Standardized Animal Care Guidelines for Gorillas (Gorilla gorilla)

Definitions:

Introduction

The genus Gorilla is composed of two species: Gorilla beringei in east Africa and Gorilla gorilla in West Africa. They are further classified into four sub-species: Mountain gorillas (Gorilla beringei beringei), Grauer’s gorillas (Gorilla beringei grauri), Western lowland gorillas (Gorilla gorilla gorilla), and Cross River gorillas (Gorilla gorilla dehli). The animal care guidelines and recommendations within this document focus exclusively on Gorilla gorilla gorilla. Much of the information presented in these guidelines has been taken from ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

Management strategy: The North American Regional population was founded in 1927. The first captive birth was recorded in 1956 and captive breeding became a significant source of recruitment to the captive population in the 1970s. The most current population analysis is available in the Western lowland gorilla (Gorilla g. gorilla) Population Management Plan (Lukas 2007). The Association of Zoos and Aquariums (AZA) Ape Taxon Advisory Group (TAG) has set a target population size for this species of 400. The AZA Gorilla Species Survival Plan (SSP) population as of 28 March 2006 was 367 specimens in 53 collections. Preliminary demographic projections indicate that under current population parameters, by the year 2020, approximately 80 males will be living in an estimated 27 bachelor groups. Currently 17 such groups exist. Given the need to increase the number of bachelor groups in the next 15 years, the AZA SSP is restricting the number of pairs recommended for breeding. As with most SSP populations, pairings are prioritized to maintain or increase gene diversity through considerations of mean kinship, focusing on low mean kinship males (<0.0109) and low mean kinship females (<0.0109) at the same institution. In addition to mean kinship, consideration is also given to the construction of same-age cohorts within institutions. Specifically, where possible, multiple low mean kinship females were recommended to breed at institutions that currently have no individuals less than 4 years old. For all breeding recommendations, inbreeding is avoided and breeding-related transfer is not recommended unless requested by the institution.

Conservation status: Both species of gorilla are listed as “Endangered” by the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List. Major threats to the survival of gorillas include poaching for bushmeat, habitat destruction, and disease.
1. Abiotic Environmental Variables (address both exhibit and off-exhibit holding)

1.1 Temperature:

Indoor: The recommended ranges for tropical primates in captivity are dependent on the individual and medical needs of the animals. USDA regulations require that the ambient temperature of the indoor area should never fall below 45°F (7°C) for more than four consecutive hours, but the AZA Gorilla SSP recommends an indoor temperature range for gorillas of 65-85°F.

Outdoor: The comfort range for gorillas is between 20-30°C (65-86°F), but with gradual acclimatization, many tropical primates can tolerate outdoor temperatures down to 32°F (0°C) on sunny days. Wind speed and wind chill need to be taken into account when evaluating outdoor conditions. The AZA Gorilla SSP recommends a minimum temperature for gorillas in outdoor conditions of 45°F (7°C) during inclement weather (e.g., rain, wind, overcast, etc), and of 35°F (3°C) during sunny conditions. Gorillas should be given access to heated, indoor holding if it is cold and wet; and it is recommended that they not be allowed out if temperatures are below 35°F (3°C).

The provision of wind protection, sun pockets, heated perches (disguised as rocks or logs) in the winter, and shaded resting places under protected trees or on north side of structures/walls in summer, will allow the animals to have access to a wide range of temperature variation. Elements such as heated perches, shade, and sun pockets should be carefully placed in an exhibit to maximize viewing opportunities.

Temperature variations: Depending on the local micro/macro climate, adjustments should be made to maintain balanced temperatures between indoor and outdoor habitats. Where weather conditions are not extreme (either hot or cold), some designers recommend a maximum variation of approximately 20°F (~10°C) between indoor and outdoor temperatures.

1.2 Humidity:

A balance of temperature, humidity, and ventilation is needed to arrive at a reasonable comfort level for gorillas and keepers. The range of indoor humidity recommended is 30-70%; however, more research is required to determine the suitability of this recommendation since gorillas typically come from areas of higher humidity. Humidity can be increased within indoor and outdoor enclosures by the use of fogger, misters, and even rain effects. These can also provide daily environmental variation.

1.3 Illumination

1.3.1. Identify light intensity, spectral, and duration requirements,

Light levels need to be adequate to be able to clean the facility effectively, and view animals in all areas of the enclosure. A minimum of 50 ft-candles should be provided within the enclosure area, taking into account the reduction in light levels as the light travels through any glass or caging materials.
Consideration should be given to the need for supplemental lighting (e.g., temporary spot lights) in the event of a medical emergency. Lighting fixtures should generally be mounted outside the cage, and far enough away from the gorillas to avoid being broken. Industrial-grade fixtures, such as those used in correctional facilities, are constructed to withstand excessive force in many circumstances, and have been successfully used in indoor night rooms. Fixtures should be mounted in waterproof and shatterproof enclosures. Florescent bulbs should be inserted in a plastic sleeve to avoid breakage in animal care staff work areas that may be adjacent to the gorilla enclosure.

Skylights encourage natural sunlight during the day, but may or may not provide full-spectrum light to penetrate to the exhibit. Natural spectrum bulbs (preferred) or fluorescent bulbs are required when animals do not have access to natural sunlight for extended periods. Like humans, gorillas require vitamin D (see section 3.1.1 for additional information), which can be provided by natural spectrum light (wavelength band 290-315nm with peak conversion at 297nm).

For animals held indoors seasonally or year-round, consideration should be given to use of UVB-transmitting material in skylights or windows to prevent the development of metabolic bone disease. These materials have been in use only recently and there are few published data on their impact on circulating vitamin D levels in primates. UVB-transmitting materials will still block many UVB rays from being transmitted, and will become increasingly less effective at transmitting UVB over time. Perching or sunning areas large enough for all animals to use at the same time should be placed as close to the skylights as possible for maximum impact. Care should also be taken to ensure that subordinate animals have the ability to use these areas. Light bulbs generating UVB wavelengths also have a limited range (often within 18°), and shelf life (6-12 months), and care needs to be taken to place these bulbs close enough to animals to ensure some UVB transmission, while maintaining the safety of the animals. High among the safety concerns are prevention of burns from the bulbs and retinal damage from the lights. UVB-transmitting skylights and UVB generating light bulbs provide a fraction of the UVB provided by sunlight. Outside areas with wire-mesh ceilings are therefore recommended as important elements of primate exhibits, though mesh will diminish the amount of UVB coming into the exhibit. Special UVB radiometers (e.g. Solarmeter®, Solartech, Inc) can be purchased rather inexpensively to determine the extent of UVB transmission through skylight material or mesh.

Special attention is needed for newborn offspring suckling from mothers housed within indoor exhibits. Vitamin D molecules are too large to pass into milk, and so are not provided to offspring from their mothers. It is recommended that infants receive a daily full-spectrum artificial light bath when they do not have access to direct sunlight for a long period of time. In the absence of sunlight (or other UV sources),
there may be a need to supplement infants with vitamin D through injections or oral dosing.

It is important to understand that vitamin D can be stored in the body and can reach toxic levels by both injection and oral dosing. The type of vitamin D used is also important. Cholecalciferol, vitamin D₃, is the animal form of the vitamin and will be better absorbed and utilized by the animal over the plant form, ergocalciferol (vitamin D₂).

1.3.2. Address the impact of and need for daily changes in light intensity and seasonal changes in light intensity and duration

Replication of natural solutions for lighting in an indoor environment is recommended. As gorillas are equatorial animals, a 12-hour light/dark cycle is appropriate in most circumstances. Long-term exposure to artificial light may create implications for primates' health and reproductive cycles.

