- Lidocaine (0.5 mg/kg IV) for an adult orangutan, a few minutes prior to extubation

- Lidocaine, 2 ml infused into the endotracheal tube prior to extubation
- Propofol, 20 mg (2 ml of 1%) IV for an adult, a few minutes prior to extubation
- Extubating early in recovery. Most veterinarians extubate when the patient is coughing/fighting the endotracheal tube to ensure the patient can swallow any regurgitated material. However, this is quite stimulating to the cords and predisposes to spasm and regurgitation. In human anesthesiology it is common to extubate the patient when there is no laryngeal reaction to the stimulation of removing the tube. For the apes, this should be done with the patient in lateral recumbency to assist with the control of any regurgitated material.

With proper planning and equipment, anesthesia risks in orangutans can be anticipated and greatly reduced. Techniques for reducing risk include:

- Weight control, to reduce obesity and consequent obstruction by the soft palate and pharyngeal walls.
- Fasting from food and water at least 12 hours prior to the immobilization.
- The use of anesthetic protocols that provide good muscle relaxation, reduce laryngospasm, and provide good cardiovascular support.
- Placement of the animal immediately into lateral recumbency, to maintain potential air sac exudates below the level of the ostia and to minimize the risk of aspiration in case of regurgitation.
- Intubation using a cuffed tube to control airway and ventilation.
- Maintenance of non-intubated animals in lateral recumbency if intubation is not an option.
- Having a laryngoscope, endotracheal tubes, suction apparatus, and oxygen close by during induction.
- IV lidocaine (0.5 mg/kg) or topical lidocaine just before intubation and extubation to reduce the potential of laryngospasm.
- Having a stylet or tube exchanger available in the endotracheal tube to facilitate placement; being prepared to try alternative positions and other methods to extend the neck for intubation.
- Having emergency and reversal drugs pre-calculated and readily available throughout the procedure.
- Institutional investment in anesthesia tools and physiologic monitoring equipment.

7.6 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that manages animal diseases, disorders, or injuries and has the ability to isolate these animals in a hospital setting for treatment if necessary. The owner of an animal on loan at a facility is to be consulted prior to any elective invasive procedures, including permanent contraception.

Orangutan care staff should be trained in meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques. Staff should also be trained to assess animal welfare and recognize behavioral indicators animals may display if their health becomes compromised, however, animal care staff should not diagnose illnesses nor prescribe treatment (AZA Accreditation Standard 2.1.3). Protocols should be established for reporting these observations to the veterinary department. Hospital facilities for orangutan must have x-ray equipment or access to x-ray services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short and long term medical treatments and control for zoonotic disease transmission.

AZA Accreditation Standard

(2.1.3) Paid and unpaid animal care staff should be trained to assess welfare and recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, animal care staff (paid and unpaid) must not diagnose illnesses nor prescribe treatment.

AZA Accreditation Standard

(2.3.2) Institution facilities must have radiographic equipment or have access to radiographic services.

Traumatic injuries: Traumatic wounds are an occasional result of accidents, normal social interactions, or hierarchy disputes or introductions of new animals. Bite wounds are relatively uncommon in orangutans compared with chimpanzees or gorillas, but the same principles of wound management apply to all species. In most cases, wounds are superficial and even full-thickness skin wounds that have exposed subcutis or muscle can be managed through topical wound care and allowed to heal naturally. Indeed, surgical closure is only necessary for the most serious wounds, where serious mechanical damage may need surgical attention or where a significant cosmetic defect may result from healing by second or tertiary intention. If skin sutures are used, orangutans exhibit a high propensity for picking at them and causing wound dehiscence. Whether closed surgically or allowed to heal as an open wound, thorough lavage of a wound is helpful. Operant conditioning will usually allow presentation of body parts for wound inspection and cleaning.

Social dynamic issues that may result in traumatic injuries from conspecific aggression can be challenging to manage. Consultation with AZA SSP representatives is highly recommended to evaluate all possible behavioral modification options available. Although chemical behavior modification has been attempted in apes to relieve social stress and decrease trauma, the use of pharmacologic management of behavior problems should be a last resort.

Respiratory disease: Respiratory tract disease is a commonly reported clinical syndrome in orangutans. The syndrome is characterized by recurrent infections of the upper and lower respiratory tract including sinuses, the laryngeal (submandibular) air sac, and/or lungs. A mix of opportunistic bacteria may be cultured, including enteric Gram negative rods, Gram positive cocci, and *Pseudomonas aeruginosa*. The syndrome may present as acute/subacute illness (pneumonia, obvious air sac distension) or chronic disease (rhinitis, bronchitis, dermatitis). The exact etiology of the syndrome is poorly understood and specific risk factors have not been identified. Consultation with a pulmonologist and/or infectious disease specialist is highly recommended. Consultants with experience treating cystic fibrosis patients are especially helpful due to the parallels with this disease and chronic respiratory disease in orangutans.

Clinical signs: The acute/subacute form may include lethargy, anorexia, moist cough, laryngeal air sac swelling, and pyrexia. There is usually a history of intermittent nasal discharge. The chronic form usually presents with either a history of recurring nasal discharge and upper airway congestion (rhinitis) with minimal signs of illness otherwise, or an intermittent cough that may have previously responded to antibiotics but recurs following treatment. Less obvious signs include halitosis, chronic dermatitis along the ventral neck and axilla that is exacerbated by self-picking (may improve temporarily with parenteral or topical antibiotic therapy), and intermittent diarrhea (Fox, 2012).

Anesthetic considerations: If the laryngeal air sac contains “fluid” secretions (more likely with the acute form), the orangutan is at risk for aspiration of the fluid via the ostia that connect the air sacs to the trachea. This risk increases with anesthesia and recumbency. Be prepared to suction, drain the air sac, and/or maintain upright positioning until intubation. Laryngospasm/tracheal sensitivity from chronic cough can be dealt with by using topical or intravenous lidocaine (0.5 mg/kg) to facilitate intubation. Delayed anesthetic recovery following isoflurane may occur due to airway disease and decreased clearance of the inhalant anesthetic.

General diagnostics include physical examination, computed tomography (of sinuses, air sac, and lungs), radiographs, complete blood count, serum chemistry analysis, bronchoscopy, bronchoalveolar lavage for cytology and culture, air sac examination (via aspirate, endoscopy, or exploratory surgery), and biopsy. Bronchoscopy of all “normal” orangutans should be considered as it may reveal subclinical airway disease in an individual. CT imaging is highly recommended as it is a more sensitive imaging modality for evaluation of the respiratory system and can provide a more accurate assessment compared to survey radiographs.

Physical exam findings: For the acute/subacute form, the following abnormalities may be present: mucoid upper airway congestion; moist rales on auscultation, possibly with tachypnea; pyrexia; dehydration; palpable “fluid” in the laryngeal air sac. For the chronic form, the following abnormalities may be present: mucoid upper airway congestion; inflamed larynx/arytenoids if a chronic cough is present;

often auscultation is normal; superficial ulcerative dermatitis in a “ring” around the neck skin overlying the air sac; palpable “pasty material” in the laryngeal air sac.

<u>CT and radiographic findings:</u> The acute/subacute form may be characterized by a bronchial to alveolar pattern (bronchitis, pneumonia). A fluid line may be seen in the air sacs. Cardiac size/shape is usually normal. The chronic form may be characterized by mild to severe bronchial pattern with areas of bronchiectasis and possibly abscessation and/or consolidation. Right ventricular hypertrophy secondary to pulmonary hypertension may be seen. Fluid accumulation in the sinuses or thickened irregular mucosa may be seen in cases that include sinusitis.

<u>Bloodwork:</u> For all forms of the disease, bloodwork findings can be highly variable. Leukocytosis and hyperfibrinogenemia may be present.

<u>Bronchoscopy:</u> For all cases, an obvious accumulation of mucopurulent material is usually present throughout the airways. If a cough has been present, the mucosal surface of the arytenoids, larynx, and proximal trachea may appear inflamed.

<u>Bronchoalveolar lavage:</u> For all cases, cytology and aerobic culture typically reveal neutrophilic inflammation associated with numerous bacteria including *Pseudomonas aeruginosa*, miscellaneous Gram negative enteric rods (e.g., *Klebsiella* spp.), and/or Gram positive cocci (e.g., *Staphylococcus* spp., Beta-hemolytic *Streptococcus* spp.).

<u>Air sac examination and biopsy:</u> Aspiration of air sac fluid using a 14 gauge needle is an option, but if thicker material is present, it is far simpler to make a stab incision into the air sac and proceed with endoscopy or exploration using a larger incision, which may be ultimately necessary for ostia closure surgery or marsupialization. It is best to explore the entire laryngeal air sac including its lateral extensions into the axillae. For acute/subacute cases, the skin over the air sac typically appears normal and the cavity itself consists of one or two compartments lined by normal-appearing mucosa but filled with a tan-green fluid. This discharge has cytology and culture characteristics similar to that collected via bronchoalveolar lavage. On biopsy, the air sac mucosa is usually intact and consists of hyperplastic epithelial cells with abundant goblet forms and ciliated superficial epithelium. Neutrophils and mononuclear cells are found transmigrating the epithelial layers and infiltrating the subepithelial connective tissue. For chronic cases, there is typically hyperkeratosis and superficial ulceration of the overlying skin. The air sac cavity consists of multiple compartments divided by fibrous bands of scar tissue and is filled with a pasty thick secretion. Cytologically, there is amorphous, proteinaceous material containing cocci and bacilli with a flora similar to that of the lavage. Biopsy often reveals ulceration of the epithelium with loss of cilia and fewer goblet cells. Mononuclear cells predominate with some transmigrating and a lymphoplasmacytic infiltrate in the subepithelial layer (Joe Smith, DVM personal communication 2016).

Treatment:
<u>Acute/subacute cases:</u> Fluids should be given as needed to correct dehydration, acid/base, and electrolyte abnormalities. Parenteral antibiotics should be given under anesthesia and continued orally for a minimum of two weeks. Pending culture sensitivities, fluoroquinolones (e.g., levofloxacin, ciprofloxacin, enrofloxacin) are often a good choice as they are usually effective against *Pseudomonas* spp. Antibiotic choice should be adjusted as needed based on culture and sensitivity results. Long term antibiotics have been used, but nebulization as “maintenance” therapy may be more effective (see below). Both ostia may be closed surgically to prevent future aspiration of air sac contents. It is advised to use a double layer closure with a purse-string suture and scarification to encourage scarring. The air sac should be marsupialized to allow drainage of air sac exudate. Marsupialization can be performed by making a large vertical or inverted-T incision in the gravity-dependent area of the air sac. Stainless steel sutures may be considered to deter picking. Topical antibiotic administration via nebulization is recommended with acute cases. Tobramycin (inhaled formulation, not injectable) or gentamicin (100 mg/ml large animal preparation) at 5 mg/kg twice a day given via nebulization for one month have been used successfully. "Maintenance therapy” with one week of nebulization per month or as symptoms recur has also been used successfully in some cases. Oral antibiotic "maintenance therapy" has also been used in some

cases where the infection is concentrated in more vascular areas of the respiratory tract (e.g., sinuses, lungs) (Joe Smith personal communication 2016).

Chronic cases: The ostia may be closed and the air sac marsupialized as above. Begin with a two-week course of nebulization therapy followed by "maintenance" therapy. If the marsupialization site in the air sac closes (which is more likely with chronic skin infections and ulceration of the air sac lining), consider removal of the air sac entirely. Mucolytic agents and antihistamines are generally not recommended as they are likely to dry the secretions and promote airway plugging. For chronic cases where significant lung pathology and bronchiectasis are present, daily nebulized bronchodilators (e.g., albuterol, arformoterol, formoterol) have been used to relieve some of the clinical signs.

Prognosis: The prognosis for respiratory disease syndrome in orangutans is generally fair to poor for long term survival, especially if it occurs in a young animal. At best, antibiotic therapy suppresses the bacterial infections and the eventual result will include bronchiectasis, pulmonary hypertension, and recurring pneumonia.

Heart disease: Heart disease is one of the most common causes of mortality in all great ape species, and orangutans are no exception. In orangutans, fibrosing cardiomyopathy is the most common presentation of cardiovascular disease, and may be subclinical until the animal presents with sudden death or unexpected anesthesia complications. The causative etiology and predisposing risk factors are poorly understood at this time. When heart disease is detected antemortem, treatment for fibrosing cardiomyopathy in apes generally starts with an angiotensin-converting enzyme (ACE) inhibitor and a beta-adrenergic blocker.

Routine screening through echocardiography is strongly recommended following the frequencies outlined in Table 11. Other diagnostics (e.g., EKG, radiographs, serum biomarkers, etc.) may be utilized, but are not as sensitive as echocardiography in detecting changes in the hearts of orangutans. Anesthetic drugs can significantly alter cardiac function and should be taken into consideration when interpreting echocardiograms obtained from anesthetized orangutans. Alpha-2 agonists have a significant effect on cardiac output and should not be used as part of the anesthetic protocol when heart disease is suspected or when wanting to obtain a meaningful echocardiogram. Echocardiograms obtained on conscious orangutans through operant conditioning are not affected by anesthetic drugs, but the quality of the views and measurements are sometimes inferior to those obtained on the anesthetized orangutan. However, conscious echocardiograms are still very useful for confirming data obtained from anesthetized echocardiograms and for more frequent monitoring of suspected or confirmed cases of heart disease.

The Great Ape Heart Project (GAHP; www.greatapeheartproject.org) has been formed to research causes, diagnostics, and treatments for heart disease in great apes. Institutions are encouraged to submit exam data to the project for inclusion in a larger database, so that this disease can be better understood. If echocardiograms are being obtained on conscious orangutans, the GAHP requests that data be sent every 6 to 9 months. Veterinarians and cardiologists working with the GAHP are available to consult on cases of suspected heart disease to help better interpret diagnostic results and determine the most appropriate treatment options.

Reproductive / pregnancy disorders: Reproductive disorders occur in orangutans, but no specific trends or specific disorders of concern have been identified. Many of the same reproductive disorders identified in orangutans are those described in humans and other apes. In a 2012 survey of AZA-accredited institutions with orangutans, a wide range of disorders were reported from the 45 responding institutions (see Table 14).

Table 14. Reproductive tract disorders reported by AZA-accredited institutions over a 10 year period. "Other reproductive diseases" include a peri-ovarian abscess, irregular menses, reproductive-related aggression, and a cervical cyst (Orangutan SSP Health Survey, 2012).

Reproductive Tract Disease	# of Institutions	% of Institutions
Dysmenorrhea	5	11.1%
Endometriosis	4	8.9%
Uterine Leiomyoma	3	6.7%

Infertility	2	4.4%
Menopause	2	4.4%
Vaginitis	2	4.4%
Endometritis	2	4.4%
Mammary Neoplasia	1	2.2%
Ovarian Cyst	1	2.2%
Uterine Cyst	1	2.2%
Uterine Neoplasia	1	2.2%
Benign Prostatic Hypertrophy	0	0.0%
Cervical Neoplasia	0	0.0%
Mastitis	0	0.0%
Ovarian Neoplasia	0	0.0%
Prostatic Neoplasia	0	0.0%
Prostatitis	0	0.0%
Testicular Infection	0	0.0%
Testicular Neoplasia	0	0.0%
Other Reproductive Diseases	4	8.9%

Problems during pregnancy are not common for orangutans, but they do occur. Potential problems include those that would affect humans or other primates. Some examples are included in Table 15. As in humans, gestational issues may be linked to concurrent health issues such as diabetes, obesity, and hypothyroidism. Uterine, ovarian, and testicular neoplasia may also affect great apes, especially older animals. In cases of severe endometriosis and uterine neoplasia, consultation with human oncological reproductive surgeons may be warranted before attempting surgical removal.

Using operant conditioning to obtain routine uterine ultrasonography during pregnancy can help to detect potential problems early. Measurements of the growing fetus such as crown rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and humerus length (HL) can be obtained to help determine fetal age and ensure that growth of the fetus is following expected trends. While orangutan-specific fetal growth curves are not currently available, work is being done to standardize measurements into a central database to aid with average growth curves for future use.

Table 15. Potential Complications of Pregnancy

Clinical Signs	Possible Complication	Diagnosis	Treatment
Bloody vaginal discharge (esp. large amounts late in gestation)	Placenta previa or placental abruption	Ultrasound, physical exam	Monitor closely, may need emergency C-section
Bloody vaginal discharge early in pregnancy	Miscarriage or normal menses (never pregnant)	Examine shed tissue/blood for evidence of fetal tissue	If miscarriage suspected-examine female for possible causes
Signs of labor that last more than 6 hours	Dystocia, maternal exhaustion	Observation, timing between contractions, signs of distress	Oxytocin, calcium, supportive care, +/- C-section
Sudden, intense pain and / or intense contractions. Decrease in amniotic fluid	Placental abruption	Physical exam, ultrasound	Emergency C-section, maternal support, possible blood transfusions
Thick, creamy, odiferous, or discolored vaginal discharge	Uterine infection	Physical exam, ultrasound	Supportive care, antibiotics, surgical intervention and tx
Lethargy or anorexia that lasts for more than 6 hours, missing a meal	Pregnancy Toxemia	Physical exam, urinalysis, blood pressure, blood work	Supportive care, +/- C-section

Caesarian sections (C-sections) may need to be performed in cases of dystocia, prolonged parturition, or for pregnancies in females that have undergone previous C-sections. When performing the surgery, the incision into the uterus is important as it determines the risk of rupture during parturition of subsequent pregnancies. In humans, a low transverse incision into the caudal uterus just under the urinary bladder is associated with the lowest risk of future uterine rupture. However, it is not known whether the anatomical differences in orangutans (i.e., deep pelvic canal with more caudal uterine position) would allow such an incision to be possible. Previous C-sections in orangutans have not employed a low transverse incision to date. For individuals that have had previous C-sections using a uterine incision other than a low transverse incision, it is recommended that all subsequent pregnancies be delivered via a scheduled C-section as well, to avoid the risk of uterine rupture. This requires very close monitoring of estrous cycles and accurate calculation of due dates so that the surgery can be performed at the appropriate time. Of the four C-sections reported to date, no complications with the dam have been reported with the surgery. All four babies delivered via C-section were successfully reintroduced to the dam, one at 12 days, one at 15 days, one at 10 weeks, and one at 8 months (Joe Smith, DVM personal communication 2016).

Menopause has not been definitively documented in orangutans, although several individuals are suspected to have undergone menopause. Menopause is defined in human medicine as 12 consecutive months of acyclicity. There is also the inference that this acyclicity is not the result of pathology or contraception, but is instead the result of normal reproductive tract senescence. Several problems exist with being able to properly document menopause in orangutans: 1) Tracking estrous cycles can be more challenging in orangutans compared with other species. Fecal hormone analysis is one proven method that works well. Using Hemastix® on urine to test for the presence of blood is another, less specific option; 2) It would have to be demonstrated that the individual was cycling normally, and then stopped cycling for 12 consecutive months using a method above; 3) The female would have to not be under the influence of contraceptives, as even the long-term effects of contraceptives long after discontinuation of their use might call into question whether an individual's acyclicity is a true menopause; 4) The reproductive tract would have to be shown to be free from pathology (which would generally be done at necropsy) (Joe Smith, DVM personal communication 2016).

Medical management of hand-reared infants: Consultation with hand-rearing and surrogacy experts from the ape management group is warranted whenever an orangutan infant needs to be taken from its dam for any period of time. If an infant should be separated from its natural mother and hand-reared until re-introduction or placement with an appropriate ape surrogate, it is important to try to simulate age-appropriate mother-rearing at all times. Maintaining maternal lactation during maternal-infant separation can be difficult, especially if the separation time frame is extensive or the mother has health issues. Some institutions have used fenugreek teas, herbal nursing remedies, and/or oxytocin and metoclopramide for this purpose. Results have been inconsistent on whether these methods work for long-term lactation stimulation. Keepers should monitor the mother for the potential side effects of these medications and remedies, such as anxiety, agitation, depression, and gastrointestinal upsets. Some apes can also be trained to allow the infant to nurse through the cage mesh. Breast pumps and manual stimulation of milk letdown by keepers can also be attempted but may not be sufficient enough to maintain lactation over a long-term time frame and may be dangerous for the staff.

Surrogacy rearing has proven very effective in orangutans in recent years. This is the ideal alternative to mother-rearing. However, if medical or other conditions mandate hand-rearing, then the infant should be raised with 24 hour a day, 7 day per week care staff. Ideally the infant "nursery" should be set up in very close proximity to the maternal/surrogate's group, with visual, auditory and olfactory stimulation for the infant. If this is not possible, frequent infant-mother/surrogate visitations should occur. These can be with or without tactile contact, depending on the situation and risk of injury to the infant and human caretaker. Some institutions have modified caging so that an infant "access" portal can be used for this tactile contact in as safe a manner as possible.

Neonates requiring nursery care or treatment are very susceptible to hypothermia and need to be kept warm, either in incubators or by being held close to the body (24-hour body contact is strongly recommended), until they can maintain their own body temperature. An orangutan mother rarely will set her infant down and human caretakers should mimic this behavior as closely as possible, as long as the infant is healthy enough to do so. It is also critical to protect the infant, who may already be immunocompromised, from zoonotic disease risks. Serious, even fatal, respiratory illness may occur in hand-reared infants with prolonged close human contact, so the use of proper personal protective

Figure 2. Infant with nasogastric feeding tube.

equipment (face masks, gloves and clean clothes) and good health of the human caregivers cannot be overemphasized. Minimizing the number of people who have close contact with the infant can also minimize the risk of serious zoonotic infections for the infant. Human caregivers should have current influenza, pneumococcus, tetanus, haemophilus, hepatitis B and varicella vaccines and have a negative TB status confirmed within the past year, and should use face masks and gloves at all times when in contact with the infant. If the caregivers develop any signs of illness, or are near other humans (especially human infants and young children) that are ill, they should refrain from working with the orangutan infant until all signs of illness are resolved (Joe Smith, DVM personal communication 2016).

Medical management of compromised neonates: The most common illnesses associated with orangutan neonates are hypothermia, hypoglycemia, dehydration, electrolyte imbalance, enterocolitis, respiratory disease, urological disturbances, and sepsis. Critically ill infants may need to be removed from maternal care for extensive periods of time and may need intensive care. If these infants are too sick to be held by human caretakers, then incubators can be used. When infants are not being held, a surrogate "ape mother" in the form of a plush animal or other soft material should be used for psychological comfort if possible. Make sure that the surrogate has high quality "hair" in order to avoid ingestion by the infant and the potential for subsequent impactions. Human and orangutan neonates share many similarities, so consultation between veterinary specialists and human neonatologists, pediatric nutritionists, and neonatal intensive care nurses may be valuable when dealing with sick neonates. Intravenous catheters, umbilical catheters, nasogastric feeding tubes, nasal oxygen delivery systems, and other specialized interventional medical equipment made for human infants may be ideal for use in these infants.

Figure 3. Haberman feeding system® (sold as SpecialNeeds® feeder).

Bottle-feeding compromised neonates can be especially difficult and the risk of aspiration can be significant. Nasogastric feeding tubes are easy to place and may be very beneficial for nutritional support until the infant is stabilized enough to suckle (Figure 2). Once neonates are ready to transition to a bottle, using a Haberman feeding system® (sold as SpecialNeeds® feeder; Medela, Inc. Breastfeeding U.S., 1101 Corporate Drive, McHenry, IL, USA 60050), which is designed as a feeder for infants that are having difficulty sucking on a nipple or swallowing formula correctly, is advantageous (Figure 3). The feeder's design enables the feeder to be activated by the tongue and gingival pressure, imitating the mechanics involved in breastfeeding, rather than by sucking. A one-way valve separates the nipple from the bottle. Milk cannot flow back into the bottle and is replenished continuously as the neonate feeds. A slit valve opening near the tip of the nipple shuts between jaw compressions, preventing formula from flowing too quickly.