1.4 Space
1.4.1. Behavioral repertoire, space requirements, and complexity.

It is difficult to estimate the appropriate space requirements for captive gorilla enclosures. Multiple factors affecting the quality of the space likely have significant influences on how gorillas perceive the quantity of space. Gorillas should be housed in large, complex, environmentally enriched enclosures. Outdoor access should be provided to all gorillas whether on exhibit or off exhibit. As newer exhibits are being planned, considerations for multiple habitats or exhibit clusters are recommended. Exhibits with multiple habitats, fully integrated with holding buildings that interconnect each habitat, as well as night quarters, shifts, squeezes, and dayrooms, are necessary to fulfill the concept of a "life-care complex" for an ever-expanding population of gorillas within a singly managed facility. Visual barriers, access to privacy, climbing apparatus, vegetation, nesting material, and manipulable objects are important in reducing stress, social conflict, and boredom (Miller-Schroeder & Paterson 1989).

The size of these multiple habitats may vary depending on available space in the facility. The space needs to be sufficient to allow for the number, age and sex ratio of the animals assigned to the area with emphasis on the social dynamics of these individual troop members. Also keeper staffing levels, and the flexibility of the space to allow for multiple shift doors, feeding chutes, sleeping platforms, etc need to be taken into account when deciding if space needs are adequate and suitable to meet the needs of the diversity of the animals in these specific habitats. As an example, the dimensions of indoor and outdoor exhibits for two facilities are provided below:
Table 1: Dimensions of Lincoln Park Zoo’s (LPZ) Regenstein Center for African Apes gorilla exhibits, Louisville Zoo’s (LZ) Gorilla Forest, and Sedgwick County Zoo’s (SCZ) Downing Gorilla Forest

<table>
<thead>
<tr>
<th>Enclosure</th>
<th>Indoor area (ft²)</th>
<th>Outdoor area (ft²)</th>
<th>Year opened</th>
<th>No. of animals &amp; groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPZ A</td>
<td>1175</td>
<td>12130</td>
<td>2005</td>
<td>9 adults</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 juveniles</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2 groups)</td>
</tr>
<tr>
<td>LPZ B</td>
<td>1070</td>
<td>5270</td>
<td>2005</td>
<td>13 adults</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3 groups)</td>
</tr>
<tr>
<td>LZ A</td>
<td>600</td>
<td>21780</td>
<td>2002</td>
<td>8 adult males</td>
</tr>
<tr>
<td>LZ B</td>
<td>600</td>
<td>21780</td>
<td>2002</td>
<td>(3 groups)</td>
</tr>
<tr>
<td>LZ C</td>
<td>300</td>
<td>378</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCZ A¹</td>
<td>2200</td>
<td>31000</td>
<td>2004</td>
<td>8 adult males</td>
</tr>
<tr>
<td>SCZ B²</td>
<td>2400</td>
<td>-</td>
<td>2004</td>
<td>(3 groups)</td>
</tr>
<tr>
<td>SCZ C³</td>
<td>~108</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Outdoor exhibit and public dayroom
² Non-public dayroom
³ Individual bedrooms (8 in total)

Outdoor exhibits: Gorillas need an appropriate amount of space to exhibit natural behaviors; including nest building, displaying, climbing, foraging, and brachiation, as well as distance enough to get away from a conspecific if desired. Western lowland gorillas largely inhabit dense rainforests and, although mostly terrestrial, make good use of trees to build nests and forage (Remis 1993, 1995; Mehlman & Doran 2002). The amount of arboreality can vary between wet and dry seasons, between years, and between sex classes (Remis 1999). For example, adult females and youngsters are more likely than silverbacks to build nests in trees (Mehlman & Doran 2002). It is recommended that an exhibit offer functional vertical space in addition to generous terrestrial space. Ross and Lukas (2006) found that gorillas use vertical space provided to them at approximately equal proportions to its availability. The quality of the space needs to be complex by offering animals different structures to climb on and explore. The exhibit should also offer enough horizontal space so that an ape can choose to be in a location that is not right up against zoo guests. Because gorillas tend to avoid open spaces (Ogden et al. 1990, 1993; Ross & Lukas 2006; Stoinski et al. 2002), a variety of structural elements should be distributed throughout the exhibit. Ross and Lukas (2006) also found gorillas prefer to spend time in corners and doorways. In the design of new exhibits, these features can be located adjacent to public viewing areas to simultaneously promote animal comfort and visibility to visitors.

Outdoor off-exhibit areas: When possible, outdoor access should be provided to animals that are housed off-exhibit. Gorillas that are held off-exhibit either temporarily or for an
extended period of time should be able to spend some time in outdoor areas. Ideally, a separate off-exhibit holding area would exist adjacent to holding areas for this purpose.

**Indoor exhibits:** The types of indoor habitats for gorillas can be subdivided into three generalized types: 1) night and shift rooms; 2) day rooms; and 3) special rooms. All indoor rooms should have floors that slope toward keeper areas to assist with cleaning and collection of urine or feces by staff.

**Night room and shift room:** The night and shift rooms are the primary holding units for gorillas, and are generally off exhibit. These rooms should be arranged in a series, to allow a rotational connection to the outdoor habitats, as well as to day rooms and special rooms, in such a way that any animal can be shifted from any room to any other room within the system, without anesthesia. The night room should be outfitted with sleeping platforms, hammocks, and other soft replaceable materials for bedding to provide a dry and comfortable resting environment, as well as multiple provisions for ad lib water. Gorillas will regularly construct night nests if provided with proper nesting materials, which could include: hay, straw, mulch, cut natural vegetation, and artificial materials such as paper, burlap, or cardboard. They will spend more time occupying elevated surfaces if offered numerous, widely placed nesting platforms (Lukas et al. 2003b).

The shift room (or rooms) provides a secondary room to shift the entire group while the keeper staff cleans the night room. The shift room can be significantly smaller than night rooms, if necessary.

**Day room:** The day room (or community room) is sized to accommodate the extended family unit, and may or may not be used for public viewing. Day rooms range from environments that are quite natural in feel and appearance, including soft substrates, landscape materials, and artificial rockwork, etc., to more functional rooms that are larger versions of night rooms, with additional opportunities to promote species-appropriate behaviors. Both must be highly complex environments designed to provide novelty and exploration for the gorilla in a climate controlled indoor environment. The use of visual barriers, topographic elements, perches, climbers and other furniture in these rooms may help to encourage positive behaviors in what is generally a more confined indoor environment. Gorilla exhibits should be conceptualized as three-dimensional rather than two-dimensional spaces, to maximize use of all available areas (Weghorst & McGrew 2000). Functional vertical space should therefore be ample and provided in the form of both permanent climbing structures and temporary, movable features such as hammocks, ropes, and vines. Because of the troop living social structure, night or day rooms should be large enough for multi-member groups to share one or more rooms. Also care must be taken to
keep from creating “dead ends” or places where gorillas can be cornered or trapped by other group members. If possible create as many “run-arounds” or opportunities for animals to escape from conspecifics as possible. This can be done with furniture or with multiple doors. This will be extremely helpful during introductions of new group members if a special room for introductions is not available.

**Special rooms:** There are many "special rooms" in animal holding areas; many perform multiple functions and can be combined as desired in the design of the indoor habitat. The following represents a range of functions that need to be considered in the design of the “life-care center” for gorillas.

- **Quarantine facilities:** Prior to transfer to a new location, gorillas are subject to AZA Guidelines for quarantine requirements (AZA 2008). Depending on the population of great apes at any given institution, the building of a Center for Disease Control (CDC) rated facility adjacent to the general holding area should be considered. Consideration should be given to space that meets CDC standards to serve a wider variety of species.

- **Introduction suites:** As a new member prepares to migrate into a group, special introduction areas can facilitate this event. Introduction areas can consist of two rooms, with an adjoining doublewide mesh "howdy" wall (6” between mesh), to allow touch, smell and sight, but not grabbing and biting. The opportunities for enrichment/play devices within the howdy wall mesh frame are endless and should be exploited. The design of these facilities should include the capability to create a circular pattern of movement between rooms and should not include places where individuals can get trapped.

- **Medical areas:** Separated medical areas should be provided within the general holding area for those individuals needing special immediate care. McManamon & Bruner (personal communication, 1990) suggest (for orangutans) the medical area should be designed to enable examination of animals, taking blood samples, suturing wounds, and other minor surgical procedures. Emergency equipment should be available (oxygen, EKG, heat lamps, immobilization equipment). The size and complexity of this area depends on the size of the animal population it is serving.

- **Nurseries:** A nursery is a dedicated space devoted exclusively to hand-rearing an infant gorilla. It must be next to conspecifics, have auditory, visual, olfactory and supervised tactile capabilities, share common features with living space of gorillas (e.g., structures, etc.), mimic the adult program, be
capable of being an intensive care unit if necessary and provide opportunities for age-specific movements, activities etc. A nursery area is important if hand-rearing an infant is the only option. Nurseries, hand-rearing suites, or portable modules have met with success; ideally, they should be situated within visual contact adjacent to the holding area of the natal group. These areas should permit easy access to the infant for feeding and care while still being within the holding area. This permits early exposure to the sights, smells, and sounds of future family members and provides accelerated learning of behaviors. Interconnected passageways that are sized for the youngster provide access when integration occurs (Lindburg & Coe 1995). Even if a stand-alone nursery is present, the holding facility should have introduction facilities suitable for early socialization of neonates.

- **Squeeze cages**: The squeeze cage is a confined cage (generally 2m x 2m x 2m) with an additional moving wall that directs and maintains an animal to one side wall, where close examination and medical procedures can be undertaken. These are designed to examine gorillas without invasive or hazardous means and for quick, efficient capture and restraint. They can be either built-in to the sequence of cages or used as a plug-in, portable unit. The built-in variety has the advantage of being part of a daily routine and not being associated with a particular stress event. In this case, transfer doors lead into and out of these cages and into the general holding rotation. Provisions can also be made to connect a transport box to these squeeze cages.

- **Collection cages**: The collection cage is similar to the squeeze cage except that it has an elevated mesh floor. This cage type is used to monitor the animals’ intake and output over time and to facilitate fluid collection. The solid "lower" floor should be isolated from other area drainage and sloped to a single point where a collection pan can be inserted to collect fluids. Attention must be given to the most appropriate collection devices for particular needs. The elevated floor should be high enough to adequately clean the lower floor and should match the height of the transport box.

- **Overhead transfer chutes**: Overhead transfer chutes are used to provide linkages from one space to another or across keeper corridors. These are typically 1m x 1m (3’ x 3’) with mesh on all sides. Care should be given to provide adequate clearance under chutes and to restrict use of spaces under these chutes.

- **Weigh stations**: Weigh stations should be provided within the caging system. These can be, again, built-in or portable depending on the location. Weigh stations have been associated
with transport cages, collection cages, and overhead transfer chutes with equal success.

More information: For more information on the design of appropriate gorilla enclosures see the ‘Design’ chapter of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997), and Coe et al. (in review).

1.4.2. Minimum inter-individual distances that must be maintained and that will influence size of space.

As a minimum, the environment should allow the gorillas to be out of sight from one another, if desired. Not only the amount of space, but the complexity of the space should be considered. There is some evidence to suggest all-male groups exhibit higher levels of aggression at institutions that additionally house females (Stoinski et al. 2004a,b). Therefore, it may be advantageous to provide areas for male gorilla groups that are outside of visual, olfactory, and auditory contact of females.

1.4.3. Identify appropriate furnishings to accommodate an array of locomotory and foraging behaviors as well as resting and sleeping.

In order to elicit species-appropriate behaviors from exhibited animals, there are a host of furnishings that should be provided to replicate objects found in the gorilla's natural environment.

Foraging: The use of live and dead plant materials is generally considered to be the most useful furniture in outdoor enclosures. Vegetation provides shade/cover, display and foraging items, browse/food elements and nesting materials, and allows for visual cover from other animals, thus promoting species-appropriate behavior conducive to both the apes’ well-being. It is important to know specific animal behaviors elicited by plants to determine plant selections and plant maintenance schedules. See Appendix A for a list of browse species approved for gorillas. See section 2.1.4 for additional information on promoting foraging behavior.

Locomotion: Various rock outcrops, artificial or natural topographic features, and deadfall trees can be arranged in a manner to encourage natural movements and locomotion patterns within the exhibit, to simulate the daily foraging behaviors of wild gorillas. The placement of exhibit furniture, and the planting of islands and climbers, teamed with barrier and view conditions, can create a dynamic outdoor environment for both apes and visitors. As a caveat, any moveable piece of furniture must be used carefully; gorillas have used branches as ladders to escape from exhibits (e.g., Woodland Park Zoo). Climbing, perching, and elevated rest areas have been traditionally made of hard, washable surfaces such as steel or dense plastic. Wood is normally
sealed to make it non-porous. Natural materials are recommended for perching in the event that the perching items are consumed. Non-washable materials such as ropes, fabrics, etc. are typically discarded when soiled (USDA 1991), although see section 1.4.7.

Although it has been noted that gorillas are primarily terrestrial primates, given the opportunity, they will climb and use trees. Artificial climbers provide for some of the range of locomotion and behaviors displayed in natural trees. Wide, comfortable crotches for perching and well-placed branches for climbing can be designed into the form of artificial trees. However, some of the more subtle qualities, including flexibility, shade, manipulation, destructibility, and food source, may not be provided by artificial trees. Combinations of climbing structures, artificial and dead trees, vines, ropes, and wooden constructions may promote a wider array of behavioral options for expanding vertical and horizontal dimensions to habitats.

Resting & sleeping: Gorillas make and use nests on a daily basis in the wild; therefore, this opportunity is an important aspect to provide in a captive environment.

Abundant materials should be provided in such a way to allow access to multiple animals sharing a given space (Lukas et al. 2003b). Many individuals, especially the very young, the very old, and pregnant females, have a special need for comfort while resting. Wind protection, sun pockets, heated perches (disguised as rocks or logs) in winter, and shaded resting places under protected trees or north side of structures/walls in summer, allow the animals to be comfortable within a wide range of temperatures.

In the wild, silverbacks use ground nests more often than non-silverbacks do (Mehlman & Doran 2002). Male gorillas may spend more time than females do on ground nests because many trees lack structural support for the larger bodily size of silverbacks (Remis 1995, 1999). However, when elevated spaces are composed of structures designed to support the weight of adult males, males and females have been found to exhibit equivalent use of elevated space (Lukas et al. 2003b).