Medical management of geriatrics: With the increased medical concerns of geriatric animals, maintaining a schedule of routine physical examinations is of continued and possibly increased importance even when the increased anesthetic risk is considered. For example, cardiovascular diseases are a significant cause of morbidity and mortality in managed great apes (Loomis, 2003) and routine examination of the heart becomes increasingly important in the geriatric animal.

Degenerative arthritis, particularly involving the knee joints, is commonly seen in orangutan necropsies and older, obese males show a higher incidence (McManamon et al., 2007). With the stoic, energy-conserving nature of many orangutans, many cases of arthritis are likely to be missed and careful examination of the joints should be part of all routine examinations. Affected orangutans have been managed using NSAIDs (non-steroidal anti-inflammatory drugs) or glucosamine supplements at several institutions. Enclosure furniture and design may need to be altered to accommodate older and arthritic animals. In all ages, maintenance of a healthy body weight and regular exercise should be encouraged. Signs of pain that may be present in orangutans with osteoarthritis include:

- Could be NONE!
- Decrease in appetite
- Decrease in activity
- Changes in behavior
- Holding/pointing to painful area
- Sensitive to touch
- Lameness/decreased use of limb
- Radiographic changes (may not correlate well with pain)
- If the clinical situation would cause pain in a person, assume it also causes pain in primates

Treatment options for controlling pain that may be caused by osteoarthritis in orangutans:

- Opioids (primates are sensitive)
- Steroids (consider side effects)
- Non-steroidal anti-inflammatory drugs (NSAIDs)
- Tramadol
- Gabapentin/pregabalin (for neuropathic pain)
- Nutraceuticals
- Physical therapy/exercise
- Environmental modifications
- Acupuncture
- Laser therapy

Therapeutic agents: The similar size and physiology of great apes and humans makes human formularies and medical texts excellent resources for dosage recommendations for orangutans and other apes. In the United States, because no medications are specifically approved for use in orangutans, all veterinary or human pharmaceuticals are therefore prescribed for them in an "extra label" fashion. Veterinarians in the United States may legally utilize any human or animal drug that is FDA-approved for use in animals or humans, although these medications have not been formally evaluated for scientific evidence of safety or efficacy in exotic animals.

Hereditary diseases: A complete listing of the hereditary disorders of the orangutan has not been compiled. However, it is likely that this species is susceptible to many of the known inheritable disorders found in other great apes and humans. These should be investigated, and appropriate literature and veterinary and human medical specialists consulted on individual cases.

Behavioral indicators of compromised health: Orangutans who are experiencing health problems may display any of the following: increased lethargy, reduced social activity, and lack of appetite. In general, any sign that if displayed in a human indicates ill health should also apply to orangutans. It is important to note that like all wild animals, orangutans will mask outward signs of pain and illness. If there are observable physical indicators of illness, it is likely that the individual orangutan is experiencing high levels of discomfort.

Staff should report any signs of disease to supervisors and/or facility veterinarian as per the individual facility protocol. Animal care staff should be specific about the observed potential indicators of compromised health and make it clear if they are concerned that the situation is an emergency.

Euthanasia: As caregivers for the animals residing in our zoos and aquariums, it is vital that we provide the best care possible for them until the time their health deteriorates to a point where euthanasia is the most humane treatment, or the animal dies on its own. Euthanasia should be considered for progressively deteriorating quality of life, intractable disease without cure, or irreparable trauma. Prior to euthanasia, a deep plane of anesthesia should be achieved. Options for humane euthanasia include barbiturate or sedative overdose as dictated by the American Veterinary Medical Association (AVMA) Guidelines on Euthanasia and the American Association of Zoo Veterinarians (AAZV) Guidelines for the Euthanasia of Nondomestic Animals.

AZA Accreditation Standard

(1.5.8) The institution must develop and implement a clear and transparent process for identifying, communicating, and addressing animal welfare concerns from paid or unpaid staff within the institution in a timely manner, and without retribution.

Animal Welfare: AZA-accredited institutions must have a clear process for identifying and addressing orangutan animal welfare concerns within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. This process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, their Institutional Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues. It is recommended that institutions maintain libraries containing relevant animal welfare literature and provide funding for staff to attend conferences, workshops and other professional development opportunities to expand their training and knowledge of orangutan welfare.

Necropsy: AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support orangutan longevity. In the occurrence of death however, information obtained from necropsies is added to a database of information that assists researchers and veterinarians in zoos to enhance the lives of orangutans both in their care and in the wild. Necropsies should be conducted on deceased orangutans to determine their cause of death, and the subsequent disposal of the body must be done in accordance with local, state, or federal laws (AZA Accreditation Standard 2.5.1). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA Orangutan SSP-approved active research requests that could be filled from a necropsy.

If an animal should die, a necropsy should be performed on it to determine cause of death in order to strengthen the program of veterinary care and meet SSP-related requests (AZA Accreditation Standard 2.5.1). The institution should have an area dedicated to performing necropsies, and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standards 2.5.2 and 2.5.3). If the animal is on loan from another facility, the loan agreement should be consulted as to the owner's wishes for disposition of the carcass; if nothing is stated, the owner should be consulted. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination.

A standardized necropsy protocol for great apes is provided on the AZA Orangutan SSP web site (http://www.orangutanssp.org/uploads/2/4/9/9/24992309/necropsy_wkst_nov10.pdf). This protocol is an evolving document and is subject to revision. Pathology reports should be submitted to the AZA Orangutan SSP veterinary advisors for evaluation and comparison with other deaths and pathology. With any orangutan death, a full necropsy (gross and histopathology) is necessary to advance understanding of the species' medical management, baseline anatomy, and for appropriate care of the remaining group members.

Especially important is a thorough examination of the respiratory tract including sinuses, air sac, and lungs, because infection of these areas is common in orangutans. Prosecutors are encouraged to perform bacterial cultures on organs suspected of infection, and to collect blood at necropsy and bank the serum for possible future use in viral serology or toxicology. Additionally, the brain and spinal cord should be examined, as significant CNS pathology can easily be missed if these organs are not examined. Similarly, endocrine glands should be thoroughly evaluated, as well as the aorta, peripheral arteries, and peripheral nerves. These organs can easily be missed when the examiner is rushed, but should be examined and sampled just as major organs such as heart, lung, liver, etc. Particular attention should also be paid to the coronary arteries for evidence of atherosclerosis, and to the vermiform appendix, as appendicitis has been reported in orangutans.

Chapter 8. Reproduction

8.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the animals in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve.

In male great apes there is a large range of variation within each species for the onset of maturation and the age when full adulthood is reached. Because of this wide range of individual variation and because puberty is reached more rapidly in managed and provisioned animals, it is difficult to isolate a “normal” growth pattern. For orangutans, this is particularly true – they have the widest range in variation in timing of maturation among the apes and there is evidence that extended arrest of secondary sexual development occurs in some males, further complicating the picture of their growth patterns. Along with gonadal maturation and the onset of fertility, in male orangutans the maturation process includes the development of marked secondary sexual features. These changes include: large cheek flanges, a specialized laryngeal pouch, distinctive hair growth including a beard and mustache, large body size due primarily to increased muscle mass, and a distinctive odor (Graham & Nadler, 1990).

Most commonly, the first visible signs of puberty in male orangutans are changes in facial morphology. Typically, this begins at 7 to 9 years of age, but may happen as early as 5 or as late as 17 years of age. Commonly, males are fully mature by the age of 14 (with functioning primary sexual organs and marked secondary sexual features). However, many males may look “subadult” for years longer. “Unflanged” is the term applied to males with arrested secondary sexual maturation. Depending on the individual housing situation, along with morphological changes, adolescent male orangutans may show marked behavioral changes. They may become more aggressive and more sexually active, including increased incidence of forced copulation. Both *ex situ* and in the wild, the maturation process can take as little as a few months or as long as 10 years (MacKinnon, 1979; te Boekhorst et al., 1990).

According to Maple (1980), it has been “unwritten zoo lore” that the “complete development of secondary sex characteristics seems to be suppressed” in young male orangutans housed in proximity to adult males. However, if the dominant male is removed, the suppressed male begins to develop immediately. Importantly, it has been noted that “the transformation from subadulthood to full adulthood in male orangutans is sudden and dramatic”, and in the wild it takes only a few months (MacKinnon, 1979). According to zoo lore, aggressive human keepers may cause the same suppression effect (Maple, 1980).

To document Maple’s anecdotal data, Kingsley (1982) studied the gonadal endocrinology of 20 managed male orangutans ranging from 1 to 16 years of age housed in European zoos. Early morning urine samples were collected from each animal and analyzed by radioimmunoassay. Flange growth was also measured. One year into the study, a pair of cohabiting males—a dominant, flanged male and a subordinate, unflanged male—were separated and isolated from one another. Upon separation, the subordinate male developed secondary sexual features. Kinglsey found that testosterone levels in suppressed, unflanged males were intermediate between unflanged juvenile and flanged adult males. High testosterone is required for flange development, which commences a few months after an initial testosterone rise. Kingsley concluded that the presence of a dominant, flanged male indeed suppresses flange growth in subordinate, unflanged males for a period and that this is not a permanent condition. Te Boekhorst et al. (1990) have confirmed that the arrested phenomenon also occurs in wild male orangutans. Thus, morphological and behavioral differences between dominant and subordinate male orangutans have been observed both *ex situ* and in the wild. The arrest of secondary traits is not permanent, but is known to last up to 7 years in managed environments (Kingsley, 1988) and for 10 years or more in the wild (te Boekhorst et al., 1990).

Secondary sex characteristic suppression could be because of pheromones, or olfactory signals, transmitted between males, auditory signals, or threats of aggression between males. The odor, sight, or sound of a dominant male may act as a stressor to subordinate males by constantly reminding them of the dominant male’s proximity. Developmentally arrested adolescent male orangutans appear to have a distinct hormone profile as compared to other age classes of males (Maggioncalda, 1995a, 1995b). Their hormone levels indicate that these males are likely to be fertile, but they do not have necessary levels of hormones for full growth of body size or secondary sexual characteristics. They also have lower levels of stress hormones than do males of a similar age that are developing secondary sexual characteristics. Given this, it is likely that there is an olfactory or auditory cue that triggers males to suppress development, rather than prolonged stress or the threat of aggression.

Males that remain subadult in appearance but are fertile and can sire offspring represent a reproductive strategy that has not been documented in any other mammal, with the possible exception of male mandrills (Wickings & Dixson, 1992). Arrested males may have an advantage when compared to fully adult males who are also fertile but suffer the metabolic costs of high testosterone and high rates of intrasexual aggression and injury (Dufty, 1989), along with the demands necessary to attain and maintain a large body size. Although dominant males have access to more food sources and fertile females, subordinate males can also gain access to females and potentially sire offspring by being submissive and unobtrusive (Galdikas, 1985). Subordinate males avoid injury from agonistic encounters with dominant males and can travel more easily in trees, allowing them to escape predation and to follow females. Arrested males also avoid metabolic costs associated with maturation and high testosterone. Arrested males thereby may defer the costs and benefits of dominance until a time when a dominant male becomes old or dies and they can replace him as a range-holder (Galdikas, 1981).

Based on the endocrine data together with behavioral information, it appears that male orangutans have evolved a flexible developmental timeline, whereby subordinate males may postpone secondary sexual development in order to avoid aggression and stress, but retain timely primary sexual maturation and achieve reproductive success.

Females show no obvious secondary sexual characteristics (Graham, 1981). Female sexual maturity occurs at about 7 to 10 years of age. Wild orangutan females do not typically give birth until approximately 12 to 15 years of age. In managed environments, females have given birth as early as 7 years of age. The earliest documented age of parturition for a managed female is 5 years and 3 months (Markham, 1994). The first menstrual period, menarche, marks the onset of sexual maturity. Adolescent sterility has not been documented in this species. Females should be monitored carefully as they approach sexual maturity if they are in a potential breeding situation. The births of infants should be spaced to allow maturing orangutans (both females and males) to gain social experience with infants prior to being recommended to breed themselves.Females should not be bred before the age of fourteen, nor should they be bred if they are rearing an infant less than 6 years of age.

Adolescent females do exhibit sexual behavior. The AZA SSP recommends that at 5 ½ years of age, ALL juvenile females housed in a reproductive situation (this includes being housed next to males when separated by mesh) should be monitored for cycling. This can be accomplished through daily urine collection with Hemastix® for menstrual blood. Hemastix® can be ordered through most pharmacies or via the Internet. Once the female initiates menstrual cycling, she should be contracepted or otherwise prevented from becoming pregnant until she has reached social maturity and has been recommended for reproduction by the AZA Orangutan SSP steering committee.

The length of the menstrual cycle is calculated from the onset of menses in one cycle to the onset of menses in the next cycle. Menstrual cycles have been reported from 23 to 33 days in length in mature, managed individuals (11–22 years old) with a mean of 27.8 days (Nadler, 1981). Most sources list normal cycles between 28 to 30 days, but the sample sizes are small. Markham (1990) noted that menstrual cycles tend to be longer in the first 2 years after menarche. She also documents the irregular cycles of “Mawas,” a female orangutan in her late 40s. At 48 years of age, Mawas was not menopausal but her cycles were shorter than those of younger conspecifics. Menses typically lasts from 1 to 4 days. The flow of blood is slight and only seldom apparent. Hemastix® are the most reliable method of detecting menses. A clean urine sample should be used since contamination with feces may indicate a false positive from occult blood (Wells et al., 1990). Cycle status should be regularly recorded for all potentially breeding females. It is a good idea to keep a chart of the cycle status.

Mating behavior: In general, adult females prefer to mate with the dominant flanged male. Females may initiate consortships with dominant males at times of high ovarian activity, but they generally resist mating attempts by unflanged males and subordinate flanged males unless there is little or no cost associated with the mating. Unflanged males attempt to mate with adult females, although access may be restricted by flanged males, infrequent encounters, and the risk of association with the female. However, unflanged males may forcefully copulate with females, and they are able to sire infants this way. Flanged males attempt to exclude all other males from receptive females and try to maximize the length of consortships with receptive females. Flanged males that are not dominant may attempt to force copulations with a female. Consortships between an adult female and dominant flanged male can be initiated by females at the time of estrus. Consortships can last between a few hours and several months, but 5–6 days is average (Rodman & Mitani, 1986; Nadler, 1988; Fox, 2002).

Forced copulations and consortships have both been documented in zoo-housed orangutans (Nadler, 1994). These strategies were not exclusive of each other within a pair, but rather pairs have been observed exhibiting a mixture of both strategies (Maple, 1980). In a managed setting, most copulation is initiated by males and involves chasing of the female. In contrast, female-initiated copulation attempts generally involve no chasing. When the length of copulation bouts with respect to the presence or absence of chasing was compared, copulations preceded by a chase were significantly longer than those which were not initiated by a chase (11.5 minutes compared to 2.3 minutes; see Maple, 1980). The chase element is generally characterized as being aerial and involving several circuits of the animals' enclosure. The chase component does not appear particularly aggressive nor does it seem to induce fear in the female. Following a chase, the female submits or is wrestled down by the male and generally lies on her back on the floor or in an elevated location. The male then approaches her, inspects her genitals, and then mates with her (often in a crouching or sitting position). Although the predominant position during copulation has been reported as ventro-ventral, many varied positions and postures have been observed, including dorso-ventral (with the female lying on her stomach or standing quadrupedally), or with both animals suspended, i.e., hanging from climbing structures. The duration of copulations is extremely variable, but can last up to 15 minutes (Maple, 1980).

Although less often observed, female orangutans do exhibit proceptive behavior. The following proceptive behaviors have been observed in managed females: hand-genital contact, mouth-genital contact, rolling the male on his back, dorso-ventral and ventro-ventral mounting and pelvic thrusting (Maple et al., 1979). These proceptive behaviors appear to correlate with ovulation (Maple et al., 1979; Nadler, 1988; Fox, 2002).

Since all aspects of orangutan behavior are directly related to adaptations in their wild environment, duplicating these conditions *ex situ* can be challenging. For example, many managed orangutans have been and are maintained in larger social groupings than their wild counterparts appear to adopt, yet orangutans appear to be adaptable to changes in social structure under artificial living conditions. Many natural behaviors are often misunderstood or may be exhibited out of context in a managed setting (i.e., males forcibly copulating with females or adult males throwing and banging objects in their enclosures when they are long calling). Therefore, knowledge of wild orangutan behavior is essential in helping to interpret managed interactions and can be useful in overall species management.

8.2 Assisted Reproductive Technology

The practical use of artificial insemination (AI) with animals was developed during the early 1900s to replicate desirable livestock characteristics to more progeny. Over the last decade or so, AZA-accredited zoos and aquariums have begun using AI processes more often with many of the animals residing in their care. AZA Studbooks are designed to help manage animal populations by providing detailed genetic and demographic analyses to promote genetic diversity with breeding pair decisions within and between our institutions. While these decisions are based upon sound biological reasoning, the efforts needed to ensure that transports and introductions are done properly to facilitate breeding between the animals are often quite complex, exhaustive, and expensive, and conception is not guaranteed.

AI has become an increasingly popular technology that is being used to meet the needs identified in the AZA Studbooks without having to re-locate animals. Males are trained to voluntarily produce semen samples and females are being trained for voluntary insemination and pregnancy monitoring procedures such as blood and urine hormone measurements and ultrasound evaluations. Techniques used to preserve and freeze semen have been achieved with a variety, but not all, species and should be investigated further.

Besides physical issues, AI procedures also bring issues of ownership of semen and/or the animal being inseminated. Very often, semen from multiple animals may be used. As with any natural (physical) breeding, the rights of the owners of all materials and animals involved should be considered. Appropriate transaction documents (and loan agreements, if appropriate) should be fully completed before AI is attempted. To date, only one successful artificial insemination procedure has occurred in orangutans (Forde, 2014).

8.3 Pregnancy, Egg-laying/ Parturition

It is extremely important to understand the physiological and behavioral changes that occur throughout an animal's pregnancy.

Confirmation of pregnancy: The AZA Orangutan SSP recommends the best method to confirm a pregnancy is the presence of labial swelling. This physiological sign of pregnancy is easily observed. The labia majora begin to swell about 2 to 4 weeks after conception. The swelling is very pronounced and easy to see. The labia swell abruptly over a 1- to 2-day period and may continue to enlarge through the remainder of the pregnancy. The swelling does not disappear until after parturition (Sodaro, 1988). Labial swellings vary in appearance and size (Figure 4).

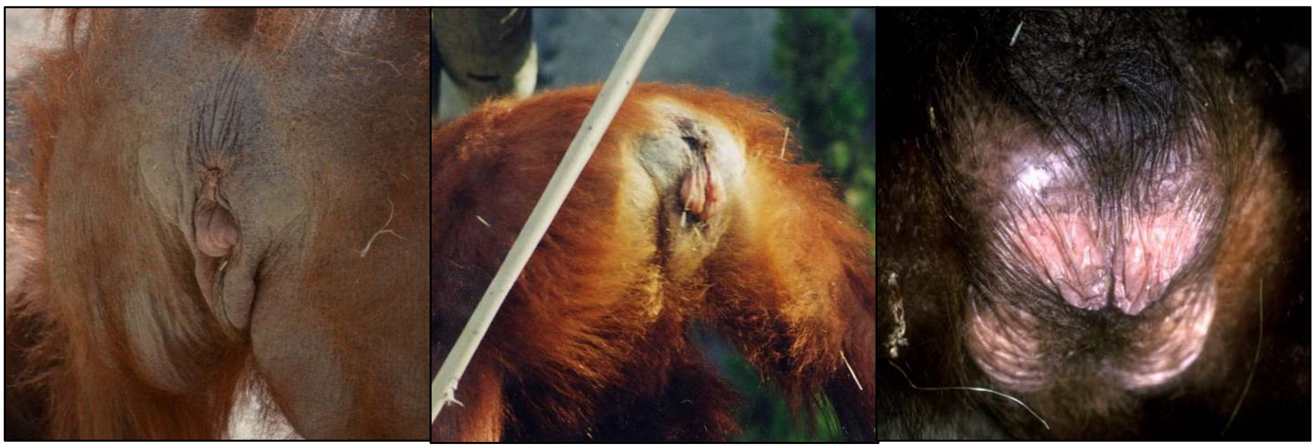

Figure 4: Examples of labial swelling.
Photos courtesy of C. Sodaro.

Pregnancy test kits: Human test kits can be used to further confirm pregnancy, but consistency of results has been mixed. A wide variety of results have been obtained using these tests which confirm human chorionic gonadotropin (HCG) in urine. The following kits are able to cross-react with orangutan chorionic gonadotropin (orCG):

- OvuQuick® (but not in 3rd Trimester)
- ICON® II HCG (but not in 3rd Trimester)
- Cards Q.® (but not in 3rd Trimester)
- Abbott TestPack Plus™ (but not in 2nd Trimester)
- E.P.T.™ (not in 2nd or 3rd trimester)
- Clear Blue Easy®
- One Step™
- Osco™

The human test kits are readily available in drug stores or via the Internet, but they are not standardized to guarantee cross-reactivity between ape and human chorionic gonadotropins. However, past experience indicates that they are usually close. It should be noted that many of the tests show a cross-reaction between HCG and luteinizing hormone (LH), so a single positive test actually may be detecting the LH released during ovulation. Therefore, Hemastix® should be used to detect whether blood is present. Ovulation test kits, including OvuQuick® have been successfully used at some institutions.

Testing should be performed with fresh, morning urine, if possible. The urine should not be contaminated with any soap or foreign materials.

Additional methods to confirm pregnancy:
Ultrasound: Ultrasound can be a useful diagnostic tool to confirm pregnancy. “Jill,” an orangutan at the Kansas City Zoo, was trained to present her abdomen for weekly ultrasounds performed by zoo staff (Moore, 1999). This female was also trained to allow cooperative blood draws. During this pregnancy, urinary hormone levels were analyzed. This was the first instance in which all three testing procedures were used simultaneously to correlate the progression of an orangutan pregnancy (Suedmeyer, 2002). The use of ultrasonography to monitor the progress of pregnancies is becoming increasingly routine.

Physiological sign: Labial swellings appear and are maintained or may increase in size throughout the gestation period. Approximately one month after conception, changes begin to occur in the mammary area. The nipples begin to swell and the mammary glands enlarge. One zoo reports that a pregnant female’s hair appeared thicker.

Behavioral changes: Reported behavioral changes include: loss of appetite, lethargy, and personality changes. Females have been reported to self-nurse prior to parturition. Pregnant females may continue to participate in sexual behavior. Maple (1980) described the behaviors of female orangutans in the Berlin Zoological Gardens to be rather unpredictable and sometimes aggressive during the first months of pregnancy. A female at the one zoo tended to act more docile and subdued during the first trimester in three of her pregnancies. Behavior among group members should be monitored carefully and changes in behavior should be recorded in the animal’s records. In the later stages of pregnancy, females may appear agitated, restless, and lethargic, avoiding interactions with conspecifics. Loss of appetite and constipation have also been noted.

Medical problems associated with pregnancy: Problems related to pregnancy in orangutans are varied. Abortion, placenta previa, fetal septicemia, dystocia, and maternal/fetal incompatibility have been reported. As in humans, diabetes or obesity can be associated with significant medical complications during pregnancy. These cases and other related disorders are covered in *Medical Management of the Orangutan (*Wells et al., 1990). A prenatal ultrasound examination with routine blood tests to check hematology/serum chemistry status can provide valuable information to confirm the health of the mother, fetus, and normal placental placement. It also allows potential problems (such as hypocalcemia or anemia) to be identified and corrected proactively.

Gestation: Gestation ranges 245 $\pm$ 12 days. This is an average of 35 weeks or 8.16 months. Twinning does occur, at least in *ex situ*, but is a rare event (less than 1% of recorded managed births internationally).

Diet changes and vitamin supplementation: Proper nutrition during pregnancy is essential for the health of both the mother and the developing fetus. Intake of a well-balanced diet should be assured, with special attention to adequate levels of protein, energy, calcium, vitamins, and minerals (especially folic acid). The appropriate quantity of food is best determined by observation of the animal, maintaining adequate conditions and avoiding excessive weight gain (obesity can cause significant medical problems during pregnancy and labor). As a general rule, the developing fetus is so small that a significant increase in food is not necessary until lactation begins (lactation can double or triple metabolic needs). Oral supplementation with any standard human prenatal vitamin is recommended during pregnancy and lactation.

Social housing during pregnancy: It is not necessary to alter a pregnant female’s housing situation during pregnancy unless there is a risk to the female or her infant. Separation training, however, should be undertaken well before parturition in the event that the female and infant need to be separated from usual companions. Some zoos separate pregnant females from adult males overnight as the parturition date nears. Adult males have been present during delivery. There are known instances of adult males exhibiting aggression or interfering with an infant immediately post-partum. Some males have become aroused and attempted to copulate with a female during labor (Caine & Mitchell, 1979). It is recommended to separate a pregnant female once labor begins to allow an uninterrupted birth process.

Zoo staff familiar with the adult male's behavior during the birthing process should make the decision about how the pregnant female should be housed during labor and delivery. The pros and cons of this decision should be carefully weighed prior to implementation. If females with infants have been separated from their social group, they should be housed with auditory and visual contact to their group. After birth, reintroduction to conspecifics should take place based on the institution's postpartum management plan. Animals should be monitored closely during this period.

Development of a birth management plan: It has been well documented in the literature that the mother-infant relationship forms the basis of nearly all social behavior in animals. A lack of conspecific mothering during infancy has been linked to deficiencies in both sexual and maternal behavior in adulthood (Maple, 1980). Management practices that involve the removal of the infant from its mother at birth or at a very young age (under 6 years) should be avoided.

Thorough planning for an impending birth is critical to minimize the necessity of an infant being removed from its mother for hand rearing. All institutions should contact the AZA Orangutan SSP Husbandry Advisor, and/or the Ape TAG Birth Management Committee to discuss a birth management plan for their female as soon as the pregnancy is confirmed. These sources can also be contacted for examples of birth management plans that can be used as templates. As of 2011, all institutions receiving a breeding recommendation receive a copy of the newly developed birth management manual.

A sound birth management plan addresses the social, reproductive, and medical history of the pregnant female. It also establishes the development of an action plan driven by review of the orangutan involved. This also includes staff assignments, determination of due date, prepartum plan, birth-day plan, and any other considerations relating to the birth. A birth management plan helps to prepare staff and animals for the impending birth. All animal care staff involved with the pregnant female should familiarize themselves with the birth management plan well in advance of parturition.

<u>History of the expectant female</u>*:* One of the most important aspects of developing a sound birth management plan is to know the complete history of the female involved. This can be accomplished through a careful review of house records, records from prior institutions housing the animal, and review of the APES profile. An in-depth review will allow staff to make appropriate preparations to promote maternal care and ensure the well-being of the infant. All females that receive a breeding recommendation from the Orangutan SSP should be engaged in a maternal skills training program. A pregnant female may fall into one of the following categories:

- Nulliparous female who has had no prior exposure to infants. Considerations: If the female is under 10 years old, and/or was hand-reared, it is recommended to begin a positive reinforcement training program to promote maternal care giving skills. Note that females younger than 14 years are not recommended for breeding, per AZA SSP policy.
- Nulliparous female who has been present at a birth(s) and/or who has had exposure to females with infants who exhibit proper maternal care. Considerations: this animal may have a better chance of being a competent mother due to exposure to proper infant care in the past.
- Multiparous female who has successfully raised infants. Considerations: This female should continue to care for future infants unless there is a change in her health status or the infant has medical concerns.
- Multiparous female whose infant required intervention. Considerations: The nature of the intervention required will dictate your next birth management plan. Review discussion of intervention types in the next section.

<u>Discussion of intervention types:</u> Females who consistently neglect their offspring should be considered for a positive reinforcement maternal care giving skills training program. Careful evaluation of past circumstances surrounding neglect should be closely reviewed. The following information should be included in the review:

- Housing situation during prior birth(s)
- Review conspecifics present for prior birth(s) and any behavioral interactions that may have impacted the female's behavior toward the infant
- Age of parturition

- How the female was reared (dam-reared, hand-reared, peer-reared, foster-reared, surrogate-reared, or unknown)
- Were the appropriate preparations made for the birth (bedding, diet, environmental conditions)?
- Was she in good health?
- Was the infant healthy?
- Was the birth difficult?

By closely reviewing all of the above, caregivers may be able to determine factors that affected the unsuccessful rearing of past infants as well as implement changes for the future. If a maternal skills training program cannot be implemented or is not successful, consideration can be given to placing the infant with a foster or surrogate mother. Contact the AZA SSP Coordinator well in advance of the parturition date to discuss this option.

Females who have shown competent mothering skills but failed to allow nursing with previous offspring should be considered for a positive reinforcement training program that focuses on promoting nursing. A training program of this nature may include breast desensitization and manipulation of breasts with a breast pump prior to parturition.

There are reports of females who consistently neglect or abuse their offspring. If possible, these individuals should be housed in an environment that may promote and/or improve their maternal skills. Females who are known to abuse their infants require special monitoring and considerations immediately postpartum. If a female has rejected past infant(s), a positive reinforcement training program that promotes infant care-giving behaviors should be initiated during pregnancy. This type of training program has been successful at many institutions. Contact the AZA Orangutan Husbandry Advisor, or the Birth Management Committee, for information on how to set up a maternal training program.

Labor and delivery: Reports on the length of labor vary. Graham-Jones and Hill (1962) noted that labor lasted for approximately 25–30 minutes for a primiparous managed orangutan. When twins were born, labor lasted approximately 3–4 hours for the first twin and about another hour for the second (Heinrichs & Dillingham, 1970). Labor for a previously managed, primiparous orangutan at one facility lasted 3 hours. A discharge of amniotic fluid was observed 5 minutes before birth occurred. During the birth, the female adopted a squatting posture and whimpered (DeSilva, 1972). In the first stage of labor, there is usually a clear vaginal discharge. The female may show signs of discomfort and her activity level increases.

Stage two encompasses the birth process. The female may assume a lateral- or dorsal-recumbent position. The frequency of contractions increases and the infant's head appears. In one observed birth, the female rested on her right forearm and knee and grasped the infant's head with her left hand. She appeared to be assisting in the expulsion of the infant, which took 13 minutes (Schwartz, 1988). In another described birth posture, the female placed her head on the floor, leaning on her lower arm and elbow. Her legs were extended so that her pelvis oriented upward. There is one reported instance of a male assisting a female in this posture during parturition (Schwartz, 1988). The infant is normally born in a head-first presentation. Breach presentations have been reported and successfully delivered.

The third stage is the expulsion of the placenta. The placenta may be passed immediately after the second stage of birth but is usually passed within a few hours. The umbilicus is broken by the female chewing through the cord. Females typically consume the placenta. If the female does not chew through the umbilicus or consume the placenta, continue to closely monitor the umbilical site. Staff should also carefully monitor the position of the umbilical cord in relation to the infant's body to ensure it does not constrict the infant's body in any way. Any placenta tissue that is not consumed and is easily retrievable should be submitted in a sterile container to veterinary staff for examination.

Contractions may continue to be observed post-delivery. Vaginal bleeding may also occur for several days after delivery. This should be reported to veterinary staff. But as long as the amounts are small, the discharge is not abnormally odiferous or discolored, and the animal acts healthy, this is usually normal.

Problems associated with birth and delivery: Difficult birth (dystocia) is not common in orangutans, but it can occur. Veterinary staff should be prepared for any eventuality, and should be alerted when birth is expected. Ideally, a consultant MD with obstetrics experience should be available if complications occur. The AZA SSP Veterinary Advisors can also be consulted. Pre-existing medical problems (such as urinary infection, diabetes, hypothyroidism, obesity, or malposition of the placenta) can complicate pregnancy and delivery. These cases and other related disorders are covered in *Medical Management of the Orangutan* (Wells et al., 1990). A few institutions have recent experience with performing Caesarian sections and reintroducing infants.

Physical appearance of the newborn: Newborn infants are typically wet and appear small in size. Many zoo staff are surprised at the small size of an infant orangutan. Reported infant weights vary dramatically. Seitz (1969) reported the average birth weight of seven male infants to be 1,740 grams (61 oz.) (range 1,590 to 2,015 grams [56 to 71 oz.]). Five females in his study ranged from 1,420 to 2,040 grams (50 to 72 oz.) with the average being 1,694 grams (60 oz.). The average birth weight of the 12 infants total was 1,720 grams. The head might be slightly misshapen from passage through the birth canal. The rib cage is prominent and the abdomen may appear sunken. The newborn may not defecate or urinate immediately. Often the first bowel movement of the newborn is dark in coloration. Typical feces of a mother-reared infant are pale yellow in color.

Figure 5. Male genitalia and umbilical area at 48 hours of age.
Photo courtesy of C. Sodaro

Post-partum behavior: Immediately post-partum, females have been known to insert their fingers into the infant's mouth or suck on the infant's face to remove mucus from the oral and nasal cavities. In one instance, a female was seen breathing into the infant's mouth (Graham-Jones & Hill, 1962). Females may inspect the ano-genital area of the newborn. Sexual behavior exhibited by the females towards an infant may include: dorsal-dorso mounting, oral-genital inspection, and manipulation and insertion of fingers into ano-genital areas.

After giving birth, a female may spend more time than usual resting. Her appetite may be increased or decreased. Females carry infants continuously after birth. Both *ex situ* and in the wild, the infant may be carried in a side ventral position, or on top of the head or upper back. Inexperienced females may carry an infant upside down or in a seemingly awkward position. If the infant appears to be healthy, is gripping with hands and feet, and is nursing regularly, this does not present a cause for concern.

Lactation and nursing: Before birth, milk production and even milk expression (called "milk let down") can occur. Self-nursing during pregnancy and after birth has been observed frequently and has not been correlated with any medical problems to date (although the phenomenon has not been well-studied). Although milk is typically present immediately after birth, the breast tissue (especially in primiparous animals) may not appear full or engorged for a few days. Colostrum (the first milk, which contains essential immunoglobulins for protection against disease), as well as milk, are typically thin and watery in appearance.

One institution has successfully used the drug Reglan® to stimulate lactation in a female orangutan. This drug has been used to increase maternal milk supply in humans (Wight, 1995). Some zoos have had mixed results with the use of Reglan®, including unpredictable agitation in the dam.

Nursing bouts are normally frequent and of short duration. In the wild, nursing takes place during short rest periods on the part of the mother. The intervals, on average, are 40 minutes apart during the first year of life (Rijksen, 1978). Suckling usually occurs within 4 to 6 hours after birth. Occasionally up to 2 days will pass before nursing takes place. The decision to remove an infant from its mother should be based on the physical condition and behavior of both the infant and the mother.

Diet and supplementation during lactation: Energy needs typically double or even triple over the period of lactation. The diet composition should remain balanced, and should be gradually increased in correlation with the animal's general condition, weight, and activity. It is essential that adequate levels of total calcium, with a ratio of at least two parts calcium to one part phosphorus, be provided throughout lactation.

Infant death: If the infant is stillborn or dies during birth or shortly after, the female may attempt to carry or nurse the dead infant. Try to remove the infant as soon as possible for necropsy, but retrieving the baby from the mother should not be done forcefully or negatively. It is advisable during this time to keep the animals out of public view.

8.4 Birthing/Hatching Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed." This area does not need to be a specially designed facility; the use of existing exhibit or off-exhibit space will suffice as long as appropriate updates are made to ensure infant safety and privacy following birth. The use of existing, but modified, spaces will also minimize stress to expecting mothers as they will already be familiar with these areas and shifting to these areas will be part of a normal routine. It is not recommended that females be physically transferred to new areas for birth. The time mother-infant pairs stay in this space exclusively will be dependent on the health and the skill-level of the mother. If concerns or questions exist it is recommended to contact the SSP. This will be dependent on the institution's birth management plan. Females should be given as much choice as possible to move around and choose the birth location. It is recommended to heavily bed the enclosures the female gives birth in with at least 8 to 10 inches of bedding. Bedding types may include: timothy hay, straw, shredded paper or wood wool. Providing a deep layer of bedding ensures that the female will be comfortable. Bedding can also prevent falling-related injuries, and help prevent the infant from lying on a cold surface if the birthing female does not carry the infant, delaying hypothermia.

8.5 Assisted Rearing

Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in *ex situ* populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these offspring when deemed necessary. A goal of the AZA SSP is to promote maternal care of infants. This can be accomplished with a variety of methods including: maternal training for females that have been identified as potential risks to exhibit inadequate maternal care, infant reintroduction to a dam at a later date, and surrogate mothers. Successful mothering comprises learned behaviors and it is thought that females are more likely to rear successive offspring if given as much time as possible to establish a relationship and perform some maternal care with the present infant. However, in some cases, due to the health and welfare status of the mother and/or the infant, the need to hand-rear an infant may be unavoidable. Post-partum observations by experienced staff are essential to carefully evaluate the relationship between mother and infant. Prior to the birth, staff should familiarize themselves with mother/infant behavior so they are able to accurately assess the animals' behavior. Monitoring with minimal disruption is recommended (e.g., by the use of remote cameras if possible). The female is likely to respond positively to familiar caregivers' encouragement. The decision to hand-rear an infant should be based on the health status and behavior of both the mother and infant.

Frequent evaluation of the above criteria by animal care staff is essential. If the infant's physical condition is questionable, such as dehydration, hypoglycemia/weakness, hypothermia, and/or if the mother exhibits complete disinterest or abuse that is determined to be life threatening, removing the infant may be justified. Other potential problems include lack of adequate maternal milk production or let down, mastitis, or critical maternal illness/weakness. As a general rule, infants do not need to nurse for approximately 12 hours after birth, but the infant should not appear to be weak or unresponsive. Signs of infant weakness may include:

- Not being able to hold its head up (head dropping back).
- Eyes glazed in appearance.
- Loss of grip on mother – infant should have a strong grip and be able to hold on without support from the mother.
- Appearance of skin folds which may indicate dehydration.
- Loss of ability to suckle properly – during nursing, infant fails to move jaws while on nipple.
- Excessive crying (a potential indication of inadequate milk intake).

In some cases, transient hypothermia, hypoglycemia, and/or dehydration can be quickly evaluated and medically treated (warmth for hypothermia; subcutaneous fluids for dehydration; subcutaneous fluids and dextrose for hypoglycemia), and the infant may be successfully re-introduced to its mother. Such situations require careful evaluation, teamwork, and constant attention to ensure that the problems are adequately resolved.

AZA Orangutan SSP hand-rearing guidelines: It is recommended that a birth management plan be developed prior to the birth of an infant (see above). Hand-rearing should only occur in cases where an infant has a health problem and/or as an interim step prior to reintroduction to the dam or surrogate mother. It is NOT recommended to remove an infant from its mother at birth or a very young age. 24-hour a-day, 7-day-a-week continual care is necessary until reintroduction to the dam or surrogate is possible. Caregivers should be dedicated to caring for and carrying the infant continually. This is essential for the psychological well-being of the infant. Institutions that are unable to provide 24/7 care should contact the AZA SSP Coordinator for further direction. Caregivers should be familiar with, and emulate, orangutan behavior. The AZA SSP Coordinator should be contacted immediately if hand-rearing is necessary.

From field studies, MacKinnon (1974) observed that during the first year of life an infant is in almost permanent bodily contact with its mother, clinging tightly to her side as she travels, or clambering over her in an exploratory fashion when she pauses to rest or feed. Although these infants see and often sample the foods their mothers find in the forest, they are nourished almost entirely from her milk. By the second year, the infant is less dependent. Although never far from its mother's side, the infant is rarely carried and is capable of finding some of its own food. By the third year, MacKinnon (1974) states, the youngster is actively searching for playmates. Juveniles remain with their parent until the birth of a new infant. Galdikas (1981) reports inter-birth intervals of 5 years, although longer intervals have been reported more recently. From then on, the close bond between mother and offspring starts to change. Juveniles, particularly males, gradually wander farther from their mother and spend increasing periods alone. Young females are less adventurous and often stay with their mother and play with the new infant. They likely learn the fundamentals of infant care at this time.

As successful mothering includes learned behaviors, maternal contact for young orangutans should be maximized. During maturation, it is recommended that individuals be given the opportunity to observe infant-rearing, if possible. It is thought that females lacking in maternal skills are more likely to rear successive offspring if given as much time as possible to establish a relationship and perform some maternal care with their present infant. It has been well documented in the literature that the mother-infant relationship forms the basis of nearly all social behavior in many species of mammals. A lack of conspecific mothering during infancy has been linked to deficiencies in both sexual and maternal behavior in adulthood (Maple, 1980). However, as with many mammals, the behaviors that are learned and those that are innate have yet to be determined.

Intervention types (when to hand-rear):

<u>If the infant can be returned to the dam in the immediate future:</u> When an infant has been removed from the dam due to medical issues affecting either animal, full consideration should be given to reintroduction of the infant when the animal's medical condition improves (or as soon as possible). If, in order to remove the infant, the dam needs to be sedated, her lactation status should be checked. If the medical condition of the infant is stable, the infant should be allowed to nurse from the sedated female. This will help stimulate further lactation and encourages natural infant suckling. If the infant is not able to nurse from the sedated female, breast milk should be collected and stored to feed at a later time. This can be done via manual expression or a breast pump. Be aware that milk collected during the beginning stages of lactation can appear thin and watery. It does not have the typical appearance of cow's milk.

The length of time an infant has been removed from the dam is one consideration that factors into planning a reintroduction. Other considerations are the ability for the infant to nurse naturally once reintroduced to the dam and the lactation status of the dam. Bottle-fed infants may have difficulty in returning to a natural "nursing" situation unless the reintroduction is planned for the immediate future. This is because it is much easier for an infant to drink milk from a synthetic bottle nipple than to nurse naturally from the dam's nipples. Switching from a man-made nipple to the breast is also a change in the infant's daily routine. During this time, the infant should be cared for in front of the dam's enclosure. Contact the AZA Orangutan Husbandry Advisor for additional recommendations.

<u>If the infant cannot be returned to the dam in the immediate future, but a reintroduction at a later date is possible:</u> The earliest an infant has been successfully reintroduced to her dam is 12 days of age. A positive reinforcement training program should be initiated for both the infant and the dam. If possible, the infant should continue to nurse from the dam's breasts through the enclosure front. If this is not possible, the goals of the training program should include the infant learning to drink from a bottle (and eat solid foods if old enough) while housed in the dam's enclosure and the dam to allow the infant to be bottle fed (or eat solid foods) from the care giving staff.

If, due to the health status of the infant or the dam, an introduction cannot take place in the immediate future, follow the guidelines for hand-rearing in this chapter. Animal management plans should focus on 24/7 care and emulating maternal behavior. Facilitating dam/infant contact should be encouraged as much as practical.

<u>If the infant cannot be returned to the dam, and the infant will go into a surrogate situation:</u> When the best rearing option for an infant is a surrogate mother, follow all general hand-rearing guidelines in this chapter. It is a rare situation for an infant to be sent to a surrogate mother that is lactating. With most recent surrogate situations, the infant was hand-reared at the birth institution before being sent to a surrogate mother at another institution. Refer to Surrogate Mother Case Histories in the Orangutan Husbandry Manual for more information on animal management plans and preparations for surrogacy. It is strongly recommended to not raise the infant in a "nursery" situation. It is preferable to raise the infant in the orangutan area so the infant can maintain at least visual, auditory, and olfactory contact (and possibly even tactile contact dependent on the adult animals' personalities). Caregivers should carry the infant on a 24/7 basis.

Once the decision has been made to hand-rear an infant, it should be kept warm and medically evaluated. A dextrose stick can be used to determine if the infant has glucose, which will assist in determining if the infant has nursed. Ensley (1981) recommends preliminary care be given to the umbilical cord and examination of the placenta. An unhealthy or abnormal placenta will assist in identifying if an infant may require specific additional medical care. The neonate's body temperature should be stabilized at about 37 °C (98.6 °F). If the infant's body temperature is below normal, the AZA Orangutan SSP recommends having a caregiver hold the infant close to their own body while placing a hot water bottle or heat source between themselves and the infant, or provide skin-to-skin contact. Take the infant's temperature every 15 minutes to closely monitor body temperature changes until the infant stabilizes its body temperature. The ambient room temperature should also be increased until the infant's temperature is normalized.

Other methods may be used to normalize the infant's body temperature. Although these methods will help to normalize body temperature, they do not provide the infant with the necessary physical contact to ensure proper psychological well-being. The AZA Orangutan SSP strongly encourages 24/7 care of all infants. Less desirable alternatives include:

- Incubator – ensure that temperature of incubator is continually monitored. If the infant should be housed in an incubator, constant contact should be given by the caregiver by putting their hands/arms through the arm holes at all times.
- Radiant heaters that are commonly used for human infants in maternity wards.
- A crib with a heating pad or a hot water bottle covered with bedding. The best type of heating pad to use is the type with a thermostatic control that displays the actual temperature.
- With all of these options, provide a shaggy surface or artificial surrogate (stuffed animal) for the infant to cling to in an upright position. By placing the infant on its abdomen, it is able to cling to a comfortable surface with ease. Neonatal medical disorders are described in *The Medical Management of the Orangutan* (Wells et al., 1990).

Once the infant's condition has been assessed, a feeding regime can be implemented. Initially, a 5% dextrose solution or an oral electrolyte solution (Pedialyte®) is recommended until a stable suckling reflex is noted (usually during the first few feedings). This will prevent any accidental inhalation of the formula while adjusting to the bottle and nipple. This milk formula (or breast milk) should be diluted with dextrose, an electrolyte solution, or distilled water, when first introduced to the diet and increased gradually, to prevent digestive upsets. The goal should be to feed 110–120 kcal/kg body weight in 24 hours. Standard milk- or soy-based formulas are 20 kcal/oz. (0.67 kcal/cc) and should be mixed (if using the powdered formulation) according to the label directions. There are also formulas available with higher calorie counts (24 kcal/oz.; easily digestible, hypoallergenic, low-iron, etc.) that can be used with infants that are not growing well, and/or are having formula-tolerance issues. Infants initially can be offered formula (or breast milk) at a ratio of 20% to 25% of their body weight divided by the number of daily feedings, or feedings should approximate 100 ml formula/kg BW/day (24 hours), increasing to about 200 ml/kg/day by the third week; or 120 kcal/kg BW/day. The amounts should be monitored and adjusted based on animal acceptance, hunger level, and weight gains. Care should be taken not to overfeed as this can cause gastric distension, vomiting, and aspiration. On average, the infant should be accepting full strength formula within 4 to 7 days. Neonates require feedings at 2 to 3 hourly intervals or on demand. As the infant matures, the frequency of feedings can be reduced as the amount fed per meal and the overall total increases. Positioning of the infant during feedings should approximate its natural position and burping should be encouraged during and after feeding.