Many types of sleeping platforms have been provided in interior holding facilities. Consideration for easy access for all age/sex classes must be made. Although silverbacks may be more likely to build floor nests, adult females and youngsters often seek elevated nesting opportunities (Lukas et al. 2003b). The size of sleeping platforms may vary, depending on the number and type provided, but corner sleeping platforms measuring 5' x 5' have been used with success. The use of items such as rope or fire hose hammocks or flexible, heavy-duty chain-link fabrics can also provide resting and sleeping opportunities. All furniture items should be secured or light enough that if they are thrown they do not injure visitors or break containment glass.
1.4.4. Address the need for and appropriateness of visual, acoustic, and olfactory barriers within the space.

**Acoustic:** The effect of noise on captive animals remains little understood, and further research is recommended. As with humans, there is basic understanding that loud noise is stressful (e.g., Tempest 1985; de Boer et al. 1988). With gorillas, preliminary data suggest that the presence of some sounds (e.g., food preparation, cleaning, and other species' vocalizations) may be stressful (Ogden et al. 1994). This is clearly an important factor to consider when designing exhibits, and may recommend the use of more sophisticated acoustical treatments than are generally included in holding areas.

One method often used in human environments is a “masking” treatment that uses another sound or music to cover up potentially stressful sounds. Research on the effects of music on captive primates has had mixed results (see Wells et al. 2006; Videan et al. 2007). Unfortunately, the use of such a treatment in one study was only marginally successful (Ogden et al. 1994); while the stressful responses to sounds such as cleaning were eliminated in younger animals, the stressful responses were actually increased in adult animals. Other studies identify sounds (e.g., classical music) that may be more relaxing for animals (Wells et al. 2006). More research is needed in this area.

Every effort should be made to dampen harsh sounds and vibrations. Most noise absorbent materials are not waterproof, but there are still techniques, such as the use of deep bedding and natural plant materials, that can be used to quiet the environment. Rubberized floors have also been used successfully with non-primate species; such floors might serve to soften the environment while still being easily disinfectable.

**Visual and olfactory:** While there is little research that specifically examines the impact of visual stimuli on gorilla behavior, gorillas are known to react to display postures of other animals and exhibit a tight-lip face or display stance in response. Additionally, there is preliminary evidence that gorillas in all-male groups are more aggressive at facilities that hold a second group containing females (Stoinski et al. 2004a). Whether the signals causing this increase in aggression are visual, olfactory, or acoustic is unclear at this time. However, the use of visual barriers may be appropriate when multiple groups of gorillas are held at the same facility.

1.4.5. Identify appropriate substrates and nesting/bedding materials if required.

The majority of institutions are now using natural substrates with gorillas. Leaf litter, exposed roots, thickets, brambles, marshes, packed earth, and cultivated field are examples of the complexity of substrates that can be used.
Indoor enclosures: Softening of the hard/sealed concrete enclosure can be achieved by the use of various kinds of litter. Bedding is especially important when access to exterior habitats is not permitted, due to weather or access problems (Chamove et al. 1982). Captive gorillas will also build more elevated nests, and spend more time on floor nests, or scattered hay in colder weather and more time on bare floor substrates in warmer weather (Lukas et al. 2003b).

Not only the choice of bedding type, but the method of delivery and replacement needs to be considered. Gorillas make and use nests on a daily basis in the wild; therefore, this opportunity is important to provide in a captive environment. Many individuals, especially the very young, the old, or pregnant females, have a special need for comfort while resting.

- Deep mulch substrate: A number of facilities (e.g., Calgary Zoo, Franklin Park Zoo, Louisville Zoo, Lincoln Park Zoo, and Toronto Zoo) have incorporated deep bedding as the primary substrate for indoor enclosures. A 1-3' layer of wood chips provides a soft, easily manageable indoor substrate for gorillas. Types of wood chips can vary between institutions based on availability and pricing and to meet zoos’ specific needs. Louisville Zoo and Franklin Park Zoo use all hardwood chips, while Lincoln Park Zoo uses a combination of redwood bark chips and pine bark chips. See section 1.4.7 for recommendations on cleaning when deep mulch substrate is used.

1.4.6. Address mechanisms for the provision of change and variation in the environment.

The USDA requires a program to promote the psychological well being of nonhuman primates (USDA 2002). One method of achieving this is by providing change and variation in the environment. This can be accomplished by providing gorillas with a variety of physical spaces (Coe 1992; Lukas et al. 2003b), or by implementing a rich and varied enrichment program that encourages species-appropriate behavior (Mentz & Perret 1999). A primary component of an enrichment program should involve rotation of enrichment options to maintain novelty and interest. Variation and change can be utilized in many different areas, including:

- Diet (type, schedule, and presentation)
- Cage and exhibit furniture
- Enrichment devices/toys
- Social interaction (conspecifics, mixed species, keepers)
- Behavioral training
- Sensory enrichment
- Bedding material
Facility design can greatly influence the ability to utilize variety and change easily. Features such as eyebolts or attachment points on walls or ceilings for perching, nets, hammocks and toys, will make changing out enrichment more straightforward. Locations that allow animal-keeper interactions for socialization, training, feeding, as well as food ports, chutes or other features that allow keepers to easily feed animals throughout the day will make the implementation of food enrichment and food reward easier. Structures and features that allow keepers easy access to platforms and raised areas in the enclosure for provisioning enrichment and cleaning, etc. will help make implementation of enrichment and change simpler and safer.

Whenever possible, enrichment features should be serviceable from outside the enclosure. As examples, trees and climbing structures should be easy to replace, and it should be possible to restock feeding stations from outside the exhibit, so that they can be restocked throughout the day if desired. Vehicle and equipment access for grading, landscape maintenance/replacement, and earthwork machinery should be included within exhibit designs. Service access for cranes must also be planned to replace furniture and landscape materials as they decay.

Ideally, an enrichment plan that incorporates change and variation within the animals’ environment will foster the provision of opportunities for species-appropriate behaviors, and progression toward an activity budget that mirrors that in the wild as much as possible.

Plants: Plant material within outdoor and indoor enclosures provides natural environmental variation throughout the year. Care should be taken to ensure that these environments contain only non-toxic plants. Plants can provide an opportunity for a wide range of species-appropriate behaviors, including foraging and eating, nest building, and display. It is important to know the specific animal behaviors elicited by plants to determine the most appropriate plant selections and plant maintenance schedules. Different plants or plant parts may be used at different times of the year by the gorillas. Animals can be rotated on and off a planted area to allow recovery time – similar to the concept of pasture rotation with livestock – by having multiple planted areas, compartmentalization of the exhibit, or adequate non-planted spaces for exhibit/holding while the planted area is recovering.

1.4.7. Address issues, such as scent marking, that may influence how and how often space is cleaned.

Outdoor: Spot-cleaning of fecal material and food wastes is critical to maintain a healthy and odor-free environment, reducing pathogens and pests.

Indoor: On a daily basis, bedding materials can be temporarily removed or piled in a dry corner while the more soiled areas of the enclosure are cleaned and disinfected. Bedding materials should be
totally replaced and the enclosure completely disinfected as needed. Enclosures should be dried, by squeegee, fan, wet vacuuming, etc., before animals are returned to them. Degreasers may also be used to remove body oil buildup. Steam-cleaning or high-pressure washing can be used periodically, provided appropriate measures are taken to protect both gorillas and staff from exposure to aerosolized fecal material, thus preventing parasitic or bacterial infection. To be an effective disinfectant, steam should be over 300°F. Bedding, food, fecal matter, and other items in an animal's enclosure should be removed before cleaning to decrease the potential of aerosolizing infectious material and improve the effectiveness of the disinfectant agent.