Human infant formulas are recommended. The most commonly used are Similac®, Enfamil®, and SMA®. Prosobee® and Isomil®, which are both soy-based formulas, have been used for infants suspected of having allergies to milk protein or lactose. Human infant bottles with regular nipples are recommended (orangutan infants tend to need a larger nipple than would be presumed; the mother's nipples are large and the infant's mouth is similarly large), and should be sterilized before use. A vitamin supplement may be added to the formula from two weeks of age. Formulas with added iron can cause constipation. Consult veterinary and/or nutrition staff for advice on iron-fortified formulas. Reactions to formulas may include enlarged axillary and inguinal lymph nodes, mild fever, negative or stalled weight gain, abdominal discomfort (fussiness), diarrhea, melena, and hematochezia.

Probably the most important lesson learned when hand-rearing an ape infant is to adjust the routines based on daily assessment of the infant. There is no one formula that will guarantee success every time for every infant. There are several published plans that may be used to determine the amount and strength of formula to feed and every infant will grow at a slightly different rate and tolerate slightly different amounts and types of formula. Always determine what works best for the individual animal through daily weighing and physical evaluation of temperature, alertness, fecal and urine production, etc. Stay flexible but avoid rapid and premature changes to formulations or feedings since this can also cause gastrointestinal stress.

After approximately 3 months of age, the feeding frequency can start to taper off. If the infant appears hungry between feedings, feeding smaller volumes more frequently may be needed. Monitor the infant's body weight and growth daily, and this information can be used as indication of the right volume and frequency of feeding. As the infant grows and feeding frequencies start to decrease, solid foods may be introduced (softened vegetables and other adult dietary items) and feeding intervals can decrease to every 4 hours or longer. Formula should be the foundation of the diet for the first 12 months, but the infant should be given solid foods as soon as teeth erupt and interest is shown. By 6 months, infants should be offered approximately ¼ of the adult diet throughout the day. At 1 year of age, formula feeds should be reduced to three times daily and by 4 to 5 years of age, the infant should be totally weaned. As infants grow and slowly wean off formula and onto adult diets, it is important to ensure that they are receiving balanced diets, and to support them during this transitional phase with special attention to vitamins, calcium, and phosphorus.

In certain cases, early weaning may be encouraged in order to facilitate an early reintroduction. Weaning should not be premature and should be done under the guidance of a veterinarian and nutritionist. Training the infant to accept a bottle through the enclosure mesh at an early age may eliminate the need for early weaning. Solid food can be introduced to the infant at 3 months of age. Foods should be smooth in consistency to prevent being lodged in the throat. Consult with a nutritionist for recommendations of what food types to offer. Initially, small amounts (approximately 1 teaspoon) of one food item should be introduced. Additional food items should be gradually introduced one at a time to monitor for signs of gastric upset and digestibility. A suggested interval is one new food item every 3 days prior to adding a new item. This schedule will help to ensure proper digestibility and rule out any food allergy-related issues. Some suggestions for food items include mashed banana; unsweetened applesauce; steamed, mashed sweet potatoes; or infant rice cereal. It is preferable to offer fresh produce. In cases where this is not practical, human baby food that contains only pureed fruits and vegetables can be an acceptable substitute. A mixture of formula-soaked monkey chow which has been mashed can be offered once other foods have been introduced and the infant can process semi-solid foods.

Infant records should be maintained daily. Daily records should include weight, formula consumption, incubator temperature (if applicable), urine and fecal output and general health information. To record accurate and consistent weights, the infant should be weighed naked at the same time of day. Other information to record may include reaction to environment or changes in environment, motor skills, and other physical developments such as dental eruption. Hand-reared animals may reach developmental milestones at a different rate than a mother-reared infant. It is important to record infant development using the AZA SSP Developmental Data Sheet, which can be obtained from the Birth Management Manual or the Husbandry Advisor. If the infant and dam will be introduced at a later date, keeping detailed records on the behavioral interactions of both animals (and other potential group members) prior to reintroduction will help assess the animals' progress.

As far as infant hygiene is concerned, ideally, diapers or other forms of swaddling should be avoided in order to replicate a more natural situation for the infant. Diapers or other forms of swaddling may be used when stool consistency is poor. Diapers should be changed frequently to help prevent rashes. It is recommended to clean the ano-genital area after each diaper change. "Preemie-sized" diapers work best. Always remove a diaper prior to weighing the infant. In cases where the infant is having stool consistency issues and a diaper is used, it is recommended that the infant be allowed to go without a diaper for a period of time each day. Remove diapers and other forms of swaddling when allowing tactile contact of the infant with conspecifics, when the infant is on public display (public display of infants being reared or held by humans is strongly discouraged), or during photographs (publication of photographs of infants being reared or held by humans is strongly discouraged). The infant does not need regular baths or cleaning unless excessively soiled.

As previously stated, 24/7 care of infants should be provided. It is optimal for the infant to be carried at all times as this will encourage a good clinging response and provide critical social comfort. Continual contact provides a more natural rearing situation and meets an infant's psychological needs. It also provides physical stimulation necessary to develop and maintain muscle tone, as well as aiding in proper digestion, and avoiding aspiration. Mobility is somewhat limited during the first 3 to 6 months of life, so the caregiver is the most important factor in the infant's life. Warmth and movement, which allows the infant to cling and to receive comfort when distressed, are of extreme importance. At several zoos, caregivers wear furry vests made from material that simulates the color and texture of an orangutan. The infant can cling while the caregiver moves and uses their arms freely. Although not optimal, carriers designed for human infants work well, too.

Dependence on a caregiver can be a result of species isolation, not of too much handling (Fritz & Fritz, 1985). The infant should have exposure to conspecifics immediately unless there is a health risk. This will help in the reintroduction process and may help promote further interest in the infant by its mother and vice versa. A balance between caregiver contact and peer contact is recommended. Forcing independence onto the infant should be discouraged because it may promote insecurities that can inhibit development and exploration rather than encourage it.

All caregivers should familiarize themselves with orangutan behavior. It is optimal to observe mother-infant behavior directly, but this can also be accomplished by watching a videotape. The number of caregivers involved in the hand-rearing process varies from one institution to another. Multiple caregivers are preferred to reduce unhealthy dependence on any given individual and vice versa. It is recommended to involve more than one staff member. Until veterinary staff has determined that the infant's condition is stable, it is advised to limit the number of caregivers. This will allow the infant to have consistent care until a daily routine can be established. Recruited volunteers should undergo an orientation process to become familiar with the protocols and techniques of hand-rearing. Consistency between caregivers is critical. Volunteers should be medically screened prior to contact with the infant.

It is recommended that caregivers wear protective clothing, masks and gloves when handling the infant. Medical screening for infant care staff should include a recent negative TB test, parasite screening, and current vaccinations. Consult the AZA Orangutan SSP Veterinary Advisors for additional recommendations. Caregivers who are ill should never be in contact with the infant.

The detrimental consequences of prolonged isolation and artificial rearing for certain species are well documented (Anderson, 1986). Socialization with conspecifics at an early age is essential for the hand-reared neonate. It is strongly recommended that infant housing be in the orangutan area and in front of the dam's enclosure. This allows the infant and dam to have visual, auditory, olfactory and tactile contact with one another. Ideally, an orangutan enclosure within view or adjacent to that of the dam should be used. This location will get the infant ready for a future introduction while providing a stable location from which to explore its environment. The same bedding and nesting materials provided to the adult orangutans should be used for the infant.

A nursery environment is a relic of the past and does not meet the psychological needs of the infant or the dam. Infants that are raised in a nursery situation and on public display should not be dressed in clothes. The AZA Orangutan SSP policy prohibits the public display of orangutans dressed in clothing. If there is a need for the infant to be viewed by zoo guests, a remote video monitor can be set up to allow guests to view the animal while being hand-reared in the orangutan area.

As the infant develops, stimuli should change and become more complex and challenging. Fritz and Fritz (1985) noted that lack of enrichment toys and climbing structures can seriously handicap a young orangutan's ability to develop motor skills. Care should be taken, however, to avoid over-exercising infants. Zoos should provide a variety of enrichment to help promote psychological well-being. The same enrichment items provided to adult orangutans should be used with the infant (within reason). Interactions with caregivers should encourage species-typical behaviors and locomotion skills that will help to promote normal development. The following is a partial list of enrichment items that have been provided to hand-reared infant orangutans: classical music, mirrors, photos of orangutans, blankets or hay (substrate) that have been used by the infant's mother, shaggy material, cardboard boxes, paper bags, access to orangutan enclosure structures, swings, fire hose, webbing strips, browse (if the infant is old enough), and tapes playing vocalizations of orangutan sounds (including male long calls). On a cautionary note, ropes can cause strangulation. Contact the AZA SSP for appropriate and safe uses of ropes or alternatives such as fire hose. It is also important to ensure that no enrichment devices have dangerous features or sharp edges.

With the provision of a stimulating environment (being housed in the orangutan area), 24/7 contact, enrichment from caregivers, and contact with other orangutans (preferably the infant's dam and natal group), abnormal behaviors can usually be avoided. Watts (1992) reported the following stereotypic behaviors in her hand-rearing survey of zoos: self-clutching of hands and feet (although this behavior discontinued after the infant was given more stimuli), thumb- and lip-sucking (short-lived), and scratching of the entire body. Decreasing the number of feedings may also be implicated in many of the behavioral aberrations seen in hand-reared ape infants due to loss of body contact time (Fritz et al., 1985).

It is highly advisable to develop a management plan for the infant as soon as the infant is stable and into a regular feeding routine. This management plan should address the progression of steps needed to properly socialize the infant, dam, and other conspecifics (if applicable). Your plan may include positive reinforcement training for all the animals involved in the future reintroduction. Contact AZA Orangutan Husbandry Advisor to assist in developing a plan to determine if any changes are needed as the hand-rearing process progresses.

Considerations for reintroductions of a hand-reared infant: There is a high success rate for infant reintroductions. These include introductions to mothers, surrogate mothers, peers, and older conspecifics. Here are some considerations for review when planning for a reintroduction:

- Provide 24/7 dedicated care in front of the dam's enclosure to ensure visual, tactile, auditory, and olfactory contact with conspecifics.
- Make sure the infant and dam (and other conspecifics) are healthy.
- Ensure interactions between infant and conspecifics are of a positive nature prior to physical introductions.
- Determine how the infant will be fed once reintroduced – this is a critical step and may involve positive reinforcement training.
- Review the introduction plan. This plan should address all potential scenarios that could take place during the introduction. All orangutan keepers and management staff should be involved in the development of the reintroduction plan. Introduction progress should be continually evaluated by caregivers and animal management staff. Management plans should be updated regularly based on the animals' behavior and progress.
- Reintroduce in a familiar place with familiar people. The infant should be very familiar with all aspects of the enclosures in which the reintroduction will take place. Baby doors have worked well in allowing a quick escape in case the introduction does not progress in a positive manner. Limit the amount of staff actually present for the reintroduction as to not overwhelm or distract the animals involved. Do not allow unfamiliar observers to be present. If the introduction is to be videotaped, make sure the animals involved have been desensitized to the presence of a video camera and lighting prior to reintroduction. Once acclimated to a video camera, a remote viewing location set up with a monitor can allow additional staff to view the reintroduction with no disruption to the animals involved.
- When all animals seem adjusted to a step, move on the next. Let the animal's behavior dictate the pace of progression of the introduction. Allow the animals time to interact and adapt to change.
- If staff time allows, formalized behavioral observations should be done to objectively assess the progress of the introduction.
- If the introduction initially dictates short introduction periods, ensure visual, olfactory, and auditory contact between infant and conspecifics.

To summarize, in almost all recent cases of removal, infants have been successfully returned to the mother or have been reared by a surrogate mother. If infants have to be removed from their mothers, prolonged hand-rearing should be avoided. Preparations/planning for a reintroduction should begin immediately. An early reintroduction to the dam is the most preferred situation. Thorough planning prior to any birth is crucial. If a female has previously rejected offspring or exhibits questionable maternal skills, a positive reinforcement training program should be instituted prepartum. The development of training programs in a number of zoos has enabled staff to teach female orangutans to nurse their infants or permit feeding of infants by caregivers. Dedicated 24/7 care for the infant is strongly recommended and is critical in meeting the infant's psychological needs. Infants should be reared within close proximity to the mother to ensure necessary visual, auditory, olfactory, and tactile contact for both the infant and the mother. The introduction of hand-reared infants to conspecifics should be started as early as possible and detailed records should be kept. Contact the AZA Orangutan SSP Coordinator for additional recommendations.

8.6 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size. In the case of an animal on loan from another facility, consult the loan agreement or owner regarding authority to contracept. In the case of permanent contraception, prior permission of the animal's owner should be obtained.

In addition to reversible contraception, reproduction can be prevented by separating the sexes or by permanent sterilization. In general, reversible contraception is preferable because it allows natural social groups to be maintained while managing the genetic health of the population. Permanent sterilization may be considered for certain individuals, including those for whom reproduction would pose health risks, after consulting directly with the AZA Orangutan SSP Coordinator. The contraceptive methods most suitable for orangutans are outlined below. More details on products, application, and ordering information can be found on the AZA Reproductive Management Center (RMC) webpage: www.stlzoo.org/contraception.

Recommended methods include birth-control pills, MGA implants, Depo-Provera® injections, and Implanon® implants. The individual's health, immobilization risks, social situation, and facility design (i.e., constraints on delivery method) are factors to consider in determining the most appropriate contraceptive method for a particular female orangutan.

Combination birth control pills: Human birth control pills are available in different formulations of combined synthetic estrogen and progestin. The human regimen for most formulations is 21 days of hormone treatment and 7 days of a placebo, which results in withdrawal bleeding similar to menstruation. The majority of great apes that have been treated with birth control pills have followed the same regimen. Consumption of birth control pills has been reported to be problematic in some orangutans, so special precautions should be taken to ensure the pill is received each day. A list of birth control pill brands can be found on the WCC webpage, which is updated annually. In animals that are lactating, a progestin-only birth control pill is recommended until the infant is at least one year of age. Combination birth control pills (progestin / estrogen) may be used safely if late in lactation and may provide better protection for contraception. According to human research (World Health Organization, WHO), the amount of E2 that is secreted in the milk is negligible, but these pills may cause a decrease in milk production. For this reason, combination pills are not recommended early in the lactation period. However, if estrous behavior is not desired, some have not included the placebo period. A new formulation designed for 3 months without menses are available (visit RMC webpage for details) which allows for just four withdrawal bleeding weeks a year.

Progestins: Progestins (e.g., MGA Implant, Implanon®, Depo-Provera® injections, Ovaban® tablets) block ovulation and can interfere with sperm transport and implantation. However, they seldom completely prevent follicle growth, so estrous behavior sometimes occurs. MGA implants have been used extensively in orangutans and have proven an effective contraception (for more information, visit WCC website). Progestins are considered safe to use during lactation.

MGA implants: The MGA implant consists of a silastic rod containing 20% by weight of melengestrol acetate, a synthetic progestin. Implants can be ordered from Wildlife Pharmaceuticals, with dosages provided by the WCC (see webpage for exact dosing instructions). MGA implants are considered effective for a minimum of 2 years but may be active longer. Thus, for continued contraception, they should be replaced every 2 years. If reversal is desired, the implant should be removed even if 2 years have elapsed.

Depo-Provera®: This injectable formulation contains the synthetic progestin medroxyprogesterone acetate. The recommended dose is 2 to 3 mg/kg body weight every 2 to 3 months, respectively. Time to reversal varies greatly among females and can be as long as 2 years. It may be best used as an interim contraceptive method.

Implanon®: This single-rod implant containing another synthetic progestin etonogestrel was recently approved for sale in the U.S. It may be effective for as long as 3 years but replacement every 2 years is a more cautious recommendation.

Gonadotropin releasing hormone (GnRH) agonists: GnRH agonists (e.g., Suprelorin® implants or Lupron Depot®) achieve contraception by reversibly suppressing the reproductive endocrine system, preventing production of pituitary (FSH and LH) and gonadal hormones (estradiol and progesterone in females and testosterone in males). The observed effects are similar to those following either ovariectomy in females or castration in males, but are reversible. GnRH agonists first stimulate the reproductive system, which can result in estrus and ovulation in females or temporary enhancement of testosterone and semen production in males. Then, down-regulation follows the initial stimulation. The stimulatory phase can be prevented in females by daily megestrol acetate (2 mg/kg) administration for one week before and one week after implant placement (Wright et al., 2001). Or, the female can be given the progestin-only pill for this time period as well, as an alternative to megestrol acetate.

GnRH agonists should not be used during pregnancy, since they may cause spontaneous abortion or prevent mammary development necessary for lactation. They may prevent initiation of lactation by inhibiting progesterone secretion, but effects on established lactation are less likely. New data from domestic cats have shown no effect on subsequent reproduction when treatment began before puberty; no research in prepubertal orangutans has been conducted.

A drawback of these products is that time of reversal cannot be controlled. Neither the implant (Suprelorin®) nor the depot vehicle (Lupron®) can be removed to shorten the duration of efficacy to time reversals. The most widely used formulations are designed to be effective either 6 or 12 months, but those are for the most part minimum durations, which can be longer in some individuals.

Although GnRH agonists can also be an effective contraceptive in males, they are more commonly used in females, because monitoring efficacy by suppression of estrous behavior or cyclic gonadal steroids in feces is usually easier than ensuring continued absence of sperm in males, since most institutions cannot perform regular semen collections. Suprelorin® has been tested primarily in domestic dogs, whereas Lupron Depot® has been used primarily in humans, but should be as effective as Suprelorin®, since the GnRH molecule is identical in all mammalian species.

If used in males, disappearance of sperm from the ejaculate following down-regulation of testosterone may take an additional 6 weeks, as with vasectomy. It should be easier to suppress the onset of spermatogenesis in seasonally breeding species, but that process begins at least 2 months before the first typical appearance of sperm. Thus, treatment should be initiated at least 2 months before the anticipated onset of breeding. Suprelorin® has been used successfully to control aggression in bachelor groups of Coquerel's sifakas and black lemurs (Williams, 2015).

Vaccines: The porcine zona pellucida (PZP) vaccine has not been systematically tested in orangutans. This approach is not recommended at this time.

Ovariectomy or ovariohysterectomy: Removal of ovaries is a safe and effective method to prevent reproduction for animals that are eligible for permanent sterilization. In general, ovariectomy is sufficient in young females, whereas, removal of the uterus as well as ovaries may be preferred in older females. Before any permanent surgery is performed, the AZA Orangutan SSP should be consulted.

Vasectomy: Vasectomy of males is a safe option if the AZA Orangutan SSP gives permission. It is important to consider the male fertile for at least 6 weeks following the procedure because spermatozoa can survive in the vas deferens after surgery. Reversible vasectomies are possible if the initial surgery was performed open-ended. More information on the vasectomy and reversal can be found on the WCC webpage.

Chapter 9. Behavior Management

9.1 Animal Training

Classical and operant conditioning techniques have been used to train animals for over a century. Classical conditioning is a form of associative learning demonstrated by Ivan Pavlov. Classical conditioning involves the presentation of a neutral stimulus that will be conditioned (CS) along with an unconditioned stimulus (US) that evokes an innate, often reflexive, response. If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the animal will begin to produce a conditioned behavioral response to the CS.

Operant conditioning uses the consequences of a behavior to modify the occurrence and form of that behavior. Reinforcement and punishment are the core tools of operant conditioning. Positive reinforcement occurs when a behavior is followed by a favorable stimulus to increase the frequency of that behavior. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus to also increase the frequency of that behavior. Positive punishment occurs when a behavior is followed by an aversive stimulus to decrease the frequency of that behavior. Negative punishment occurs when a behavior is followed by the removal of a favorable stimulus also to decrease the frequency of that behavior.

AZA Accreditation Standard

(1.6.4) The institution should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the overall health and well-being of the animals.

AZA-accredited institutions are expected to utilize reinforcing conditioning techniques to facilitate husbandry procedures and behavioral research investigations. Institutions should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the health and well-being of the animals (AZA Accreditation Standard 1.6.4). Animal training records should be maintained for good record keeping for each orangutan. These records should document the approximations used to train behaviors and the various behaviors in an ape's repertoire. Training records can also be helpful when problem solving and can assist with communication between current trainers as well as future trainers.

All of the techniques behind positive reinforcement training lead back to one basic principle: *the frequency of a desired behavior can be increased by positively reinforcing the occurrence of that behavior.* The reinforcement should be something the animal wants. It may be a tactile, verbal, food reward, or conspecific. The timing of the delivery of the reinforcement is crucial. It should immediately follow the desired behavior for the animal to make a connection between the behavior and the reinforcement. Once the animal makes this connection, however, it will repeatedly display the behavior to earn additional reinforcement. If the reinforcement is delivered too late, the animal may associate it with a behavior other than the one the trainer was trying to reinforce.

Because it is not always possible to deliver a food or tactile reward immediately following the desired behavior, a "bridge", which may also be called a secondary reinforcer or conditioned reinforcer, is used to bridge the gap between the behavior and the actual reward. The bridge is usually a sound from a whistle, a clicker, or a word that tells the animal, "Yes, that's what I wanted you to do." This sound signals to the animal that a tangible reward will be delivered shortly. Use of a bridge allows a trainer to communicate more exactly the precise action that is desirable and is being reinforced.

When an animal is first learning behaviors or an approximation of a behavior, a reinforcer should be given for each correct response to communicate that this is the behavior that is earning the reinforcement. Once the animal consistently responds correctly and the trainer feels certain the animal has learned the behavior, it is more effective to reinforce the behavior randomly. When using a random or variable schedule of reinforcement, the trainer gives the animal a tangible reward after a variable number of correct responses. This random schedule of reinforcement strengthens the desired behavior. Although the concept of variable reinforcement is somewhat hard to understand, animals tend to get bored if the pattern becomes too predictable, and so it is actually better to reward for every two or three correct responses rather than every response after the behavior has been learned. Variable reinforcement also strengthens a behavior since the animal can't predict when he or she will receive a reward.

Variation in any aspect of the training session also serves to hold the animal's interest. Making some sessions long, some short, some easy and fun, some more challenging, and training in a different enclosure or location in the same enclosure are all good ways to add variety. The size or magnitude of the reward should vary, too. More difficult behaviors deserve rewards of greater value. For a discussion on the importance and implications for varying rewards see Friedman et al. (2006).

Behaviors can be taught either by "capturing" the spontaneous occurrence of a behavior that is already present in the animal's behavioral repertoire, or by "shaping" a new behavior. Capturing a behavior is the process of repeatedly pairing an existing behavior with a reward. For example, if a trainer decides to train an orangutan to take a drink of water on command by capturing the behavior, the trainer would watch the animal, wait until it took a drink, and then quickly sound the bridge and give the animal a reinforcer. After many pairings of taking a drink with a reinforcer, the animal will associate its action of drinking with receiving a reward. It is difficult to capture spontaneous behaviors unless they occur frequently when the trainer is present. If the trainer rarely sees the orangutan drinking, there will be little opportunity to reinforce the behavior and it will take longer for the orangutan to make a connection between drinking and reinforcement.

Shaping involves molding a desired behavior by training small sequential steps that progressively approximate the behavior until the final behavior has been realized. Shaping is usually necessary to train complex behaviors or behaviors that don't occur frequently. The trainer needs to shape a behavior through a series of small steps that approximate the final desired behavior rather than just rewarding a final desired behavior when it occurs. It may take longer to shape a behavior than to capture one that occurs frequently.

Once a trainer is certain that an animal is purposefully behaving a certain way to earn reinforcement, the trainer can put the behavior on a command or "cue", which enables the trainer to request the animal to display the behavior at any particular time. To establish a cue, the trainer precedes the desired behavior with a voice command or hand signal and only reinforces the animal for displaying the desired behavior when it occurs after that cue. For example, to establish a cue for "drinking", the trainer would, upon seeing the animal moving toward the water source for a drink, quickly clap his hands and say the word "drink", the cue he has chosen for this behavior. After many repetitions of pairing the behavior with the cue, the orangutan will associate the clap and words with being reinforced for taking a drink and will eventually offer the behavior for the cue.