Protective clothing should be worn when cages are cleaned. Additional protective devices such as face shields, goggles, or respirators should be worn when using high power hoses or steam cleaners.

- **Deep mulch substrate**: Daily maintenance may consist of spot-cleaning soiled areas and/or turning the wood chips with a shovel or pitchfork to combine with mulch, which results from the breakdown of woodchips. Turning the woodchips and mulch also aerates the substrate and prevents the growth of mold and mildew. If excessive mold is observed treatment with 1:10 vinegar:water solution helps prevent further mold growth. Fresh wood chips may be placed on top of broken down material as needed. If the substrate becomes too dry, it may be wetted with water as needed. Once to twice per year, the substrate should be completely removed so the permanent flooring beneath, as well as vertical and horizontal structures of the three-dimensional space, may be thoroughly disinfected and a fresh layer of woodchips added. The frequency of woodchip removal and disinfection may need to occur more or less frequently depending on environmental conditions and the consistency and quality of the substrate. The use of woodchips as a semi-permanent substrate requires a vigilant pest control program to deter fly and rat/mouse infestation.

1.4.8. **Identify number of air or water changes/hour required**

The USDA regulations require that indoor areas must be sufficiently ventilated at all times to provide for health and well-being, and to minimize odors, drafts, ammonia levels, and moisture condensation. Ventilation can be provided by windows, vents, fans, or air-conditioning. Auxiliary ventilation must be provided when the ambient temperature is 85°F (29.5°C) or higher.

Ten to fifteen air changes per hour are recommended for small areas (such as holding areas), or areas which contain high densities of animals. This same level is used for areas with potential contamination, such as sterile surgical areas, necropsy rooms, and waste storage areas.
Air entering animal areas should be fresh and should be exhausted without recirculation (100% air exchange in animal rooms or equivalent if possible). Separate zoning of air systems, to prevent cross contamination, should be part of any non-human primate facility.

1.4.9. **Identify necessary measures for safety and containment.**

Gorillas are not usually known to be great jumpers or great acrobats, but they are strong and agile climbers. However, there have been cases of gorillas escaping their enclosures through running and jumping (Dallas) and climbing (Boston). Each institution should determine minimum barrier dimensions and maintain these consistently throughout. Combinations of barrier types can be employed, depending on factors such as site conditions, construction access, viewing opportunities, and landscape replication. While not necessarily continuous by type, barrier dimensions should be continuous around the animal’s perimeter. In selecting barrier types, it is important to consider their varying psychological impact on the confined animal. The perception of available space can be enhanced, as can the ability to escape from public view.

**Primary containment barriers:** Containment barriers can be classified into a limited number of types, with selection based on cost, function, and viewing distance/aesthetics. Four types are used successfully to contain great apes: 1) walls, 2) moats, 3) mesh structures, and 4) glass walls or view blinds.

- **Walls:** The texture of walls must be smooth to ensure that the gorillas cannot find foot or finger holds; walls must be non-climbable. Some institutions in the past have utilized professional rock climbers to assess the potential for obtaining foot or finger holds in the walls. It is important to understand that while this can be useful, it should be not used as a guarantee that gorillas are not able to obtain these holds. Overhangs may be added to prevent scaling. The layout of the walls should avoid perpendicular or acute angles to adjoining walls to prevent the animals from "chimneying" out, or the walls should be capped at these dangerous intersections. An outdoor exhibit barrier height of 15-17' (4.6-5.2m) has been proven adequate in most cases, but we need to remain cautious that some animals can be agile climbers even where other gorillas have not been able to climb (e.g. Little Joe escapes from Franklin Park Zoo in 2003). Any estimates of jump distance for gorillas should include both the standing jump ability of gorillas (up to 4') as well as their standing reach (up to 9'). In all cases, exhibits should be designed to limit the ability of animals to use trees, structures, or sloping hills to extend jumping heights (Coe et al. 2001).
- **Moats**: Field research has shown that gorillas in the wild do not ford deep water and are not able to swim. Although shallower, wet moats have been used with captive gorillas, there are potential safety problems, and their use should be limited. For example, a male gorilla died after drowning in a water moat in 2006. If water moats are used, handles or other provisions for allowing gorillas to climb or pull itself out should be prominently available. The dry moat is clearly the safer approach. The exterior wall (public side) of the moat must not be climbable, while the inner wall (animal side) may be textured, or in some cases sloped. The use of sloped moats may provide a better alternative, or can be used in combination with vertical wall surfaces. The bottom of the moat should be filled with a resilient material (e.g., soil/turf or cargo nets) to absorb the shock of accidental falls. Barrier dimensions need to consider topographic variation, especially in relation to moats. One common method for maintaining the appropriate barrier distance is to ensure that a distance the height of the barrier wall is maintained from all adjacent surfaces (i.e., "radial distance"). As an example, if the barrier wall is 12' high, no object in the exhibit that could be used to facilitate escape (such as a tree or a hill) should be less than 12' from the wall. With multi-group exhibits, double moats should be used between groups.

- **Mesh structures**: Steel mesh enclosures can be large outdoor cages with structural steel columns and beams with in-fill panels of mesh, or post-and-cable structures with less rigid forms. Because these are total enclosures, barrier distances are limited to the size of the mesh openings. To minimize gorilla-visitor contact, 5cm (2") openings have been used, with people approximately 2m (6') behind secondary barriers. With larger mesh openings, 10-16cm (4-6"), visitors should be kept 2-3m (6-9') away, as the animals will be able to reach their arms through the larger mesh openings. It should be noted that some veterinarians recommend a 15' distance to reduce the potential for disease transmission.

- **Glass walls or view blinds**: Glass is best combined with viewing blinds, because as glass is exposed to direct sun, reflections can obscure viewing. Darkened visitor shelters provide a glare-free environment for the viewer; glare should be controlled on the animal side as well by extending overhangs. Structural characteristics must be determined by glass specialists based on the size of openings and assumed loads. Barrier heights must be determined from any horizontal member to the top of the wall.
Secondary containment barriers: High voltage electric fencing has been used successfully in gorilla enclosures to: 1) maintain protection around vegetation areas, 2) discourage use of moated/out-of-view areas, and 3) as insurance on top of barrier walls and fencing. Electric fence elements should be redundant and carefully monitored to ensure proper function, but at no point should electric fencing be considered primary containment for gorillas. Additionally, care must be taken to consider the functional loss of space resulting from the application of hotwire. In an effort to steer clear of hotwire, gorillas may avoid surrounding areas as well thus resulting in an unintentional decrease in the amount of usable space within the exhibit.

Indoor enclosures: Containment in the indoor habitat is defined by the structural frame, surfaces, and substrates of the building, together with caging systems. To separate adjoining rooms, solid walls should be used between groups. These walls should be either cast-in-place with a smooth (rubbed) finish or reinforced concrete masonry units (CMU’s). In either case, holes should be filled in to prevent collection of bacteria growth. In the use of CMU’s, grout between blocks or tiles must be pargeted smooth to the wall surface. Epoxy or other durable finishes should be applied to the walls and floor surfaces. Ceilings must have strength, moisture resistance, and washability characteristics similar to walls. In most cases, poured concrete slabs, precast concrete planks, or skylights with protective caging are used for ceiling surfaces.

The use of pre-fabricated, panelized mesh systems has been used extensively in night rooms, day rooms, and shift rooms, as well as in some special rooms: 5.08cm x 5.08cm x 6.36mm (2" x 2" x ¼") woven and crimped wire in 3/16" channel frames are erected into tubular or angle subframes to support the cage wall. This wall-type provides a safe interface between caregiver and gorilla, while allowing for close visual contact if needed. Continuous openings between caging and floor and wall planes and door panels need to be restricted to acceptable limits to prevent young apes from reaching through or escaping. In areas of high keeper interface, vertical gaps should be limited to 1/2".

Gates, doors, and access panels: Hinged 3' x 6' (approximately 1m x 2m) mesh panels are recommended for keeper access to holding rooms, with stops towards the keeper side. This system, which swings in towards animal spaces, prevents charging animals from pushing their way into keeper zones. Alternative arrangements with horizontal sliding doors are also used. Slam latches with multiple paddock tabs are used to provide positive latching at key locations. When used for regular keeper access, cremone locks have been successful. Various forms of transfer doors have been used with gorillas.

Door sizes for gorillas range from 80cm² (2'8") to 100cm² (3-4'). The use of mechanically advantaged devices (hydraulic, pneumatic controls, etc.) have added safety and additional control to the basic door
All of these forms should be designed to be locked in the open or closed position. Gates between adjacent holding areas should be located near the cage front to facilitate training the apes to use the gates. There should be two doors (at opposite locations) leading into major animal activity areas to prevent dominant animals from blocking others. Door materials should be chosen for strength, safety, resistance to corrosion/rust, and ease of cleaning. Doors and caging tend to be targets of aggression and display, so these elements need to be secured from vibration and noise. Polypropylene sheeting has been an effective material in reducing corrosion and noise.

More information: For more information on containment, see the ‘Design’ chapter of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

1.4.10. Address issue of transport

Transport of gorillas is regulated by the United States Department of Agriculture (USDA); Convention on International Trade of Endangered Species (CITES); Endangered Species Act (ESA); Centers for Disease Control (CDC); and (for air transport) the International Air Transport Association (IATA). Specific USDA regulations exist for crate design, transport vehicle, temperature during transit, food and water, and general care of the animal (Code of Federal Regulations 9, section 3.86 through 3.91). The IATA Live Animals Regulations manual is published annually and can be obtained from: Publications Assistant, IATA, 2000 Peel Street, Montreal, Quebec, Canada H3A 2R4.

Before the shipment takes place, the following list of steps must be considered:

- Locating an appropriate crate
- Determining best & quickest mode of transportation
- Verifying & performing necessary medical testing
- Obtaining adequate permits
- Contacting experienced transporters & pricing costs
- Assessing weather conditions at both locations
- Ascertaining quarantine space at receiving institution

1 Information on pre-shipment testing and examinations can be found in section 3.2.1

There are several factors that determine the best mode of transportation to use, including the age of animal, the place of destination, and the weight and size of the crate. The most used and reliable ways of transporting a gorilla are: 1) ground transportation (via the institution's vehicle, rented truck, or by an experienced exotic animal transporter); and 2) air transfer (commercial carrier or freight carriers).

1.4.10.1. Type of transport container

Materials: Container materials that can be used for young/sub-adult great apes include wood, metal, wire mesh or other light material; for adult great apes these materials include hard wood, metal, welded mesh and muslin or other light material.

Frame: The container frame for young/sub-adult great apes should be made of solid wood or metal that is bolted or screwed together; for adult great apes, welded metal lined with smooth wood or other similar material of a minimum thickness of 1.2cm (1/2") is recommended. Additional strengthening braces must be present on the sides of the container when the total weight is more than 60kg (132lb).

Sides and front: The sides of the container for young/sub-adult great ape should be wood or metal. The front must consist of 2.5cm (1") weld or chain link that must be attached to the frame with a steal strip (staples must not be used). Behind the mesh 2cm (4/5") bore steel tubes must be sunk into the top and bottom of the frame to a depth of approximately 2.5cm (1") at a distance of 7.5cm (3") apart center to center. The distance between bars and mesh must be such that the animal cannot poke its fingers outside the container. A 2/3 solid panel with 1/3 mesh wire at its lower portion and two 10cm (4") observation openings in the upper part must be placed in front of the weld mesh/chain link. The other three sides must be solid with ventilation openings.

For adult great apes, solid wood or lined metal. The front must consist of iron bars spaced in such a manner that the animals cannot push its arms through the bars. The bars must have a sheet of welded mesh fixed at a distance of 7.5cm (3") in front of them. A wooden shutter with slots or holes for ventilation must cover the whole front in order to reduce the amount of light inside the container, as well as to reduce the disturbance to the animal and to protect the handling personnel. The other three sides, one of which is the door, must be solid with ventilation openings.

Handling: For all apes, handling and spacer bars must be provided on three sides of the container.

Floor: For all apes, the base of the container must be solid and leak proof. A grill must be securely fixed and placed over a leak proof droppings tray in order that the excreta fall onto it.
Roof: For all apes, the roof of the container should be solid but with mesh ventilation openings.

Door: For young/sub-adult great apes, access into the container must be by a vertical sliding door at the back that extends the whole height of the container. It must be fastened with tamper proof fasteners or bolted shut after loading. A center batten must be provided across the whole width of the container, including the door, which is put in place after the door is closed.

For adult great apes, a sliding door the same height and made of the same material as the container must be placed in the rear of the container. It must have strong and secure means of fastening that cannot be opened accidentally.

Ventilation: For sub-adult great apes, mesh ventilation openings approximately 2.5cm (1") in diameter must be provided along the base, in the upper 1/3 of the sides and rear and on the top of the container. Whenever openings are covered by mesh, care must be taken that there are no sharp edges present within the container, and all edges must be covered with smooth material that is tamper proof. A muslin, or similar material, curtain must cover all ventilation openings including the front.

For adult great apes, mesh ventilation openings, approximately 2.5cm (1") in diameter must be provided at heights that will give good ventilation at all levels but particularly when the animal is in a prone position. Openings must cover the sides, rear and top, as well as the sliding shutter. All openings can have exterior mesh screening. A muslin, or similar material, curtain must cover all ventilation openings including the front.

For more information on ventilation requirements for transport crates, see “Specifications for the Humane Handling, Care, Treatment, and Transportation of Nonhuman Primates” (USDA 1991).

1.4.10.2. Appropriate size of transport container

The size of the container must be related to the actual size of the animal for which the container is constructed. It must in general allow the animal to stand, turn, and lie down in a natural manner. Forklift extrusions must be provided when the total weight of the container plus animal weighs more than 60kg (132lb).
1.4.10.3. **Provision of food and water during transport**

Separate food and water containers must be provided, and should be either revolving or fixed. If fixed inside the container, they must be placed at a height that does not allow the animal to sit upon it and there must be outside access for filling and emptying which does not allow the animal any chance of escape. Water containers should only be filled to demand and must be emptied after each use so animals do not splash themselves and become wet and chilled. These containers must have rounded edges and be made of non-toxic material suitable for the species.

Feeding and watering instructions must be affixed to the container and a copy must accompany the documents. Any feed or water given must be recorded on the container instructions with the date and time of supply. Food must be provided by the shipper but it must be checked that it does not contravene any regulations of the country(ies) of transit or importation. IATA regulations state that animals do not normally require additional feeding or watering during 24 hours following the time of dispatch. If feeding is required due to an unforeseen delay or excessively long travel periods (i.e. greater than 12 hours), food that duplicate the current diet of the individual, including raw vegetables, greens, and appropriate high fiber primate biscuits, would be suitable as food for transport. Soft fruit and vegetables must be fed sparingly since, if taken in excess, they can cause the animal discomfort. Arrangements for feeding in these situations should be made in advance.