Targeting and desensitizing are two of the most commonly used techniques for training most husbandry behaviors. Gaining an understanding of these two methods and learning to apply them can enable the shaping of a variety of husbandry behaviors. Targeting is a way of shaping a behavior from a distance in a situation where physical contact is impossible. When training domestic animals, it is often safe to have physical contact with them, but targeting is a safe extension of a hand that can help show a more dangerous animal, like an adult male orangutan, what is being requested. Targets are a shortcut for shaping many behaviors, including teaching orangutans to present body parts to the enclosure front. Any object that cannot harm the animal if they happen to pull it into the enclosure can be used as a target. Spoons, plastic spatula handles, and wooden dowels can be used effectively as targets.

Desensitizing is the process of making something tolerable that was once aversive. It is taught using successive approximations, but shapes tolerance to a stimulus rather than shaping a physical movement, taking great care not to elicit a fear response. One might desensitize an orangutan to the look and feel of an ear thermometer to dissipate any fear related to it. Desensitizing requires attention to the animal's subtle cues and learning how to read them. Because the animal is being asked to allow something that may be momentarily uncomfortable, it is important for the animal to trust the trainer, and to move ahead slowly. Only move forward when the animal is accepting the current level of stimulation without hesitation. When training a behavior that requires tolerating discomfort, it is very important to reward any discomfort heavily. When an animal is aware of what is going to happen, trusts its trainer, and expects a desirable reward following the behavior, then fear can be avoided.

Helpful husbandry behaviors to train: Voluntary cooperation in these behaviors reduces the need for physical restraint and/or anesthesia, and the accompanying risks associated with those events (Bloomsmith, 1992; Reinhardt et al., 1995). The following trained behaviors are recommended for advanced orangutan husbandry programs:

- **Blood draws and injections**: Some facilities are designed to accommodate blood draws by the use of a steel or strong plastic pipe sleeve attached to enclosure barriers. Orangutans can be trained to insert their arms into the sleeve and allow blood draws or injections. These sleeves can be removed when not in use (Coe et al., 2001). The use of the sleeve allows the staff access to the orangutan in a relatively safe manner. Orangutans can also be trained to present body parts against a mesh barrier to accommodate vaccines, anesthesia, and insulin injections.

- **Medical procedures**: Orangutans can be trained to cooperate during medical procedures, such as presenting the chest for the use of a stethoscope, or an ear for the use of a thermometer. Additionally, orangutans can be trained to present their abdomen so that ultrasounds can be performed. Cardiac ultrasound, blood pressure, and chest x-ray are additional behaviors that have been trained in orangutans.
- **Scales**: Weighing individuals regularly can help detect illness or physiological changes that can affect overall health. It also ensures more accurate drug dosing. Weighing stations may be built-in features within transfer areas, or freestanding scales may be rolled into place. A scale attached to a climbing rope can also be used. Using these approaches, weights can be obtained without sedating the orangutans (Coe et al., 2001).
- **Urine collection**: A regular collection of urine can be used to monitor the reproductive cycle, stress, and other health indicators of orangutans. Urine collection can be facilitated by the construction of a trough or specialized drain that orangutans can be trained to use (Coe et al., 2001), or by providing areas where orangutans can be trained to urinate on command into a small receptacle held by the trainer.
- **Maternal behavior:** Numerous behaviors can be trained to encourage appropriate maternal behaviors toward an infant orangutan, and/or help a female develop and learn appropriate behaviors with some assistance and reinforcement. These behaviors should be trained proactively with females prior to and during pregnancy, as well as with other females who could serve as surrogate mothers if needed. Please contact the AZA Orangutan SSP Husbandry Advisor for details.
- **Station**: Orangutan holds place at a specified location, which may be identified with a station marker such as a colored piece of PVC tubing that is distinguishable from other markers in use.
- **Shifting**: Orangutan moves from one location to another upon command. This may be prompted with station markers, laser pointers, or other indicators.
- **Body present**: Orangutan provides access to specific body parts through a mesh barrier to allow a keeper's touch or visual inspection without interference. Common body parts that are easily trained are shoulder, head, ear, arm, leg, back, and open mouth.
- **Injection**: Orangutan is trained to tolerate the presence of a syringe and needle to the point of the blunted end touching his shoulder. This training can progress to the point of faux injections that simulate real medical procedures, and actual injections.

Specific enclosure designs recommended to promote successful training programs within orangutan facilities should include good visual access to animals in all areas, multiple access points to animals both on and off exhibit, multiple shifting points to allow access to animals as they are moved through the facility, and built-in mounts for husbandry and medical apparatus, such as blood collection sleeves or urine collection pans. Also important are large mesh access points for safe treatment of wounds or delivery of injections, overhead mesh chutes, and multiple and connected off-exhibit areas with no dead ends (Laule, 1995).

A safe means to provide close contact between caregivers and apes should be devised for each situation. Ports that can be opened during training sessions can provide more access to the orangutans. The type of barrier will also affect access. Some trainers prefer mesh with openings as large as 7 cm x 7 cm (3 in. x 3 in.) so that objects of this size can be passed through. However, 5 cm x 5 cm (2 in. x 2 in.) mesh is more commonly provided. Each institution should accept responsibility for the possible risks inherent in their choice of materials and opening sizes (Coe et al., 2001).

9.2 Environmental Enrichment

Environmental enrichment, also called behavioral enrichment, refers to the practice of providing a variety of stimuli to the animal's environment, or changing the environment itself to increase physical activity, stimulate cognition, and promote natural behaviors. Stimuli, including natural and artificial objects, scents, and sounds are presented in a safe way for the orangutan to interact with. Some suggestions include providing food in a variety of ways (i.e., frozen in ice or in a manner that requires an animal to solve simple puzzles to obtain it), using the presence or scent/sounds of other animals of the same or different species, and incorporating an animal training (husbandry or behavioral research) regime in the daily schedule.

AZA Accreditation Standard

(1.6.1) The institution must follow a formal written enrichment program that promotes species-appropriate behavioral opportunities.

AZA Accreditation Standard

(1.6.3) Enrichment activities must be documented and evaluated, and program refinements should be made based on the results, if appropriate. Records must be kept current.

Enrichment programs for orangutan should take into account the natural history of the species, individual needs of the animals, and facility constraints. The orangutan enrichment plan should include the following elements: goal setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. The orangutan enrichment program should ensure that all environmental enrichment devices (EEDs) are "orangutan" safe and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes orangutan-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1). Enrichment activities must be documented and evaluated, and the program should be refined based on the results, if appropriate. Records must be kept current (AZA Accreditation Standard 1.6.3).

Orangutan enrichment programs should be integrated with veterinary care, nutrition, and animal training programs to maximize the effectiveness and quality of animal care provided. AZA-accredited institutions must have a specific staff member(s) assigned to oversee, implement, assess, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

AZA Accreditation Standard

(1.6.2) The institution must have a specific paid staff member(s) or committee assigned for enrichment program oversight, implementation, assessment, and interdepartmental coordination of enrichment efforts.

Environmental enrichment is a term which is used to describe a range of methods that can improve animal welfare, and includes everything from social companionship to toys (Young, 2003). Bloomsmith et al. (1991) identified five major types of enrichment, each with subcategories:

- (1) Social
  - (1.1) Contact
    - (1.1.1) Conspecific (pair, group, temporary, permanent)
    - (1.1.2) Contraspecific (human, non-human)
  - (1.2) Non-contact
    - (1.2.1) (visual, auditory, co-operative device)
    - (1.2.2) (human, nonhuman)
- (2) Occupational
  - (2.1) Psychological (tasks or puzzles, control of environment)
  - (2.2) Exercise (mechanical devices, run)
- (3) Physical
  - (3.1) Enclosure
    - (3.1.1) Size (alterations)
    - (3.1.2) Complexity (panels for apparatus)
  - (3.2) Accessories
    - (3.2.1) Internal
      - (3.2.1.1) Permanent (furniture, bars, swings)
      - (3.2.1.2) Temporary (toys, ropes, substrates)
    - (3.2.2) External (hanging objects, puzzles, mirrors)

(4) Sensory
- (4.1) Visual (tapes, television, images, windows, lighting)
- (4.2) Auditory (music, recordings of vocalizations)
- (4.3) Other stimuli (olfactory, tactile, taste)

(5) Nutritional
- (5.1) Delivery (frequency, schedule, presentation, processing time required)
- (5.2) Type (novel, variety, browsing, treats)

The type of enrichment devices and opportunities provided varies greatly between institutions. Consideration should be given to naturalistic versus non-naturalistic enrichment. A combination may be used: naturalistic while the animals are in public view and non-naturalistic in the holding enclosures. The options available for animals that are off public view can actually be more diverse and cost-effective because the emphasis can be purely about function rather than aesthetics, like puzzle boards, toys and other artificial devices.

Designing environmental enrichment devices can be a time consuming and complex process. It is important to evaluate if the time, energy and money put into the device design is cost-effective. Many enrichment items can be obtained at very low cost or for free. A notice can be posted on staff bulletin boards, listing the items needed, e.g., phone books, blankets, old toys or plastic pools. A predetermined drop-off location for donations can be established for staff, docents or volunteers. Working with local vendors or zoological society members can also be a source of free or low-cost enrichment items, such as burlap bags from coffee bean distributors or carpet rolls from flooring companies. Sharing ideas on the AZA Network can be an excellent means to increase variety. Caregivers should work with their managers to develop an appropriate enrichment rotation for their facility.

Social environment: Many orangutans thrive in social groups as opposed to being solitary. Group composition will vary institutionally. The number of animals housed together depends on the individual animal personalities and enclosure space. Orangutan management may differ greatly from management of other great ape species due to a much different social system. Opportunities for social contact can provide valuable stimulation for compatible animals. Environmental enrichment may be achieved by further modifying the social environment of an animal. This environment consists of potential interactions with conspecifics, other species in multi-species exhibits, and members of the animal care staff. The addition of conspecifics creates opportunities for the expression of species-specific social behavior including courtship, mating, grooming and playing. Overall activity levels are likely to increase as well (Baer, 1998). The US Department of Agriculture (USDA) administers the Animal Welfare Act, under which certain standards of enrichment are mandated for nonhuman primates, including requirements for social housing. See Animal Welfare Act Part 3, Subpart D, Section 3.81a for detailed requirements.

Poole (1987) suggests that play seems to occupy an important role in the life of managed juvenile, adolescent and subadult orangutans. In many *ex situ* social situations, play can be observed across all age ranges. In cases in which animals should be isolated, social stimulation can come from visual, auditory, or olfactory stimuli rather than the actual physical presence of another animal (Kreger et al., 1998). These animals have a greater need for enrichment and attention from caregivers. Animals that may have the highest priority for enrichment are those in quarantine situations, animals that are separated from conspecifics for medical management, animals that are preparing for transfer to other institutions, and groups that are changed for breeding purposes.

Physical environment: *Ex situ* conditions provide animals with regular food, water and shelter. The physical environment encompasses temperature, humidity, illumination and sound exposure. When designing an exhibit for orangutans, consideration should be given to the animals' natural behavior. Arboreal locomotion can easily be encouraged by providing usable horizontal and vertical space, including nesting platforms and climbing structures. Installing ropes, firehose, vines, hanging branches, ladders, sway poles and mesh in enclosures will promote brachiation and activity. Orangutans can easily become overweight, so promoting activity is desirable. Installing privacy barriers in an exhibit can reduce stress while giving the individuals a break from conspecifics and zoo visitors. Elevated platforms, horizontal aerial pathways and nesting materials should be provided, in addition to the climbing structures for accessibility, which increase activity levels. These objects and climbing structures can be the most stimulating options for the animals.

When designing enclosure structures and enrichment devices, orangutan strength and ability to use tools should be considered. Appropriately implemented programs can contribute to better animal health by creating opportunities for the animal to exert some level of control over its environment. Whether the enrichment gives the animal the ability to avoid stressful external stimuli or the opportunity for displacement behavior, it allows the animal a means for stress reduction and helps to reduce the risk for any associated health problems (Baer, 1998). Providing a combination of fixed objects (trees, ground substrate, climbing structures, etc.) and manipulatable objects (ropes, browse, enrichment devices, etc.) is highly recommended. Wilson (1982) demonstrated that “the environmental complexity of an enclosure such as the inclusion of fixed, moveable and temporary objects, was more important to the orangutans, than the size of the enclosure, frequency of feedings or available surface area” (Cocks, 2002). Perkins (1992) confirmed Wilson’s findings.

Many zoological institutions are nonprofit organizations that are supported by local governments, visitor admissions, donations and grants. Many visitors are attracted to zoos for recreational purposes, and although it may not be the primary purpose of the institution, recreation is often the avenue of support for other zoo interests such as education, research and conservation (Hutchins & Fascione, 1991). Enrichment is a means to facilitate animal visibility and thus contribute to an exhibit’s recreational and educational potential. Different methods of feeding animals on exhibit can also be employed to make them more visible by drawing them toward more ideal viewing areas.

Enrichment strategies do have their constraints which differ from one institution to another. According to Mench (1998), the primary constraints on environmental enrichment strategies in zoological institutions are 1) resource availability, which includes social companions and materials from a natural habitat; 2) animal health; 3) aesthetics and acceptability to visitors; 4) space; and 5) conservation mission. When providing for orangutans that can be sometimes destructive in nature, exhibit and enrichment device maintenance and replacement should be included in the annual budget. This adds to the expense of enrichment in terms of caregiver time involvement as well as the financial aspect.

Husbandry routine: Enrichment should be considered a basic and necessary part of every orangutan caregiver’s daily husbandry routine. One should never forget that good animal husbandry and animal welfare are totally dependent on good management by animal caregivers. Making some changes in the basic husbandry routine can be easily accomplished while increasing the enrichment opportunities for the animals in one’s care. Studies have shown a marked increase in activity associated with the introduction of enrichment items (Tripp, 1985). Variety is important and can be accomplished through changing the daily routine of cleaning, feeding and training schedules, or rotating the enclosure(s) to which an animal has access. When developing the husbandry routine for orangutans, the focus should be on promoting foraging, activity, and arboreal locomotion while giving the animals the opportunity to have an element of control over their environment.

Allowing an animal to have some control over part of their day is very important to psychological well-being. Feeding behavior and ecology can be particularly important in formulating enrichment strategies for managed orangutans. Many studies have shown that managed animals prefer to work for their food, rather than to be fed *ad libitum* (Kreger et al., 1998). The more interesting, challenging and naturalistic ways that food can be provisioned, the more successful enrichment projects have been (Shepherdson, 1992).

All orangutans should be provided with fresh nesting material on a daily basis. Nesting material promotes species-typical behavior while giving the animals a comfortable place to rest. In addition, nesting material provides an excellent opportunity to promote foraging behavior. Foraging for food items mixed in straw, timothy hay, shredded paper or wood wool (natural wood excelsior) will occupy most animals for hours. Encouraging a time budget closer to that of wild orangutans that spend a large part of their day foraging for food can help to reduce or eliminate the performance of abnormal behavior. Enrichment opportunities can be diet-related. An animal’s regular diet can be presented in many ways. For example, an animal can be encouraged to climb and search for food by distributing the regular diet throughout the enclosure instead of placing it in a single pile in the enclosure.

Novelty, presentation method, and timing can all add variety to any program. For example, Barbiers (1985) found that orangutans consumed more monkey chow when it was presented in varied colors. Multiple smaller feedings may be more enriching than the same quantity of food presented in just two daily meals. Feeding enrichment can help to reduce the occurrence of abnormal behavior and improve the physical condition of the animals (Young, 1997). Orangutans can easily become obese, and encouraging animals to obtain their food in an active manner can help to alleviate this problem. Regular food items can be chopped into smaller pieces or frozen into a large block of ice.

Browse: The benefits of browse as a form of environmental enrichment have been well documented and is now understood to be an important part of orangutan diets. Offering browse to orangutans regularly provides nutritional supplements to the diet, stimulates natural behavior activities, and helps to decrease unwanted or stereotypic behaviors. The provision of browse may contribute to reductions in the expression of coprophagy (more commonly observed in gorillas than orangutans) and regurgitation/reingestion (R & R) behavior (Maple & Perkins, 1996). By offering more complex food items that may require increased processing time to consume, feeding time is increased. Before offering an animal any type of browse material, it is imperative that each plant species be researched for the poisonous potential of all aspects of the plant. Also, look for the list of browse items used at multiple institutions in Appendix G.

An ideal way to obtain browse for orangutans is to contact local councils or parks for donations of browse during routine pruning operations. It is critical to verify that any material received in donation has not been sprayed with any toxins, such as pesticides, and has not been subjected to high levels of pollution. When fresh-cut browse is received and not fed immediately, it may be stored in containers with water or in cool rooms to maintain freshness. In areas where colder climates do not allow for year-round growth outdoors, browse may be put in containers and frozen to prolong availability. Many zoological institutions have created successful botanical gardens on their premises.

Providing browse to orangutans is a simple means of forming a connection between caregivers and visitors through education. Discussing the many benefits of browse with visitors is an easy way to help connect people with animals and nature. While many zoo guests recognize browse as a form of food, they may observe orangutans using browse in many different ways. Some animals use browse in affiliative play interactions between conspecifics, as a means of building a sleeping nest as they would do in the wild, or as a tool to extract hard-to-reach or hidden food items (Nakamichi, 2004; Samson & Shumaker, 2015).

Novelty: Novelty and variability are an important part of any enrichment program. Adding a variety of novel objects will reduce the rate of habituation and give individuals more choices. Studies show that enrichment programs that offer novel items result in a reduction in lethargy of orangutans (Wright, 1995). Avoid boredom by rotating enrichment devices and food items. When many environmental enrichment devices are available, they can be utilized on a bi-weekly or monthly basis.

Safety: Use of any enrichment device or item should be approved by curators, veterinary staff and nutrition experts for each individual animal. There have been documented cases of animal injury related to unsafe environmental enrichment devices, including great apes that have drowned in deep water moats, ingestion of rope resulting in fatality, strangulation by loose rope, and zinc toxicosis from galvanized metal. The following list of questions from Young (2003) should be kept in mind when developing and implementing an environmental enrichment device (which includes ropes, chains, etc.):

- Does the device have any sharp edges?
- Can the animal's head, digits, limbs or other appendages become trapped inside any part of the device?
- How likely is it that the animal could break the device? If the device could be broken, would it break into sharp fragments or would the constituent parts of the device pose a safety risk?
- Could the device be dismantled by the animal? If the device could be dismantled, would any constituent parts pose a safety risk?
- Can the device or any part of it be swallowed?

- Is the device made of non-toxic material?
- Could the animal gnaw pieces off the device?
- Can the device be cleaned adequately or sterilized to prevent disease transmission?
- Can the animal become entangled in the device?
- Could the animal use the device as an instrument to harm conspecifics, caregivers, or facility visitors?
- Could the animal use the device to damage its enclosure? This is especially important in enclosures with glass windows. Orangutans in some zoos have learned that a sharp blow with a hard object to the corner of a shatter-proof window will break the glass.
- Could the animal use the device to facilitate escape from its enclosure?
- Can the animal see the object?
- Are devices using electronics properly grounded and insulated?
- Can the device be filled and maintained quickly?
- Does the installation of the device block any caregiver access or restrict views of the animals?
- Does use of the device require the caregiver to enter the enclosure?
- Is the device of the simplest design possible?

Once the safety guidelines have been addressed, the finished device should be tested before it is given to an animal. Some basic tests include the drop test, sharp edge and seams test, and testing the strength of the seams and attachments. When using metal chains and connections, the use of stainless steel should be investigated, as it is highly durable and will not rust or become a hazard as galvanized metal can. Strong connections with glue such as Loctite® are recommended since an orangutan can readily loosen screws or bolts that would take a human many hours to tighten with tools.

9.3 Staff and Animal Interactions

Animal training and environmental enrichment protocols and techniques should be based on interactions that promote safety for all involved. Caregiver-orangutan interaction is inevitable during the course of the daily care of orangutans. The relationship that forms between caregivers and orangutans influences all aspects of care. The form that relationship takes will depend on a variety of factors, including knowledge of the species, understanding of what the job entails, attitudes and expectations of the caregivers, the behavior of individual orangutans, and the tools and techniques a caregiver has to accomplish daily tasks.

The AZA Ape TAG recommends 'protected contact' for managing adult apes; there should always be a protective barrier between the ape and the human caregiver, and the two should never share the same unrestricted space. The reasons for this are threefold: 1) safety concerns for the keeper (directed and accidental injuries); 2) short- and long-term effects of extended human interaction on the apes (such as maternal, sexual and behavioral effects); and 3) the influence of human interaction on public perception of apes (and their suitability as pets). In cases where keepers should have direct contact with apes (such as in a nursery-rearing scenario), the AZA Orangutan SSP recommends that these interactions take place with appropriate zoonotic considerations, and not within view of the public. Access to any orangutan area should be limited to those individuals trained in the proper safety and care procedures, or supervised by those individuals. A secondary containment area should be established to allow any keeper a means of protection in the event of an escape.

Facilities should be designed with the facilitation of operant conditioning training in mind. As such, there should be sufficient mesh panels allowing protected contact between keepers/trainers and the orangutans. These panels should be as numerous as possible to increase the flexibility of training opportunities, including, if possible, panels at varying heights.

Care should be taken to reduce the likelihood of zoonotic disease transmission. Use of masks and latex gloves is recommended when working with orangutans. Trainer/keepers that are experiencing any illness should abstain from interacting with the apes through mesh. Likewise, care should be taken to reduce the risk of physical injury as orangutans can grab fingers, hair, and clothing through the protective barrier. Loose-fitting clothing and jewelry should be restrained, replaced or removed and long hair should be netted or tied back. Care should be taken to be aware of the location of orangutans' hands, feet, and mouths at all times during training sessions, as well as the location of conspecifics in the training location if the trainee is not separated. A commonly used strategy during training is to request that the orangutan stay in contact with a target (often a small plastic item such as a PVC elbow joint, which is easily clipped onto the mesh) with their hand. Inserting fingers through the mesh incurs a risk of biting and as such human body parts should never enter into the orangutans' side of the barrier.

9.4 Staff Skills and Training

Orangutan staff members should be trained in all areas of orangutan behavior management. Funding should be provided for AZA continuing education courses, related meetings, conference participation, and other professional opportunities. A reference library appropriate to the size and complexity of the institution should be available to all staff and volunteers to provide them with accurate information on the behavioral needs of the animals with which they work.

The foundation for a good caregiver relationship with orangutans is multifaceted. Knowledge and understanding of the species' behavior is essential. It is important to understand how a wild orangutan interacts with its environment and other conspecifics. Becoming familiar with this information will not only help staff interpret behaviors of the orangutans in their care but will help in defining solutions to problems affecting their lives. For example, orangutans are arboreal and live in habitats that are highly flexible and movable. This understanding encourages the provision of exhibits that facilitate climbing and nesting high off the ground. By making regular changes to the pathways for travel in exhibits and holding enclosures, animals are presented with variety and mental stimulation, which is an important aspect of orangutan husbandry. The development and maintenance of a mutually trusting relationship between caregiver and orangutan is critical to the successful management of the taxon.

Knowing the life history of individual orangutans is also very important. Are they wild or zoo born, hand-reared or mother-reared? Species traits and individual characteristics combine to form a unique personality for each orangutan. Learning the past histories of animals—where they have lived, which other orangutans they have lived with, and the characteristics of their previous relationships with conspecifics and caregivers—can aid in the interpretation of an individual's behavior. APES profiles help to provide a wide variety of behavioral, housing, and historical information for the majority of the orangutans within the AZA SSP population.