1.4.10.4. **Provision of bedding or substrate in transport container**

The floor of the container must be covered with absorbent material, such as wood shavings to a depth of at least 10-15cm (4-6"). The use of straw as bedding is to be avoided because of the large number of countries that have restrictions regarding its importation.

1.4.10.5. **Mechanism(s) for separating animal from urine and feces during transport**

If a grill or slatted floor is not suitable, there must be sufficient absorbent bedding material on the floor to absorb all the excreta (10-15cm). Sills must then be used at the front and rear of the container.

1.4.10.6. **Identify appropriate temperature range during transport**

Primates are affected by temperature changes and severely affected by temperature extremes. Care must be taken to ensure that they are not subjected to drafts. Most species can
withstand reasonable variations in temperature but consideration must be given not only to temperature changes but also to the chill factors involved. On the other hand primates must not be exposed to direct heat, such as placing them in sunlight or against hot radiators. Primates unavoidably subjected to extreme heat must be cooled so as to prevent dehydration or heat prostration. During prolonged transit stops, when the ramp temperature exceeds approximately 68°F (20°C), the aircraft compartment doors must be opened and, in extreme temperatures, ground equipment must be used to ventilate the compartments. The different climatic factors prevailing during a journey must always be considered when arranging the routing and carriage of live primates. For example, if crates are stranded on runways, parking areas, etc, they should be moved into the shade as soon as possible to avoid overheating the individuals in the crates.

1.4.10.7. Consider appropriate light levels and how to minimize noise during transport

The many strange environments encountered by a primate during shipping can cause stress or cause the animals to become excited. In order to minimize outside stimulation, wooden slats or shutters with ventilation openings can be placed on the outside of the shipping container.

1.4.10.8. Address appropriate group size or need for separation of individuals during transport

The United States requires that no more than one primate be transported in a container. However, a mother and her nursing young being transported to the United States for medical treatment, an established male-female pair, a family group, a pair of juvenile animals that have not reached puberty or other pairs of animals that have been habitually housed together may be shipped in the same container.

1.4.10.9. Consider need for handler/veterinarian access to animal during transport

The United States requires that all wild mammals be inspected at least every four hours whenever the cargo hold is accessible. IATA regulations should be consulted for specifications of other countries and airlines.

If immobilization for shipment is necessary, the animal is usually fasted, and enough time must be allowed for complete recovery in the shipping crate prior to movement. In cases where the animal's health is of increased concern, a
veterinarian must accompany the shipment. In such instances, immobilization supplies and equipment as well as emergency drugs are brought along.

Although it is not a regulation requirement, it is strongly recommended that an individual who is familiar with the gorilla (preferably the caretaker) accompany the animal during transport. The presence of a familiar caretaker will alleviate some of the stress associated with transport. In addition, the caretaker can serve to insure the smooth transport of the animal, supplement food and water, and provide the receiving institution with direct information about the animal's behavior.

1.4.10.10. Consider maximum duration of transport allowable before temporary transfer to “normal housing” is required.

Most transport today can be accomplished within 24-96 hours. If delays occur, it is not always possible or feasible to move an animal to a temporary holding facility. Shifting an animal out of a shipping container and then having to get it back in may be more stressful than leaving it in the shipping crate and providing for its basic needs. If a known delay or layover of more than 72 hours is planned and there is a convenient facility with appropriate veterinary and care staff available then it may be beneficial to allow the animal access to temporary housing.

1.4.10.11. Address appropriate timing of release, size and type of enclosure at transport destination

Animals should be transported to the holding institution or quarantine facility as soon as possible after being offloaded at their destination. See section 3.2.1 for additional information on quarantine recommendations. Many facilities require their own quarantine period when accepting apes from other institutions. Appropriate quarantine facilities must be available upon the arrival of the animals.

1.5 Water

1.5.1. Acceptable water quality parameters.

Water features, such as pools and moats, and drinking water sources should be maintained free of contamination by feces, urine, food, and cleaning agents. Flushing and refilling alone is insufficient to maintain an adequate level of sanitation. The use of algacides in water features must be investigated for safety. Power and/or steam cleaning of moats and pools is recommended.
Any chemicals used to disinfect pools and moats should be approved by the veterinary staff for animal safety and effectiveness, and Material Data Safety Sheets (MSDS) maintained on grounds.

1.5.2. Appropriate means of presentation of water, and appropriate placement of water sources for terrestrial and semi-aquatic organisms.

Drinking water must conform to human quality standards. Multiple locations should be provided to allow access by multiple individuals. There should always be a source of drinking water that is separate from exhibit water features to allow for proper sanitation. “Lixits” are an effective and simple watering device for great apes. Multiple locations at opposite side of the rooms should be planned to ensure free access for lower ranking group members. Piping must be kept out of animal reach.

The introduction of water in streams, pools, and waterfalls to exhibits adds a tremendous dimension to the daily environmental experience for gorillas. While there is a tendency for gorillas to avoid water, the use of shallow water features in exhibits has been shown to provide additional stimuli for species-appropriate behaviors. Behaviors typically associated with water include drinking, touching, or play. Wild gorillas have been observed using water for splash displays (Parnell & Buchanan-Smith 2001), and Breuer et al. (2005) reported the first observation of tool use in wild gorillas after observing a Western lowland gorilla at Mbeli Bai using a stick to gauge water depth. Captive gorillas have been reported to immerse themselves in shallow pools, adding enormous sensory experience to their routine. Substrates for water must be safe for the impact from gorillas; concrete and clay liners should be used, rather than plastics and rubber.

1.5.3. Address issues of depth and need for variation in depth and/or current

The water depth for pools/water should not be higher than the neck of the shortest gorilla in the group. This should include infants. It may also be advisable to drain water completely from pools when newborn infants are present in the group.

As such, the ability to raise and lower water levels as needed is preferable. Handholds/ropes/vines/ladders, etc should be provided around the edge of the pool/stream for gorillas to be able to haul themselves out should they fall in. In some cases (e.g., Zoo New England), cargo nets have been added below the water level to lessen the depth of deep areas.

Using water as primary containment is not recommended for safety/potential escape reasons. If water is used for any containment purpose it should not be deeper than an adult gorilla’s height up to their necks, and handholds on the edges should be provided.
2. Biotic Variables

2.1 Food and Water

2.1.1 Identify appropriate containers and protocols for the provision of food and water

Water: Fresh, potable water should be available at all times, ad libitum, and in a way that precludes contamination by bedding, excreta, etc. Automated drinkers, bowls, bottles, or recirculating pools are all possible sources of water. Water sources should be near a drain. All water containers should be cleaned and disinfected daily.

Food: Placement of food should encourage appropriate positional and locomotor behavior. Thus, as much as possible, feeding locations should encourage climbing and appropriate locomotor behaviors. Food should be presented in as natural a form as possible to encourage activity and manipulation. All food containers should be cleaned and disinfected daily using detergents that are considered to be food safe. It may be beneficial to consult with the facility’s Food Service Department for detergent recommendations and possible collaboration for bulk purchasing.