Open communication with previous caregivers is essential. This not only provides an opportunity to learn from contact with others zoological professionals, but also gives former caregivers much appreciated regular updates on the status of an animal with whom they have had a prior relationship. Former caregivers can always provide useful information that will benefit both caregiver and animal.

Finally, it is important for all staff members to have a solid understanding of positive reinforcement training and the ability to effectively use the techniques. At least one individual should have training skills to help deal with difficult situations or problems when they arise.

Chapter 10. Research

10.1 Known Methodologies

AZA believes that contemporary orangutan management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research both in *in situ* and *ex situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. This knowledge might be achieved by participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials (AZA Accreditation Standard 5.3). An AZA institution must demonstrate a commitment to scientific study that is in proportion to the size and scope of its facilities, staff, and animals (AZA Accreditation Standard 5.0).

> **AZA Accreditation Standard**
>
> **(5.3)** The institution should maximize the generation and dissemination of scientific knowledge gained. This might be achieved by participating in AZA TAG/SSP sponsored studies when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

> **AZA Accreditation Standard**
>
> **(5.0)** The institution must have a demonstrated commitment to scientific study that is in proportion to the size and scope of its facilities, staff (paid and unpaid), and animals.

All record-keeping requirements noted previously apply to most research animals, especially those which are part of the exhibit collection. When an animal on loan to a facility is subject to an invasive research procedure, including when done as part of a routine health exam, the owner's prior permission is to be obtained.

Orangutans are managed by the AZA Orangutan SSP. Along with the other ape taxa, the AZA Orangutan SSP falls under the oversight of the Ape TAG. Orangutans are critically endangered in the wild primarily because of clear-cutting for oil palm plantations, illegal logging and hunting. As intelligent animals that play a vital role in forest ecosystems, it is important for us to implement effective conservation plans for them. To do this, we need strong scientific research to help advance the understanding of conditions affecting orangutans in the wild, how they cope with certain habitat changes, how best to rehabilitate and reintroduce confiscated orangutans, ecological information, and more. In addition, orangutans are valuable to study both in the wild and managed environments because of their evolutionary similarities to humans. As such, they can help us to better understand human evolution.

Although orangutans have historically been studied less than the other great apes, there are many zoological institutions that house orangutans. Some of these institutions may be willing to collaborate with research projects. In looking for potential collaborators, we recommend the use of the International Directory of Primatologists: http://pin.primate.wisc.edu/idp/wdp.

Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of the species being investigated and may provide results which benefit the health or welfare of animals in wild populations. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations, and these types of programs are strongly encouraged by the AZA.

Research with orangutans has taken many forms and has given us much information about their behavior, intelligence, ecology, genetic make-up, physiology, life history, and conservation status. Research on orangutans can also help to inform zoological care-giving techniques by monitoring behavior and health before and after management changes. Research like this is important to establish biological and behavioral markers of improved health and well-being that are based on solid scientific data. Because of this, it is important to consider collaborations with researchers that may request assistance with gathering/providing data and/or biological samples from zoo-housed orangutans.

AZA-accredited institutions are required to have a clearly written research policy that includes a process for the evaluation of project proposals and identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified staff member or committee to oversee and direct its research program (AZA Accreditation Standard 5.1).

An Institutional Animal Care and Use Committee (IACUC) should be established within the institution if animals are included in research or instructional programs. The IACUC should be responsible for reviewing all research protocols and conducting evaluations of the institution's animal care and use.

If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by Taxon Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs.

Many zoos have begun supporting orangutan field researchers and conservationists. This is a great way to connect a zoo's orangutans to those that live in the wild, and to highlight this link to visitors. There are many worthy organizations that oversee orangutan conservation and research in the field. The AZA SSP has a Field Advisory Subcommittee that is available to help zoos obtain the information they need about where and how to send funding to orangutan conservation and research projects. This subcommittee can provide participating institutions with the most recent requests for funds for various projects, detailed information on various projects' missions and goals, safe ways to send money to the projects, and updates on how contributions have been used. Projects can be matched to an institution's mission and vision. Recommended projects address different facets of orangutan conservation including habitat protection efforts, rehabilitation work, education outreach projects, capacity building efforts, firefighting, and conservation-based research. The AZA Orangutan SSP goal is to have all participating institutions supporting orangutan conservation in a tangible way. Please notify the AZA SSP if your institution provides support to a project. This will allow tracking and accurate record keeping about such support.

AZA Accreditation Standard

(5.2) The institution must follow a formal written policy that includes a process for the evaluation and approval of scientific project proposals, and outlines the type of studies it conducts, methods, staff (paid and unpaid) involvement, evaluations, animals that may be involved, and guidelines for publication of findings.

AZA Accreditation Standard

(5.1) Scientific studies must be under the direction of a paid or unpaid staff member or committee qualified to make informed decisions.

10.2 Future Research Needs

This Animal Care Manual is a dynamic document that will need to be updated as new information is acquired. Knowledge gaps have been identified throughout the Manual and are included in this section to promote future research investigations. Knowledge gained from these areas will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species.

Although we know and have learned a great deal about caring for orangutans over the years, there are still some significant gaps in our knowledge of orangutan husbandry. Some areas that deserve more research include:

- Husbandry routines and exhibits that best promote arboreality, increase activity, and decrease lethargy.
- Daily caloric needs and food items that provide the healthiest diet.
- Preventing obesity and subsequent health risks that are linked to being overweight, such as diabetes.
- Ideal social structures.
- Causes, treatments, and prevention of respiratory disease.
- Prevention and reduction of undesirable behaviors such as regurgitation and re-ingestion.
- Reproductive information such as ideal contraception, what constitutes "normal" reproductive behavior, and arrested development in males.
- Orangutan personality and its links with behavior, management, and reproductive decisions.
- Influence of keeper style/personality on orangutan behavior.
- Ways to increase psychological complexity of the zoo environment and increase orangutan

control.

- The influence of zoo visitors on orangutan well-being.

Chapter 11. Other Considerations

11.1 Surplus Animals

All AZA SSP species held by institutions should be reported to the AZA SSP Program Leaders. The AZA SSP Program Leader should be responsible for making the decision as to whether or not specific animals are to be included in the managed population (e.g., over-represented animals or animals beyond reproductive age). Those animals not included in the managed population should be considered surplus to the managed population, but records still should be maintained on them to the same degree as those in the managed population. All orangutans managed in AZA institutions are considered part of the SSP, including hybrids - no orangutans, hybrid or otherwise, are considered surplus unless specifically so designated. If the recommendation is made to place an SSP orangutan in a non-AZA institution, such a decision should be communicated by the SSP to the appropriate organizations (Ape TAG, PMC, etc.) in writing.

Until the latter part of the 20th century, most zoological collections managed orangutans as a single species, regardless of individual origin, thereby creating a large hybrid population. Significant genetic studies performed in the 1980s and 1990s demonstrated that the orangutans from the two islands are indeed genetically distinct and classifiable as separate species – Pongo pygmaeus (Bornean orangutan) and Pongo abelii (Sumatran orangutan). The previous system classified the taxon as one species with two subspecies, Pongo pygmaeus pygmaeus (Bornean) and P.p. abelii (Sumatran). Species-level classification was advocated jointly in April 2000 by Conservation International, the IUCN/SSC Primate Specialist Group, and the Center for Environmental Research and Conservation. The newer system, recognizing two distinct species, is universally accepted today, based on genetic and morphological data.

Because the species (at the time, subspecies) distinction was not clearly understood until the late 1980s, there was a sizeable population of “hybrid” orangutans in human care worldwide. In 1985, the Orangutan SSP adopted a policy placing a moratorium on the production of hybrid orangutans. The other regional management programs (Europe and United Kingdom, Australia and New Zealand, Southeast Asia, Japan) adopted similar policies during the same time period. In 1994, the Orangutan SSP Steering Committee extended the policy to recommend that permanent surgical sterilization be accomplished for all hybrid orangutans held in situations in which there was any possibility of potential reproduction (whether by accident or by design), if the health of the animal permitted such surgery. This recommendation was based on the fact that despite the 1985 breeding moratorium, a low rate of production of hybrid orangutans persisted through accident; constraints on holding space made it difficult to find future suitable homes for orangutans thus produced unintentionally; and despite the potential value of hybrid orangutans as social companions and in assisted reproductive technology or other research, the Steering Committee did not believe that value would ever outweigh the potential risk inherent in maintaining their intact reproductive status. The preferred methods of sterilization are tubal ligation for females and vasectomy for males.

It is important to note that it has never been the policy or the recommendation of the Orangutan SSP to castrate any orangutan, and this has never been done under the auspices of the SSP. Similarly, the SSP has never advocated or recommended that an orangutan be hysterectomized except for reasons of individual health – never because of genetic lineage.

It is equally important to emphasize that hybrid orangutans are housed and managed identically to their Bornean and Sumatran counterparts; all orangutans in the SSP are managed equally regardless of genetic lineage. Most members of a zoo’s visiting public would never be able to differentiate between the species “by eye,” so the educational and exhibit messaging does not need to vary – the same message can be conveyed regardless of orangutan species displayed. Hybrid orangutans are a nonbreeding population within the SSP, but they are not an unmanaged or “surplus” population.

11.2 Additional Information

The Ape Profile and Evaluation System (APES) is a project started in 1995 by the AZA Orangutan SSP Husbandry Advisor (Appendix B). Its purpose is to provide a thorough behavioral and social history picture for any orangutan within the AZA SSP population. Information collected on these forms includes rearing and social history, personality traits, diet, behavioral enrichment, training, exhibits, and reproductive history.

All of the information gathered from the profiles is reviewed to search for trends and potential concerns in *ex situ* orangutan management. One of the first analyses done on the data set was to examine rearing trends. One of the goals of the AZA SSP is to eliminate hand-rearing of infants as it does not provide proper socialization and can use a great deal of staff resources. Many other trends are likely to be uncovered through examination of APES forms. Please contact the AZA Orangutan SSP coordinator for the APES form and/or for a completed example.

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Personal Communications (Optional)
Joseph Smith, DVM, Ft. Wayne Children's Zoo, 2016

Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to orangutans are taken from the AZA Accreditation Standards and Related Policies (AZA, 2017) and are referenced fully within the chapters of this animal care manual:

General Information

(1.1.1) The institution must comply with all relevant local, state/provincial, and federal wildlife laws and/or regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and/or regulations. In these cases the AZA standard must be met.

Chapter 1

(1.5.7) The animals must be protected or provided accommodation from weather or other conditions clearly known to be detrimental to their health or welfare.

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. Warning mechanisms and emergency backup systems must be tested periodically.

Chapter 2

(1.5.1) All animals must be well cared for and presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' welfare requirements with aesthetic and educational considerations.

(1.5.2) All animals must be housed in enclosures which are safe for the animals and meet their physical and psychological needs.

(1.5.2.1) All animals must be kept in appropriate groupings which meet their social and welfare needs.

(1.5.2.2) All animals should be provided the opportunity to choose among a variety of conditions within their environment.

(10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being. AZA housing guidelines outlined in the Animal Care Manuals should be followed.

(10.3.4) When sunlight is likely to cause overheating of or discomfort to the animals, sufficient shade (in addition to shelter structures) must be provided by natural or artificial means to allow all animals kept outdoors to protect themselves from direct sunlight.

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to either the institution's animals, the free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully monitored, and treated humanely at all times.

(11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

(1.5.15) All animal exhibit and holding area air and water inflows and outflows must be securely protected to prevent animal injury or egress.

(2.8.1) Pest control management programs must be administered in such a manner that the animals, paid and unpaid staff, the public, and wildlife are not threatened by the pests, contamination from pests, or the control methods used.

(11.3.6) There must be barriers in place (for example, guardrails, fences, walls, etc.) of sufficient strength and/or design to deter public entry into animal exhibits or holding areas, and to deter public contact with animals in all areas where such contact is not intended.

(11.2.4) All emergency procedures must be written and provided to appropriate paid and unpaid staff. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

(11.2.5) Live-action emergency drills (functional exercises) must be conducted at least once annually for each of the four basic types of emergency (fire; weather or other environmental emergency appropriate to the region; injury to visitor or paid/unpaid staff; and animal escape). Four separate drills are required. These drills must be recorded and results evaluated for compliance with emergency procedures, efficacy of paid/unpaid staff training, aspects of the emergency response that are deemed adequate are reinforced, and those requiring improvement are identified and modified. (See 11.7.4 for other required drills).

(11.6.2) Security personnel, whether employed by the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e. shooting teams).

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

(11.2.0) A paid staff member or a committee must be designated as responsible for ensuring that all required emergency drills are conducted, recorded, and evaluated in accordance with AZA accreditation standards (see 11.2.5, 11.5.2, and 11.7.4).

(11.2.7) A written protocol should be developed involving local police or other emergency agencies and include response times to emergencies.

(11.5.3) Institutions maintaining potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals. Appropriate response procedures must also be in place to deal with an attack resulting in an injury. These procedures must be practiced routinely per the emergency drill requirements contained in these standards. Whenever injuries result from these incidents, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident.

Chapter 3

(1.4.0) The institution must show evidence of having a zoological records management program for managing animal records, veterinary records, and other relevant information.

(1.4.6) A paid staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all paid and unpaid animal care staff members apprised of relevant laws and regulations regarding the institution's animals.

(1.4.7) Animal and veterinary records must be kept current.

(1.4.4) Animal records and veterinary records, whether in electronic or paper form, must be duplicated and stored in a separate location. Animal records are defined as data, regardless of physical form or medium, providing information about individual animals, or samples or parts thereof, or groups of animals.

(1.4.5) At least one set of the institution's historical animal and veterinary records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisition, transfer, euthanasia, release, and reintroduction.

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution.

(1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies/groups or other animals not considered readily identifiable, the institution must provide a statement explaining how recordkeeping is maintained.

Chapter 4

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to.

(1.5.10) Temporary, seasonal and traveling live animal exhibits, programs, or presentations (regardless of ownership or contractual arrangements) must be maintained at the same level of care as the institution's permanent resident animals, with foremost attention to animal welfare considerations, both onsite and at the location where the animals are permanently housed.

Chapter 6

(2.6.2) The institution must follow a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

(2.6.3) The institution must assign at least one paid or unpaid staff member to oversee appropriate browse material for the animals (including aquatic animals).

Chapter 7

(2.1.1) A full-time staff veterinarian is recommended. In cases where such is not necessary because of the number and/or nature of the animals residing there, a consulting/part-time veterinarian must be under written contract to make at least twice monthly inspections of the animals and to respond as soon as possible to any emergencies.

(2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animals24 hours a day, 7 days a week.

(2.0.1) The institution should adopt the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals,* and policies developed or supported by the American Association of Zoo Veterinarians (AAZV). The most recent edition of the medical programs and hospitals booklet is available at the AAZV website, under "Publications", at http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839, and can also be obtained in PDF format by contacting AZA staff.

(2.2.1) Written, formal procedures must be available to paid and unpaid animal care staff for the use of animal drugs for veterinary purposes, and appropriate security of the drugs must be provided.

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals. Quarantine duration should be assessed and determined by the pathogen risk and best practice for animal welfare.

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/displaycommon.cfm?an=1&subarticlenbr=839.

(2.7.2) Written, formal procedures for quarantine must be available and familiar to all paid and unpaid staff working with quarantined animals.

(11.1.2) Training and procedures must be in place regarding zoonotic diseases.

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate paid and unpaid staff in order to assure the health of both the paid and unpaid staff and the animals.

(2.5.1) Deceased animals should be necropsied to determine the cause of death for tracking morbidity and mortality trends to strengthen the program of veterinary care and meet SSP-related requests.

(2.5.2) The institution should have an area dedicated to performing necropsies.

(2.5.3) Cadavers must be kept in a dedicated storage area before and after necropsy. Remains must be disposed of in accordance with local/federal laws.

(2.0.2) The veterinary care program must emphasize disease prevention.

(2.0.3) Institutions should be aware of and prepared for periodic disease outbreaks in wild or other domestic or exotic animal populations that might affect the institution's animals (ex – Avian Influenza, Eastern Equine Encephalitis Virus, etc.). Plans should be developed that outline steps to be taken to protect the institution's animals in these situations.

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

(11.1.3) A tuberculin (TB) testing/surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animals. Each institution must have an employee occupational health and safety program.

(2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

(2.1.3) Paid and unpaid animal care staff should be trained to assess welfare and recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, animal care staff (paid and unpaid) must not diagnose illnesses nor prescribe treatment.

(2.3.2) Institution facilities must have radiographic equipment or have access to radiographic services.

(1.5.8) The institution must develop and implement a clear and transparent process for identifying, communicating, and addressing animal welfare concerns from paid or unpaid staff within the institution in a timely manner, and without retribution.

Chapter 9

(1.6.4) The institution should follow a formal written animal training program that facilitates husbandry, science, and veterinary procedures and enhances the overall health and well-being of the animals.

(1.6.1) The institution must follow a formal written enrichment program that promotes species-appropriate behavioral opportunities.

(1.6.3) Enrichment activities must be documented and evaluated, and program refinements should be made based on the results, if appropriate. Records must be kept current.

(1.6.2) The institution must have a specific paid staff member(s) or committee assigned for enrichment program oversight, implementation, assessment, and interdepartmental coordination of enrichment efforts.

Chapter 10

(1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the animals at the institution from exposure to infectious agents.

Chapter 11

(5.3) The institution should maximize the generation and dissemination of scientific knowledge gained. This might be achieved by participating in AZA TAG/SSP sponsored studies when applicable, conducting and publishing original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

(5.0) The institution must have a demonstrated commitment to scientific study that is in proportion to the size and scope of its facilities, staff (paid and unpaid), and animals.

(5.2) The institution must follow a formal written policy that includes a process for the evaluation and approval of scientific project proposals, and outlines the type of studies it conducts, methods, staff (paid and unpaid) involvement, evaluations, animals that may be involved, and guidelines for publication of findings.

(5.1) Scientific studies must be under the direction of a paid or unpaid staff member or committee qualified to make informed decisions.

Appendix B: Recordkeeping Guidelines for Group Accessions

Developed by the AZA Institutional Data Management Scientific Advisory Group
Published 23 May 2014
Edited to replace the document entitled “Updated Data Entry for Groups” published 16 December 2002

Animals can be accessioned into a collection as either individuals or as part of a group. The term "group" has many definitions when used in zoos and aquariums, and is usually defined by its application, such as a social group or animals grouped for husbandry purposes. To provide a consistent language that can be used throughout the Association of Zoos and Aquariums (AZA), the term “group accession”, as defined by the AZA Institutional Data Management Scientific Advisory Group (IDMAG),

- contains multiple animals of the same species or subspecies, which
- cannot be differentiated from one another, either physically (there are no scars or color pattern differences), artificially (they are not tagged or transpondered), or spatially (they are not held in separate enclosures), and
- are cared for as a whole.

Thus, no individually accessioned animals are included in a group accession and no individually *identifiable* animals are included in a group accession. As soon as an animal becomes individually identifiable, it is recommended that it be split from the group record and accessioned as an individual. For example, large clutches of amphibian tadpoles should first be accessioned as a group; then as individuals become identifiable, they should be removed from the group record and accessioned as individuals. Otherwise, information about an individual animal that could otherwise be tracked through the animal’s life will be lost in the group record. An exception to this occurs occasionally when a group member is removed and temporarily held separately for medical treatment, with the expectation that it will be returned to the group when treatment ends. In this case, the animal remains part of the group even though separated from it. As with individual records, group record accession numbers should not duplicate any other accession number, and once a group accession number has been assigned, it should not be changed.

Group accession provides less information on specific individuals than does individual accession. Group records make information less retrievable, and often need more clarifying comments than individual records. Whenever information applies to only part of the group, notes should be used to indicate which animal(s) the information applies to. It is of utmost importance that these notes be thorough and clear so future readers can easily understand them. Examples of information needing additional notations in group records include, but are not limited to, parentage when not every member of the group has the ˇthe group. Thus, though it is preferable to accession animals as individuals, a group accession can capture considerable information when individual accession is not appropriate.

Although colonies are often confused with groups, the term “colony” should be used to designate truly colonial organisms: those that must live and function as an intact unit, such as corals and eusocial insects. Individuals within a colony are components of a single entity rather than separate members of a group. Also, colony members generally cannot be counted and true census data is not possible, so for the purposes of inventory, a colony is a singular unit while a group is composed of a number of individuals. However, for accessioning purposes, colonies are treated in the same manner as are groups.

Examples of Appropriate Group Accessions

- A group of animals that are not individually identifiable and are the same species or subspecies.
  Your institution receives 50 Puerto Rican crested toad tadpoles to rear. Unless each tadpole is raised in a separate numbered tank, there is no way to tell one tadpole from another. All tadpoles housed together are accessioned as one group.
- Colonial species, such as coral or eusocial insects (e.g., some species of bees or ants).
  Your institution receives a piece of coral. Since the coral is in one piece, you accession it as a group of one. You make a note of the dimensions or mass of the piece to give an estimate of

colony size, since it is not possible to count individual animals in the colony. In the inventory, the colony counts as one animal. When a section of the coral breaks off, you accession that new piece as a new colony.

- A self-sustaining, breeding group of small rodents or insects.

  Your institution has a large number of Cairo spiny mice. No daily count is made, though births and deaths increase and decrease the count. A census is taken periodically, and the new count is recorded by sex and life stage. Exact counts are made whenever possible – for example, when the group is moved to a new enclosure.
- Young born to several females of the same species or subspecies and raised together without means of identifying which offspring were born to which mother.

  A flock of 3.6 peafowl raise 25 chicks this year. Identity of the hens incubating each nest, hatch dates, and number of chicks hatched from each nest can be determined and recorded. However, unless the chicks are caught and banded at hatching, once the mothers and chicks join the main flock, it is no longer possible to tell which chicks belong to which females. All chicks in the flock have the same possible parents: all the peacocks and those peahens that incubated the nests. The chicks are accessioned as a group and are split out only when they are banded or tagged (and are thus individually identifiable).
- Historical records for a species or subspecies for which there is insufficient information to attribute events to specific individuals.

  Some of your historical records are found as simple lists of events. Though there are dates for all transactions, and maybe even specified vendors or recipients for those events, you cannot create individual records for any of these animals without additional information: there is nothing connecting any specific individual to both acquisition and disposition information. If additional information is uncovered that makes this connection, then that individual can be removed from the group accession and given an individual record.

Managing Group Records

Maintaining Group Records: As with individual records, group records should also be maintained and updated. Addition of animals through births or transactions such as loans, purchases, donations, or trades are entered as acquisitions. Subtraction of animals through deaths or transactions such as loans, sales, donations, or trades are entered as dispositions.

Weights and lengths can be entered into a group record even if that data cannot be attributed to a specific individual. This information is still useful in describing the overall condition of group members, although care should be given to describe the animal that the measurement came from. For example, is the animal a juvenile or a breeding adult? Is it healthy, or sickly? Alternatively, average and/or median measurements can be entered into the record to give an indication of what size a "normal" individual might be. In this case, notes should include the maximum and minimum measurements, and how many animals were measured to calculate the average or median.

Censuses: Groups should be censused at regular intervals - ideally, no longer than one inter-birth interval. Institutions should establish and follow a census schedule for each group. An inventory must be done at least once yearly (AZA Accreditation Standard 1.4.1) but the frequency at which a group is censused depends on species biology, husbandry protocols, and animal welfare. For species in which births/hatches and deaths tend to go undetected, or for species that have high fecundity and mortality (which makes counting every animal very difficult or impossible), census data should be obtained more frequently than for species with longer inter-birth intervals. These more frequent censuses should not be undertaken when intrusion on the group has a negative effect on the welfare of the group, e.g., disruption of maternal care.

Censuses should provide as much detail as possible by recording numbers in distinctive life stages (such as newborn, immature, adult) and/or sex ratio (such as male, female, unknown/undetermined). If the census count is estimated, the estimation method and (when possible) the accuracy of the estimate should be included. When updating the sex ratio, who sexed the animals and how they were sexed should also be recorded.

Splitting And Combining (Merging) Groups: Splitting animals from groups and combining groups together are realities of group management. Animals may be removed to create additional groups, or perhaps new animals are received from another institution. When new groups are created, new group records also need to be created. However, if the entire group moves to a new location (such as a different tank), it retains the same accession number, and notation of the change in location is made.

When a single group is split into two or more groups, one of the new groups keeps the original accession number and the others are assigned new accession numbers. This is also true if a portion of a group is sent to another institution: the subgroup making the transfer must have an accession number distinct from that of the main group. The accession number(s) for the new group(s) should follow institutional procedures for the assignment of new accession numbers. Note of the new group accession number(s) should appear in the originating group record, and the new group accession record(s) should contain the originating group number. The reason for the split should be entered into both the originating and new group records.

When two or more groups combine to form a larger group, all but one of the groups are deaccessioned and their counts brought to zero. Notes in all the group records should indicate why the groups were merged, as well as the accession numbers of all groups involved – both the closed (empty) groups and the remaining group.

In all cases of splits and merges, the date of creation of the new record should be the same as the date of removal from the previous group or individual. Detailed notes should explain the reasons for all splits and merges.

Merging Individuals Into Groups and Splitting Individuals From Groups: Good husbandry dictates the use of identification methods that allow animals to be tracked as individuals whenever possible (AZA Accreditation Standard 1.4.3). Thus, most institutions initially accession newly-acquired animals as individual animals with individual identifiers.

Despite the best intentions, individual identification sometimes becomes impossible. For example, birds in large aviaries lose their bands; small frogs in a large terrarium die and decompose without being noticed. When individual identification of several of the animals in the group is lost and can't be resolved in a reasonable amount of time, it is best to move all potentially unidentifiable animals to a group record, by either creating a new group or merging them into an existing group. As with splitting and merging groups, the group record should contain the identities of the originating individuals and the individual records should show the new group identity. If the animals in the group ever become individually identifiable again, they can be split back to individual records to better capture demographic information. If this occurs, new accession numbers are generally needed for the new individual records since it is rarely possible to know which old individual record would apply to the newly identifiable group member.

Conversely, if one or more group members become identifiable, for example, the previously unbanded young of the year are caught up and banded, they should be split from the group record and given individual accessions. The group record should include the individual numbers assigned, and the records of all individuals should show the number of the originating group. In the case of new individual records, information particular to the animal being given the individual record (if known) should be transferred to the individual record. This includes birth date, origin, parent identification, etc. As in the cases of splitting and merging groups, the date of creation of the new record is the same as the date of removal from the previous group or individual, and detailed notes should explain the reasons for all changes in accession type.

Transfers Between Institutions: When accessioning a number of animals that were received from another institution, the new animals should be accessioned using the same type of record that the sending institution used, regardless of how the animals will ultimately be managed. If a group is received but the members will be managed as individuals, they should be accessioned as a group first, then split out as individuals. Similarly, if a number of individuals are received but the plan is to manage them as a group, they should be accessioned as individuals, then merged into a group. Although this is an extra step in the accession process, it allows the records from both institutions to more seamlessly link.

<u>Removing Individuals From Historical Group Records</u>: The decision of whether to use individual or group accession for historical records should be made thoughtfully and carefully. As detailed above, group accession should be used if there is insufficient information to create an *accurate* individual record. The use of group accession is preferable to the inclusion of “best guess” information, i.e. fiction, to fill the information necessary to complete an individual record.

If additional information is later found that allows the creation of an individual record for one of the members of a historical group record, the procedure for removal from the group is different from that for current records. This situation is treated differently because the historical individual was not truly part of a group accession – the information necessary for a complete individual record was merely not known and the group accession was used “temporarily” until the required information was found or learned. For this reason, the individual should NOT be split from the group, but all reference to the individual should instead be *deleted entirely* from the group, as if it were never part of the group. This will allow the individual record to begin with the initial acquisition (instead of the date of removal from a group) and will include the animal’s entire history in one record. It also prevents inflation of inventory numbers by eliminating the possible duplication of the same information in both the group and the individual records.

Appendix C: Guidelines for Creating and Sharing Animal and Collection Records

Developed by the AZA Institutional Data Management Scientific Advisory Group
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The goal of maintaining a centralized, compiled record for each animal cared for in a zoo or aquarium is ideal, however, oftentimes, information belonging in an animal record is spread across many departments and may originate with any member of the animal care staff. Therefore, it is important for zoos and aquariums to have a formal method for collecting or linking various pieces of information into the official records and that the roles and responsibilities for each named record type are clearly defined in written protocols for the reporting, recording, distribution, storage, and retrieval processes; there should also be a stated process of review for the accuracy and completeness of these records. For example, a recording/reporting protocol would state who reports births or deaths, to whom they are reported, in what manner and in what time frame they are reported, who officially records the information, and who reviews the resulting record for accuracy and completeness. Then, the maintenance and archiving protocol would state where the record is to be filed, who may have access, and how long the record is to be maintained before being archived or disposed of.

Information contained in animal records is essential not only to the immediate care of the individual animal but also as pooled data to manage larger concerns (e.g., providing norms for species-related veterinary and population management decisions, evidence of compliance with laws and regulations, showing trends in populations on every level from institutional to global, etc.). No matter what its use, it is critical for the information contained in an animal record to be factual, clear, complete, and documented. Because zoos and aquariums vary greatly in size and organizational structure, it is impossible to set defined procedures that would be applicable to all; therefore the following guidelines for creating and sharing animal records have been developed to assist with the establishment of written policies that best fit their own internal structure and protocols.

Animal and Collection Records – Definitions and Examples

The AZA Institutional Data Management Scientific Advisory Group (IDMAG) defines an animal record as: *"data, regardless of physical form or medium, providing information about individual animals, groups of animals, or samples or parts thereof".* An animal's record may include, but is not limited to, information about its provenance, history, daily care, activities, and condition; some may originate in non-animal care departments. Some examples of animal records are:

- transaction documents (including proof of legal ownership, purchase contracts, etc.)
- identification information
- reports of collection changes (including in-house moves)
- pedigrees/lineages
- veterinary information, including images, test results, etc.
- nutrition and body condition information
- information on sampling and parts/products distribution

In addition, the IDMAG defines collection records as: *"information, evidence, rationalizations about an animal collection as a whole that may supplement or explain information contained in an animal record"*. Collection records may include, but are not limited to, documentation of collection decisions and changes, evidence of structural change at the institution, evidence of building name changes, and documentation of institution level or unit level husbandry protocols and changes. Some examples of collection records are:

- collection plans
- permits
- annual inventories (which include reconciliation with the previous year)
- area journals/notebooks (including information to/from/between other animal care staff)

- keeper reports
- animal management protocols (e.g., species hand-rearing protocols, special care or treatments, etc.)
- enclosure maps/trees
- enclosure/exhibit information (monitoring, maintenance, modifications, etc.)
- research plans and published papers

Animal and Collection Records - Development
It is recommended that each zoo and aquarium develop written policies and procedures, applicable to all staff involved with animal care, that:

- define the types of records that are required.
  For example, daily keeper reports might be required from the keeper staff and weekly summaries of activities might be required from the animal curator and senior veterinarian.
- define the information that is to be included in each type of record.
  Following the example above, the institution would state the specific types of information to be recorded on the daily keeper report and the weekly summaries.
- define the primary location where each record can be found.
  For example, if a zoo does not employ a nutritionist, the policy or procedures might state that animal diet information will be found in keeper daily reports, curator-developed daily diets, and/or veterinarian-prescribed treatment diets.
- assign responsibility for the generation of each record type and set time limits for the their creation.
  For example, keepers might be held responsible for producing daily reports by the start of the next day and curators might be held responsible for producing weekly summaries by the Tuesday of the following week.
- define a process to review the accuracy of each record type and assign responsibility for that review process.
  For example, the identity of who will review each type of record, the date of reviews, and the review/correction processes might be included in the policy.
- define a process to identify official records and assign responsibility for the recording of, or linking of, information into these records.
  For example, the identity of who will be responsible for placing information into the official records and the processes of how to identify official records might be included in the policy.
- ensure entries in official records are never erased or deleted.
  For example, if an entry is determined to be erroneous, rather than deleting it, the entry should be amended and an audit trail should be created that identifies what data was changed, who made the change, the date it was changed, and the reason for the change.
- ensure records relating to specific animals in the collection, including the records of non--animal care departments, are permanently archived as part of the animal's record.
  For example, if your zoo or aquarium's records retention schedules differ from this recommendation every attempt should be made to exempt these records from schedules requiring their destruction.

Animal and Collection Records – Sharing of Information
Each zoo and aquarium should assess the ownership of their animal and collection records and determine the rights of employees and outside entities to the information contained in them. It is recommended that each zoo and aquarium develop written policies and procedures for the distribution and/or availability of the animal and collection records that:

- identify who has access to animal and collection records and under what conditions.
  For example, animal care staff whose duties require a direct need for information about specific animals or collection of animals should be identified as individuals who are allowed access to any or specified records, regardless of who created them or when they were created.

- assign responsibility for the distribution, archiving and retrieval of each record type.
  For example, the recordkeeper or registrar might be held responsible for maintaining all past and current transaction documents and the curator might be held responsible for maintaining the daily keeper reports from his/her section.
- define a notification system that specifies what information will be provided in the notification, who will be notified, the date they will be notified by, and the mechanism that will be used to ensure the notification is communicated appropriately.
  For example, the shipment of an animal might require that written notice be made to the senior keeper in the animal's area, the curator, and the veterinarian at least 30 days prior to the move, and identifies the animal by group or individual identification/accession number, sex, and tag/transponder number, etc.
- define where each record type (stored or archived) is available and what format (paper or digital) it is in.
  For example, all original animal transaction documents might be kept in the registrar's office in fire-proof file cabinets but copies of the Animal Data Transfer Forms are kept in the appropriate keeper area.
- define a system for obtaining necessary information such that the information is available regardless of department and regardless of staffing issues.
  For example, keeper daily reports might be maintained in an electronic database run on the institution's network, to which all animal care staff members have at least read-only access.

Implementation of these Recommendations

Well-written, consistent data-recording protocols and clear lines of communication will increase the quality of animal records and should be implemented by all institutions, regardless of technical resources. While the best option for availability of information is an electronic database system run on a computer network (intranet) to which all animal care staff members have unrestricted access, the above recommendations may also be adopted by zoos and aquariums without full electronic connections.

Appendix D: AZA Policy on Responsible Population Management

PREAMBLE

The stringent requirements for AZA accreditation, and high ethical standards of professional conduct, are unmatched by similar organizations and far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. Every AZA member must abide by a Code of Professional Ethics (https://www.aza.org/code-of-ethics). In order to continue these high standards, AZA-accredited institutions and certified related facilities should make it a priority, when possible, to acquire animals from and transfer them to other AZA member institutions, or members of other regional zoo associations that have professionally recognized accreditation programs.

AZA-accredited institutions and certified related facilities cannot fulfill their important missions of conservation, education, and science without live animals. Responsible management and the long-term sustainability of living animal populations necessitates that some individuals be acquired and transferred, reintroduced or even humanely euthanized at certain times. The acquisition and transfer of animals should be prioritized by the long-term sustainability needs of the species and AZA-managed populations among AZA-accredited and certified related facilities, and between AZA member institutions and non-AZA entities with animal care and welfare standards aligned with AZA. AZA member institutions that acquire animals from the wild, directly or through commercial vendors, should perform due diligence to ensure that such activities do not have a negative impact on species in the wild. Animals should only be acquired from non-AZA entities that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this Policy.

I. INTRODUCTION

This AZA Policy on Responsible Population Management provides guidance to AZA members to:

1. Assure that animals from AZA member institutions and certified related facilities are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them [*see taxa specific appendices (in development)*],

2. Assure that the health and conservation of wild populations and ecosystems are carefully considered as appropriate,

3. Maintain a proper standard of conduct for AZA members during acquisition and transfer/reintroduction activities, including adherence to all applicable laws and regulations,

4. Assure that the health and welfare of individual animals is a priority during acquisition and transfer/reintroduction activities, and

5. Support the goals of AZA's cooperatively managed populations and associated Animal Programs [Species Survival Plans® (SSPs), Studbooks, and Taxon Advisory Groups (TAGs)].

This AZA Policy on Responsible Population Management will serve as the default policy for AZA member institutions. Institutions should develop their own Policy on Responsible Population Management in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and transfer/transition standards.

II. LAWS, AUTHORITY, RECORD-KEEPING, IDENTIFICATION AND DOCUMENTATION

The following must be considered with regard to the acquisition or transfer/management of all living animals and specimens (their living and non-living parts, materials, and/or products):

1. Any acquisitions, transfers, euthanasia and reintroductions must meet the requirements of all applicable local, state, federal and international laws and regulations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals. Ownership and any applicable chain-of-custody must be documented. If such information does not exist, an explanation must be provided regarding such animals and specimens. Any acquisition of free-ranging animals must be done in accordance with all local, state, federal, and international laws and regulations and must not be detrimental to the long-term viability of the species in the wild.

2. The Director/Chief Executive Officer of the institution must have final authority for all acquisitions, transfers, and euthanasia.

3. Acquisitions or transfers/euthanasia/reintroductions must be documented through institutional record keeping systems. The ability to identify which animal is being transferred is very important and the method of identifying each individual animal should be documented. Any existing documentation must accompany all transfers. Institutional animal records data, records guidelines have been developed for certain species to standardize the process (https://www.aza.org/idmag-documents-and-guidelines).

4. For some colonial, group-living, or prolific species, it may be impossible or highly impractical to identify individual animals when these individuals are maintained in a group. These species can be maintained, acquisitioned, transferred, and managed as a group or colony, or as part of a group or colony.

5. If the intended use of specimens from animals either living or non-living is to create live animal(s), their acquisition and transfer should follow the same guidelines. If germplasm is acquired or transferred with the intention of creating live animal(s), ownership of the offspring must be clearly defined in transaction documents (e.g., breeding loan agreements).

   Institutions acquiring, transferring or otherwise managing specimens should consider current and possible future uses as new technologies become available. All specimens from which nuclear DNA could be recovered should be carefully considered for preservation as these basic DNA extraction technologies already exist.

6. AZA member institutions must maintain transaction documents (e.g., confirmation forms, breeding agreements) which provide the terms and conditions of animal acquisitions, transfers and loans, including documentation for animal parts, products and materials. These documents should require the potential recipient or provider to adhere to the AZA Policy on Responsible Population Management, and the AZA Code of Professional Ethics, and must require compliance with the applicable laws and regulations of local, state, federal, and international authorities.

7. In the case of animals (living or non-living) and their parts, materials, or products (living or non-living) held on loan, the owner's written permission should be obtained prior to any transfer and documented in the institutional records.

8. AZA SSP and TAG necropsy and sampling protocols should be accommodated.

9. Some governments maintain ownership of the species naturally found within their borders. It is therefore incumbent on institutions to determine whether animals they are acquiring or transferring are owned by a government entity, foreign or domestic, and act accordingly by reviewing the

government ownership policies available on the AZA website. In the case of government owned animals, proposals for and/or notifications of transfers must be sent to the species manager for the government owned species.

III. ACQUISITION REQUIREMENTS

A. General Acquisitions

1. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals regarding the individual or species.

2. Animals (wild, feral, and domestic) may be held temporarily for reasons such as assisting governmental agencies or other institutions, rescue and/or rehabilitation, research, propagation or headstarting for reintroduction, or special exhibits.

3. Any receiving institution must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met.

4. If the acquisition involves a species managed by an AZA Animal Program, the institution should communicate with the Animal Program Leader and, in the case of Green SSP Programs, must adhere to the AZA Full Participation Policy (https://www.aza.org/assets/2332/board_approved_full_participation_26_mar_097.pdf).

5. AZA member institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved TAG Regional Collection Plans (RCPs), Animal Program Leaders, and AZA Animal Care Manuals (ACMs) when making acquisition decisions.

6. AZA member institutions that work with commercial vendors that acquire animals from the wild, must perform due diligence to assure the vendors' collection of animals is legal and using ethical practices. Commercial vendors should have conservation and animal welfare goals similar to those of AZA institutions.

7. AZA member institutions may acquire animals through public donations and other non-AZA entities when it is in the best interest of the animal and/or species.

B. Acquisitions from the Wild

Maintaining wild animal populations for exhibition, education and wildlife conservation purposes is a core function of AZA-member institutions. AZA zoos and aquariums have saving species and conservation of wildlife and wildlands as a basic part of their public mission. As such, the AZA recognizes that there are circumstances where acquisitions from the wild are needed in order to maintain healthy, diverse animal populations. Healthy, sustainable populations support the objectives of managed species programs and the core mission of AZA members. In some cases, acquiring individuals from the wild may be a viable option in addition to, or instead of, relying on breeding programs with animals already in human care.

Acquiring animals from the wild can result in socioeconomic benefit and environmental protection and therefore the AZA supports environmentally sustainable/beneficial acquisition from the wild when conservation is a positive outcome.

1. Before acquiring animals from the wild, institutions are encouraged to examine alternative sources including other AZA institutions and other regional zoological associations or other non-AZA entities.

2. When acquiring animals from the wild, both the long-term health and welfare impacts on the wild population as well as on individual animals must be considered. In crisis situations, when the survival of a population is at risk, rescue decisions will be made on a case-by-case basis by the appropriate agency and institution.

3. AZA zoos and aquariums may assist wildlife agencies by providing homes for animals born in nature if they are incapable of surviving on their own (e.g., in case of orphaned or injured animals) or by euthanizing the animals because they pose a risk to humans or for humane reasons.
4. Institutions should only accept animals from the wild after a risk assessment determines the zoo/aquarium can mitigate any potential adverse impacts on the health, care and maintenance of the existing animals already being housed at the zoo or aquarium, and the new animals being acquired.

IV. TRANSFER, EUTHANASIA AND REINTRODUCTION REQUIREMENTS

A. Living Animals

Successful conservation and animal management relies on the cooperation of many entities, both AZA and non-AZA. While preference is given to placing animals with AZA-accredited institutions or certified related facilities, it is important to foster a cooperative culture among those who share AZA's mission of saving species and excellence in animal care.

1. AZA members should assure that all animals in their care are transferred, humanely euthanized and/or reintroduced in a manner that meets the standards of AZA, and that animals are not transferred to those not qualified to care for them properly. Refer to IV.12, below, for further requirements regarding euthanasia.

2. If the transfer of animals or their specimens (parts, materials, and products) involves a species managed by an AZA Animal Program, the institution should communicate with that Animal Program Leader and, in the case of Green SSP Programs must adhere to the AZA Full Participation Policy (https://www.aza.org/assets/2332/board_approved_full_participation_26_mar_097.pdf).

3. AZA member institutions should consult WCMC-approved TAG Regional Collection Plans, Animal Program Leaders, and Animal Care Manuals when making transfer decisions.

4. Animals acquired solely as a food source for animals in the institution's care are not typically accessioned. There may be occasions, however, when it is appropriate to use accessioned animals that exceed population carrying capacity as feeder animals to support other animals. In some cases, accessioned animals may have their status changed to "feeder animal" status by the institution as part of their program for long-term sustained population management of the species.

5. In transfers to non-AZA entities, AZA members must perform due diligence and should have documented validation, including one or more letters of reference, for example from an appropriate AZA Professional Fellow or other trusted source with expertise in animal care and welfare, who is familiar with the proposed recipient and their current practices, and that the recipient has the expertise and resources required to properly care for and maintain the animals. Any recipient must have the necessary expertise and resources to support and provide for the professional care and management of the species, so that the physical, psychological, and social needs of individual animals and species are met within the parameters of modern zoological philosophy and practice. Supporting documentation must be kept at the AZA member institution (see #IV.9 below).

6. Domestic animals should be transferred in accordance with locally acceptable humane farming practices, including auctions, and must be subject to all relevant laws and regulations.

7. AZA members must not send any non-domestic animal to auction or to any organization or individual that may display or sell the animal at an animal auction. *See certain taxa-specific appendices to this Policy (in development) for information regarding exceptions*.

8. Animals must not be sent to organizations or individuals that allow the hunting of these individual animals; that is, no individual animal transferred from an AZA institution may be hunted. For purposes of maintaining genetically healthy, sustainable zoo and aquarium populations, AZA-accredited institutions and certified related facilities may send animals to non-AZA organizations or individuals (refer to #IV.5 above). These non-AZA entities (for instance, ranching operations) should follow appropriate ranch management practices and other conservation minded practices to support population sustainability.

9. Every loaning institution must annually monitor and document the conditions of any loaned specimen(s) and the ability of the recipient(s) to provide proper care (refer to #IV.5 above). If the conditions and care of animals are in violation of the loan agreement, the loaning institution must recall the animal or assure prompt correction of the situation. Furthermore, an institution's loaning policy must not be in conflict with this AZA Policy on Responsible Population Management.

10. If living animals are sent to a non-AZA entity for research purposes, it must be a registered research facility by the U.S. Department of Agriculture and accredited by the Association for the Assessment & Accreditation of Laboratory Animal Care, International (AAALAC), if eligible. For international transactions, the receiving facility must be registered by that country's equivalent body having enforcement over animal welfare. In cases where research is conducted, but governmental oversight is not required, institutions should do due diligence to assure the welfare of the animals during the research.

11. Reintroductions and release of animals into the wild must meet all applicable local, state, and international laws and regulations. Any reintroduction requires adherence to best health and veterinary practices to ensure that non-native pathogens are not released into the environment exposing naive wild animals to danger. Reintroductions may be a part of a recovery program and must be compatible with the IUCN Reintroduction Specialist Group's Reintroduction Guidelines (http://www.iucnsscrsg.org/index.php).

12. Humane euthanasia may be employed for medical reasons to address quality of life issues for animals or to prevent the transmission of disease. AZA also recognizes that humane euthanasia may be employed for managing the demographics, genetics, and diversity of animal populations. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV's Guidelines on the Euthanasia of Non-Domestic Animals.

B. Non-Living Animals and Specimens

AZA members should optimize the use and recovery of animal remains. All transfers must meet the requirements of all applicable laws and regulations.

1. Optimal recovery of animal remains may include performing a complete necropsy including, if possible, histologic evaluation of tissues which should take priority over specimens' use in education/exhibits. AZA SSP and TAG necropsy and sampling protocols should be accommodated. This information should be available to SSP Programs for population management.

2. The educational use of non-living animals, parts, materials, and products should be maximized, and their use in Animal Program sponsored projects and other scientific projects that provide data for species management and/or conservation must be considered.

3. Non-living animals, if handled properly to protect the health of the recipient animals, may be utilized as feeder animals to support other animals as deemed appropriate by the institution.

4. AZA members should consult with AZA Animal Program Leaders prior to transferring or disposing of remains/samples to determine if existing projects or protocols are in place to optimize use.

5. AZA member institutions should develop agreements for the transfer or donation of non-living animals, parts, materials, products, and specimens and associated documentation, to non-AZA entities such as universities and museums. These agreements should be made with entities that have appropriate long term curation/collections capacity and research protocols, or needs for educational programs and/or exhibits.

DEFINITIONS

Acquisition: Acquisition of animals can occur through breeding (births, hatchings, cloning, and division of marine invertebrates = “fragging”), trade, donation, lease, loan, transfer (inter- and intra-institution), purchase, collection, confiscation, appearing on zoo property, or rescue and/or rehabilitation for release.

Annual monitoring and Due diligence: Due diligence for the health of animals on loan is important. Examples of annual monitoring and documentation include and are not limited to inventory records, health records, photos of the recipient’s facilities, and direct inspections by AZA professionals with knowledge of animal care. The level of due diligence will depend on professional relationships.

AZA member institution: In this Policy “AZA member institutions” refers to AZA-accredited institutions and certified related facilities (zoological parks and aquariums). “AZA members” may refer to either institutions or individuals.

Data sharing: When specimens are transferred, the transferring and receiving institutions should agree on data that must be transferred with the specimen(s). Examples of associated documentation include provenance of the animal, original permits, tags and other metadata, life history data for the animal, how and when specimens were collected and conserved, etc.

Dispose: “Dispose/Disposing of” in this document is limited to complete and permanent removal of an individual via incineration, burying or other means of permanent destruction

Documentation: Examples of documentation include ZIMS records, “Breeding Loan” agreements, chain-of-custody logs, letters of reference, transfer agreements, and transaction documents. This is documentation that maximizes data sharing.

Domestic animal: Examples of domestic animals may include certain camelids, cattle, cats, dogs, ferrets, goats, pigs, reindeer, rodents, sheep, budgerigars, chickens, doves, ducks, geese, pheasants, turkeys, and goldfish or koi.

Ethics of Acquisition/Transfer/Euthanasia: Attempts by members to circumvent AZA Animal Programs in the acquisition of animals can be detrimental to the Association and its Animal Programs. Such action may also be detrimental to the species involved and may be a violation of the Association’s Code of Professional Ethics. Attempts by members to circumvent AZA Animal Programs in the transfer, euthanasia or reintroduction of animals may be detrimental to the Association and its Animal Programs (unless the animal or animals are deemed extra in the Animal Program population by the Animal Program Coordinator). Such action may be detrimental to the species involved and may be a violation of the Association’s Code of Professional Ethics.

“Extra” or Surplus: AZA’s scientifically-managed Animal Programs, including SSPs, have successfully bred and reintroduced critically endangered species for the benefit of humankind. To accomplish these critical conservation goals, populations must be managed within “carrying capacity” limits. At times, the number of individual animals in a population exceeds carrying capacity, and while meaning no disrespect for these individual animals, we refer to these individual animals as “extra” within the managed population.

Euthanasia: Humane death. This act removes an animal from the managed population. Specimens can be maintained in museums or cryopreserved collections. Humane euthanasia must be performed in accordance with the established euthanasia policy of the institution and follow the recommendations of current AVMA Guidelines for the Euthanasia of Animals (2013 Edition https://www.avma.org/KB/Policies/Documents/euthanasia.pdf) or the AAZV’s Guidelines on the Euthanasia of Non-Domestic Animals.

Feral: Feral animals are animals that have escaped from domestication or have been abandoned to the wild and have become wild, and the offspring of such animals. Feral animals may be acquired for temporary or permanent reasons.

Group: Examples of colonial, group-living, or prolific species include and are not limited to certain terrestrial and aquatic invertebrates, fish, sharks/rays, amphibians, reptiles, birds, rodents, bats, big herds, and other mammals,

Lacey act: The Lacey Act prohibits the importation, exportation, transportation, sale, receipt, acquisition or purchase of wildlife taken or possessed in violation of any law, treaty or regulation of the United States or any Indian tribal law of wildlife law. In cases when there is no documentation accompanying an acquisition, the animal(s) may not be transferred across state lines. If the animal was illegally acquired at any time then any movement across state or international borders would be a violation of the Lacey Act.

Museum: It is best practice for modern zoos and aquariums to establish relationships with nearby museums or other biorepositories, so that they can maximize the value of animals when they die (e.g., knowing who to call when they have an animal in necropsy, or specimens for cryopreservation). Natural history museums that are members of the Natural Science Collections Alliance (NSCA) and frozen biorepositories that are members of the International Society of Biological and Environmental Repositories (ISBER) are potential collaborators that could help zoos find appropriate repositories for biological specimens.

Non-AZA entity: Non – AZA entities includes facilities not accredited or certified by the AZA, facilities in other zoological regions, academic institutions, museums, research facilities, private individuals, etc.

Reintroduction: Examples of transfers outside of a living zoological population include movements of animals from zoo/aquarium populations to the wild through reintroductions or other legal means.

Specimen: Examples of specimens include animal parts, materials and products including bodily fluids, cell lines, clones, digestive content, DNA, feces, marine invertebrate (coral) fragments (“frags”), germplasm, and tissues.

Transaction documents: Transaction documents must be signed by the authorized representatives of both parties, and copies must be retained by both parties*. In the case of loans, the owner’s permission for appropriate activities should be documented in the institutional records. This document(s) should be completed prior to any transfer. In the case of rescue, confiscation, and evacuation due to natural disasters, it is understood that documents may not be available until after acceptance or shipping. In this case documentation (e.g., a log) must be kept to reconcile the inventory and chain of custody after the event occurs. (*In the case of government owned animals, notification of transfers must be sent to species manager for the government owned species).

Transfer: Transfer occurs when an animal leaves the institution for any reason. Reasons for transfer or euthanasia may include cooperative population management (genetic, demographic or behavioral management), animal welfare or behavior management reasons (including sexual maturation and individual management needs). Types of transfer include withdrawal through donation, trade, lease, loan, inter- and intra-institution transfers, sale, escape, theft. Reintroduction to the wild, humane euthanasia or natural death are other possible individual animal changes in a population.

RECIPIENT PROFILE EXAMPLE

Example questions for transfers to non-AZA entities (from AZA-member Recipient Profile documents):

Has your organization, or any of its officers, been indicted, convicted, or fined by a State or Federal agency for any statute or regulation involving the care or welfare of animals housed at your facility? (If yes, please explain on a separate sheet).

Recipients agree that the specimen(s) or their offspring will not be utilized, sold or traded for any purpose contrary to the Association of Zoos and Aquariums (AZA) Code of Ethics (enclosed)

References, other than (LOCAL ZOO/AQUARIUM) employees, 2 minimum (please provide additional references on separate sheet):

Reference Name		Phone	
Facility		Fax	
Address		E-mail	
City	State		Zip
Country		AZA Member?	

Reference Name		Phone	
Facility		Fax	

Address		E-mail	
City	State		Zip
Country		AZA Member?	

Veterinary Information:

Veterinarian		Phone	
Clinic/Practice		Fax	
Address		E-mail	
City	State		Zip
Country			

How are animals identified at your facility? If animals are not identified at your facility, please provide an explanation about why they are not here:

Where do you acquire and send animals? (Select all that apply)

AZA Institutions	Non-AZA Institutions	Exotic Animal Auctions	Pet Stores
Hunting Ranches	Dealers	Private Breeders	Non-hunting Game Ranches
Entertainment Industry	Hobbyists	Research Labs	Wild
Other			

What specific criteria are used to evaluate if a facility is appropriate to receive animals from you?

Please provide all of the documents listed below:
Required:
1. Please provide a brief statement of intent for the specimens requested.
2. Resumes of primary caretakers and those who will be responsible for the husbandry and management of animals.
3. Description (including photographs) of facilities and exhibits where animals will be housed.
4. Copy of your current animal inventory.

Only if Applicable:
5. Copies of your last two USDA inspection reports (if applicable).
6. Copies of current federal and state permits.
7. Copy of your institutional acquisition/disposition policy.

(in-house use only) In-Person Inspection of this facility (Staff member/Date, attach notes):

(Local institution: provide Legal language certifying that the information contained herein is true and correct)

(Validity of this: This document and all materials associated will be valid for a period of 2 years from date of signature.)

Example agreement for Receiving institution (agrees to following condition upon signing):
RECIPIENT AGREES THAT THE ANIMAL(S) AND ITS (THEIR) OFFSPRING WILL NOT BE UTILIZED, SOLD OR TRADED FOR THE PURPOSE OF COMMERCE OR SPORT HUNTING, OR FOR USE IN ANY STRESSFUL OR TERMINAL RESEARCH OR SENT TO ANY ANIMAL AUCTION. RECIPIENT FURTHER AGREES THAT IN THE EVENT THE RECIPIENT INTENDS TO DISPOSE OF AN ANIMAL DONATED BY (INSITUTION), RECIPIENT WILL FIRST NOTIFY (INSTITUTION) OF THE IDENTITY OF THE PROPOSED TRANSFEREE AND THE TERMS AND CONDITIONS OF SUCH DISPOSITION AND WILL PROVIDE (INSTITUTION) THE OPPORTUNITY TO ACQUIRE THE ANIMAL(S) WITHOUT

CHARGE. IF (INSTITUTION) ELECTS NOT TO RECLAIM THE ANIMAL WITHIN TEN (10) BUSINESS DAYS FOLLOWING SUCH NOTIFICATION, THEN, IN SUCH EVENT, (INSTITUTION) WAIVES ANY RIGHT IT MAY HAVE TO THE ANIMAL AND RECIPIENT MAY DISPOSE OF THE ANIMAL AS PROPOSED.

Institutional note: The text above is similar to the language most dog breeders use in their contracts when they sell a puppy. If people can provide that protection to the puppies they place, zoos/aquariums can provide it for animals that we place too! Some entities have been reluctant to sign it, and in that case we revert to a loan and our institution retains ownership of the animal. Either way, we are advised of the animal's eventual placement and location.

Appendix E: Recommended Quarantine Procedues

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a 70 °C (-94 °F) frost-free freezer or a 20 °C (-4 °F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for orangutans:

Orangutans:

Required:

1. Direct and floatation fecals
2. Vaccinate as appropriate

Strongly recommended:

1. CBC/sera profile
2. Urinalysis
3. Appropriate serology (FIP, FeLV, FIV)
4. Heartworm testing in appropriate species

Appendix F: Ambassador (Program) Animal Policy and Position Statement

Ambassador (Program) Animal Policy

Originally approved by the AZA Board of Directors—2003
Updated and approved by the Board—July 2008 & June 2011

The Association of Zoos & Aquariums (AZA) recognizes many benefits for public education and, ultimately, for conservation in ambassador animal presentations. AZA's Conservation Education Committee's *Ambassador Animal Position Statement* summarizes the value of ambassador animal presentations (see pages 42–44).

For the purpose of this policy, an Ambassador animal is defined as "an animal whose role includes handling and/or training by staff or volunteers for interaction with the public and in support of institutional education and conservation goals." Some animals are designated as Ambassador Animals on a full-time basis, while others are designated as such only occasionally. Ambassador Animal-related Accreditation Standards are applicable to all animals during the times that they are designated as Ambassador Animals.

There are three main categories of Ambassador Animal interactions:

1. On Grounds with the Ambassador Animal Inside the Exhibit/Enclosure:
    - Public access outside the exhibit/enclosure. Public may interact with animals from outside the exhibit/enclosure (e.g., giraffe feeding, touch tanks).
    - Public access inside the exhibit/enclosure. Public may interact with animals from inside the exhibit/enclosure (e.g., lorikeet feedings, 'swim with' programs, camel/pony rides).
2. On Grounds with the Ambassador Animal Outside the Exhibit/Enclosure:
    - Minimal handling and training techniques are used to present Ambassador Animals to the public. Public has minimal or no opportunity to directly interact with Ambassador Animals when they are outside the exhibit/enclosure (e.g., raptors on the glove, reptiles held "presentation style").
    - Moderate handling and training techniques are used to present Ambassador Animals to the public. Public may be in close proximity to, or have direct contact with, Ambassador Animals when they're outside the exhibit/enclosure (e.g., media, fund raising, photo, and/or touch opportunities).
    - Significant handling and training techniques are used to present Ambassador Animals to the public. Public may have direct contact with Ambassador Animals or simply observe the in-depth presentations when they're outside the exhibit/enclosure (e.g., wildlife education shows).
3. Off Grounds:
    - Handling and training techniques are used to present Ambassador Animals to the public outside of the zoo/aquarium grounds. Public may have minimal contact or be in close proximity to and have direct contact with Ambassador Animals (e.g., animals transported to schools, media, fund raising events).

These categories assist staff and accreditation inspectors in determining when animals are designated as Ambassador Animals and the periods during which the Ambassador Animal-related Accreditation Standards are applicable. In addition, these Ambassador Animal categories establish a framework for understanding increasing degrees of an animal's involvement in Ambassador Animal activities.

Ambassador Animal presentations bring a host of responsibilities, including the safety and welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that make Ambassador Animal presentations to develop an institutional Ambassador Animal policy that clearly identifies and justifies those species and individuals approved as Ambassador Animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that education and conservation messages must be an integral component of all Ambassador Animal presentations. In addition, the accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, appropriate environmental enrichment, access to veterinary care, nutrition, and other related standards. In addition, providing Ambassador Animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, free-flight birds may receive appropriate exercise during regular programs, reducing the need for additional exercise. However, the institution must ensure that in such cases, the animals participate in programs on a basis sufficient to meet these needs or provide for their needs in their home enclosures; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

Ambassador Animal Position Statement

Last revision 1/28/03
Re-authorized by the Board June 2011

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of Ambassador Animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective (emotional) messages about conservation, wildlife and animal welfare.

Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of Ambassador Animals has been demonstrated to result in lengthened learning periods, increased knowledge acquisition and retention, enhanced environmental attitudes, and the creation of positive perceptions concerning zoo and aquarium animals.

Audience Engagement

Zoos and aquariums are ideal venues for developing emotional ties to wildlife and fostering an appreciation for the natural world. However, developing and delivering effective educational messages in the free-choice learning environments of zoos and aquariums is a difficult task.

Zoo and aquarium educators are constantly challenged to develop methods for engaging and teaching visitors who often view a trip to the zoo as a social or recreational experience (Morgan & Hodgkinson, 1999). The use of Ambassador Animals can provide the compelling experience necessary to attract and maintain personal connections with visitors of all motivations, thus preparing them for learning and reflection on their own relationships with nature.

Ambassador Animals are powerful catalysts for learning for a variety of reasons. They are generally active, easily viewed, and usually presented in close proximity to the public. These factors have proven to contribute to increasing the length of time that people spend watching animals in zoo exhibits (Bitgood, Patterson & Benefield, 1986, 1988; Wolf & Tymitz, 1981).

In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey, 2002; Povey & Rios, 2002), visitors viewed animals three and four times longer while they were being presented in demonstrations outside of their enclosure with an educator than while they were on exhibit. Clearly, the use of Ambassador Animals in shows or informal presentations can be effective in lengthening the potential time period for learning and overall impact.

Ambassador Animals also provide the opportunity to personalize the learning experience, tailoring the teaching session to what interests the visitors. Traditional graphics offer little opportunity for this level of personalization of information delivery and are frequently not read by visitors (Churchman, 1985; Johnston, 1998). For example, Povey (2002) found that only 25% of visitors to an animal exhibit read the accompanying graphic; whereas, 45% of visitors watching the same animal handled in an educational presentation asked at least one question and some asked as many as seven questions. Having an animal accompany the educator allowed the visitors to make specific inquiries about topics in which they were interested.

Knowledge Acquisition
Improving our visitors' knowledge and understanding regarding wildlife and wildlife conservation is a fundamental goal for many zoo educators using Ambassador Animals. A growing body of evidence supports the validity of using Ambassador Animals to enhance delivery of these cognitive messages as well.

- MacMillen (1994) found that the use of live animals in a zoomobile outreach program significantly enhanced cognitive learning in a vertebrate classification unit for sixth grade students.
- Sherwood and his colleagues (1989) compared the use of live horseshoe crabs and sea stars to the use of dried specimens in an aquarium education program and demonstrated that students made the greatest cognitive gains when exposed to programs utilizing the live animals.
- Povey and Rios (2002) noted that in response to an open-ended survey question (“Before I saw this animal, I never realized that . . . ”), visitors watching a presentation utilizing a Ambassador Animal provided 69% cognitive responses (i.e., something they learned) versus 9% made by visitors viewing the same animal in its exhibit (who primarily responded with observations).
- Povey (2002) recorded a marked difference in learning between visitors observing animals on exhibit versus being handled during informal presentations. Visitors to demonstrations utilizing a raven and radiated tortoises were able to answer questions correctly at a rate as much as eleven times higher than visitors to the exhibits.

Enhanced Environmental Attitudes
Ambassador Animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991), and Davison and her colleagues (1993) evaluated the effect live animal shows had on visitor attitudes. Both found their shows successfully influenced attitudes about conservation and stewardship.
- Yerke and Burns (1993) also evaluated a live bird outreach program presented to Oregon fifth-graders and recorded a significant increase in students' environmental attitudes after the presentations.
- Sherwood and his colleagues (1989) found that students who handled live invertebrates in an education program demonstrated both short and long-term attitudinal changes as compared to those who only had exposure to dried specimens.
- Povey and Rios (2002) examined the role Ambassador Animals play in helping visitors develop positive feelings about the care and well-being of zoo animals.
- As observed by Wolf and Tymitz (1981), zoo visitors are deeply concerned with the welfare of zoo animals and desire evidence that they receive personalized care.

Conclusion
Creating positive impressions of aquarium and zoo animals, and wildlife in general, is crucial to the fundamental mission of zoological institutions. Although additional research will help us delve further into this area, the existing research supports the conclusion that Ambassador Animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

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Appendix G: Browse List

Potential Browse List for Orangutans

- Acacia (*Acacia P. Mill.)*
- Alder (*Alnus spp.)*
- Alfalfa (*Medicago sativa)*
- American Beech (*Fagus grandifolia)*
- Apple (*Malus spp.)*
- Arborvitae (*Thuja spp.)*
- Ash (*Fraxinus spp.)*
- Aspen (*Populus spp.)*
- Bamboo (*Phyllostachy spp.)*
- Bamboo Palm (*Chamaedorea erumpens)*
- Banana (*Musa spp.)*
- Beech (*Fagus L.)*
- Birch (*Betula spp.)*
- Black Mulberry (*Morus nigra)*
- Blackberry (*Rubus allegheniensis)*
- Boxelder (*Acer negundo)*
- Butterfly Bush (*Buddleia davidii)*
- Carob (*Ceratonia siliqua)*
- Cattails (*Typha spp.)*
- Corn Plant (*Dracaena fragrans)*
- Cotoneaster (*Cotoneaster spp.)*
- Cottonwood (*Populus spp.)*
- Crabapple (*Malus spp.)*
- Daylily (*Hemerocallis)*
- Dogwood (*Cornus spp.)*
- Elaeagnus (*Elaeagnus spp.)*
- Elm (*Ulmus spp.)*
- Ficus (*Ficus spp.)*
- Fig (*Ficus spp.)*
- Forsythia (*Forsythia spp.)*
- Giant Reed Grass, Elephant, Grass, Cane Grass (*Arundo donax)*
- Grape (*Vitis spp.)*
- Hackberry (*Celtis spp.)*
- Hawthorn (*Crataegus spp.)*
- Hazlenut (*Corylus spp.)*
- Hibiscus (*Hibiscus spp.)*
- Honeylocust (*Gleditsia spp.)*
- Honeysuckle (*Lonicera spp.)*
- Indian Rubber Tree (*Ficus elastica)*
- Kerria (*Kerria spp.)*
- Kudzu (*Pueraria lobata)*
- Linden, Basswood (*Tilia spp.)*
- Maple (No Red Maple) *(Acer spp.)*
- Mock Orange (*Philadelphus virginalis)*
- Mulberry (*Morus spp.)*
- Nasturtium (*Trapaeoleum majus)*
- Norway Maple (*Acer platanoides)*
- Oak (No Red Oak) (*Quercus spp.)*
- Oregon Grape Holly (*Mahonia spp.)*
- Pear (*Pyrus spp.)*
- Pine (*Pinus spp.)*
- Poplar (*Populus spp.)*
- Raspberry (*Rubus spp.)*
- Red Mulberry (*Morus rubra)*
- Red Tipped Photinia (*Photinia x fraseri)*
- Redbud (*Cercis canadensis)*
- Rose (*Rosa spp.)*
- Sugar Maple (*Acer saccharum)*
- Sugarcane (*Saccharum officinarum)*
- Sweet Gum (*Liquidambar spp.)*
- Sycamore (*Platanus occidentalis)*
- Tipu Tree, Pride of Bolivia (*Tipuana tipu)*
- Tulip Tree (*Liriodendron L.)*
- Weeping Fig (*Ficus benjamina)*
- Weeping Willow (*Salix x sepulcralis Simonkai)*
- White Mulberry (*Morus alba L.)*
- Willow (*Salix spp.)*
- Yellow Grove Bamboo (*Phyllostachys aureosulcata)*

Appendix H: Target Serum and Tissue Nutrient Evaluations

There are a few published reports on serum nutrient concentrations in orangutans. The data from ISIS are not included here as they represent both healthy and ill zoo orangutans.

Total cholesterol, triglyceride, high density lipoprotein cholesterol (HDL), and low density lipoprotein cholesterol (LDL) concentrations (mg/dl) in serum of free-ranging orangutans (*Pongo pygmaeus*).

Reference	Gender	N	Cholesterol	Triglyceride	HDL	LDL
Kilbourn et al., 2003	range	38	77 - 1,125	27 - 161	n/a	n/a
Schmidt et al., 2006 mean ± SEM	male	10	167.1 ± 11.7	77.6 ± 9.8	47.6 ± 4.8	94.9 ± 7.5
Schmidt et al., 2006 mean ± SEM	female	10	118.0 ± 11.7	71.6 ± 9.8	27.6 ± 4.8	72.4 ± 7.5
Schmidt et al., 2006	range	20	87 - 236	37 - 181	15 - 82	38 - 140

Serum vitamin concentrations in wild and zoo orangutans.

Reference	Retinol (µg/dl)	Retinyl Palmitate (µg/dl)	γ-Tocoperol (µg/dl)	α-Tocopherol (µg/dl)	25(OH)D (ng/ml)	1,25(OH)D3 (pg/ml)
Kilbourn et al., 2003 (wild, range)	16 - 87	n/a	10 - 55	70 - 488	n/a	n/a
Crissey et al., 1999 (zoo; mean ± SEM)	69.2 ± 16.0 n=7	4.4 ± 2.5* n=7	23.1 ± 2.0 n=7	757.9 ± 85.9 n=7	15.6 ± 3.9 n=8	22.6 ± 6.2 n=8

*Some values were not detectable.

Serum mineral concentrations in wild and zoo orangutans (ppm).

Reference	Ca	Co	Cu	Fe	K
Kilbourn et al., 2003 (wild, range)	88 - 125 n = 33	0.11 - 0.16 n = 33	1.48 - 3.37 n = 33	0.55 - 4.76 n = 33	142 - 250 n = 33
Crissey et al., 2001 (zoo; mean ± SEM)	101.7 ± 6.93 n = 7	0.6 ± 0.03 n = 7	1.4 ± 0.16 n = 7	2.8 ± 0.36 n = 7	185.9 ± 17.52 n = 7

Serum mineral concentrations in wild and zoo orangutans (ppm).

Reference	Mg	Mn	Mo	P	Zn
Kilbourn et al., 2003 (wild, range)	10.1 - 44.5 n = 33	0.06 - 0.62 n = 33	0.22 - 0.33 n = 33	73.2 - 195 n = 33	0.5 - 2.0 n = 33
Crissey et al., 2001 (zoo; mean ± SEM)	25.5 ± 2.72 n = 7	------ ------	------ ------	61.7 ± 8.94 n = 7	1.7 ± 0.35 n = 7