2.1.2 Identify appropriate foodstuffs and feeding schedules

Depending on their location in the wild, gorillas can be considered primarily folivores (Harcourt & Fossey 1977; Watts 1984, 1985a,b), or frugivore/folivores (Remis 1997; Remis et al. 2001; Rogers et al. 2004). In the wild, their diet consists primarily of foliage of herbs and vines, with leaves, stems, pith, epithelium from roots, bark, roots, flowers, and fruit, all consumed in varying proportions. Though more reports are showing higher fruit concentrations in the diets of free-ranging gorillas, the foods, including fruits, consumed in the wild are significantly higher in fiber and lower in readily absorbable sugars than produce, especially fruit, grown for human consumption (Schmidt et al. 2005). Popovich et al. (1997) analyzed neutral detergent fiber (NDF) concentrations of foods consumed by free-ranging gorillas in the Central African Republic and reported NDF concentrations of 79% for fruit, 64% for leaves, and 80% for stems. For comparison, a whole ear of corn, including the kernels, cob, and husk, only had 40% NDF (Schmidt et al. 2005), which is approximately half of the average fiber concentration of fruits selected by gorillas in the wild.

Successful diets fed to captive gorillas at San Diego and Toronto Zoos consist of the following components on an as-fed basis: 7% fruits, 57% leafy green vegetables, 4% root vegetables, 17% other vegetables and 15% high-fiber primate biscuits. As a general rule, enrichment and/or training items should replace no more than 5% of the primate biscuits daily on a caloric basis.

The fruit portion of the diet is typically reserved for training. Since fruits and primate biscuits will be the most calorie dense items, feeding them to animals individually will help control caloric intake, especially
for overweight individuals. Some zoos with obese animals may consider completely eliminating fruit from the diet of gorillas. There is no need to feed animal products, including dairy and/or eggs, to gorillas, and it is not recommended. The feeding of milk products may also be associated with increased regurgitation and reingestion activities (Lukas et al. 1999).

Each animal’s daily diet should be fed throughout the day in small portions rather than one large daily feeding. The presentation of multiple feedings throughout the day is recommended. This not only mimics the feeding patterns of wild gorillas but also provides multiple interesting events throughout the day. Ideally foods that require some kind of physical or mental effort to obtain should be available during most of the apes' waking hours.

**Enrichment and training items:** A variety of low calorie food items can be used as a source of enrichment for puzzle feeders, termite mounds, or scatter feeds. Items such as sugar free flavored drink mixes, spices, hot sauce, low sodium condiments, vinegars etc. have been used successfully in termite mounds. Some items (e.g., popcorn, hot sauce, and garlic) have also been mixed in appropriate proportions to add even more variety to ape diets. As a general rule, enrichment and/or training items should replace no more than 5% of the primate biscuits on a caloric basis.

**Browse:** Browse provides a highly effective form of feeding enrichment and can greatly lengthen the amount of time that a gorilla spends eating during the day (Gould & Bres 1986a,b). This clearly combats boredom with a constructive behavior, and may also assist in situations where regurgitation of food is a factor (Akers & Schildkraut 1985). See Appendix A for a list of appropriate browse species. All browse offered must be approved by veterinarians or nutritionists, and the nutritional contribution of the browse to the total diet should be considered.

Any browse plants should be naturally nontoxic. Additionally, it should be known whether or not the browse has ever been sprayed with insecticide or other chemicals. The location from where the browse has been harvested should also be investigated (e.g., is the tree being pruned regularly exposed to heavy automotive emissions?). Any browse items that still have soil attached and were collected in an area with a feral cat population may contain a risk of transmitting toxoplasmosis if provided to a pregnant ape. Additionally, the presence of thorns or other physical characteristics that may lead to health issues need to be considered. Some nontoxic compounds, such as fiber, may also be problematic by forming phytobezoars in the gastrointestinal tract (Ensley et al. 1982; Seier et al. 2005). However, it should be noted the gastrointestinal tract of the gorilla is significantly larger in volume than that of the primates in which the phytobezoars were identified.
More information: For more information on the nutritional needs of gorillas, see the ‘Nutrition’ subsection of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

2.1.3. Address the provision of variability in food type and presentation (e.g. spatial and temporal dispersal of food resources)

Apes living in social groups should generally be fed in several locations to increase access by subordinate individuals. Variation and novelty can be introduced by simply varying where food is placed in ape enclosures.

As long as the nutrient compositions of diets are known and maintained, varying the types of food provided to gorillas is recommended. Items of similar composition, such as eggplant, green pepper and green beans may be rotated throughout the week to provide variety. The same could also be done for fruit, browse, and primate biscuits. Introducing variation throughout the week, rather than offering a wide variety of food items daily, may help to maintain interest in less preferred food items and stimulate investigation.

2.1.4. Address opportunities for animals to process food in ways similar to their wild counterparts, and consider mechanisms that enable animals to work for food

The psychological well-being of primates in relation to foraging opportunities must be considered when designing a feeding program for captive gorillas (APHIS 1999). For the majority of primates, there is general agreement that allotting a significant portion of a day’s activities to foraging and feeding is healthy and important (Clutton-Brock & Harvey 1977). It is important to use foods already considered part of the animal’s diet for these ideas. The basic act of adding food above and beyond what is considered appropriate for the animal is not considered enrichment. This will add extra, unwanted calories to the diet and ultimately lead to problems with obesity and nutritional imbalances.

Browse, variety in the daily diet, and novel presentation of foods are all effective ways to stimulate normal feeding patterns. Examples of feeding techniques appropriate for apes that extend foraging and require work include:

- Heavily protected foods (e.g., coconuts, artichokes) so animals must expend energy to obtain the edible portions.
- Puzzles or ‘pipe feeders’ requiring the use of tools.
- Foraging bins (with food in with pine shavings, dried leaves);
- Embedded food items inside boxes or paper bags;
- Making food difficult to get to or retrieve easily (e.g., animal needs to jump or cross unstable furniture to reach location);

Because gorillas are selective herbivores, wherever possible whole vegetation or produce items including the stalk and peels should be fed
to simulate wild conditions and promote species-appropriate foraging behaviors. Not only are browse materials used for manipulating, foraging, and feeding, but whole items, or pieces, are frequently used during display behaviors. Pieces that have been stripped of their leaves and bark are used in nesting and to solicit and promote play behavior. Browse pieces are also used as reaching tools, providing caretakers with an opportunity to devise interesting foraging tasks that are challenging for the gorillas. Many of the leftover pieces may still be used by gorillas after a day or two.

Food items can be distributed throughout an animal's environment to encourage natural foraging behavior. Food may be placed on whatever features exist within a given area to encourage movement throughout the exhibit. For example, forage foods may be hidden on, in, or around logs to promote investigation and traveling in their vicinity. Foods may also be scattered in substrate that requires searching behavior, such as deep grass or bedding. Substrate materials provide a ready medium for encouraging foraging. Any type of dry foods (seeds, nuts, grains, low-sugar breakfast cereals) can be sprinkled in the substrate. Not all dry foods work equally well as scatter feeds; consideration must be given to appropriate size for manipulation and palatability as it pertains to individuals or the troop. The amount of time that the animals spend searching through a substrate is considerably greater than if the foods were scattered on a bare floor. It is also important to offer items in appropriate quantities. Too much of certain items can lead to an overabundance of calories consumed and/or encourage vermin to enter the area to scavenge uneaten feeds.

Foods can be given sealed in cardboard boxes, burlap bags, paper bags, pillowcases, etc. Shallow tubs can be filled with water and provisioned with a variety of produce items, including fruits or preferably vegetables. In cold climates, similar tubs can be filled with snow, and the food can be buried within. During hot weather, produce items can be given after being frozen whole and in the peel, or produce can be frozen in a bucket of water and provided as a giant cube in the enclosure for the gorillas to manipulate. To maintain appropriate calorie consumption, use foods already allotted for the animal’s normal diet.

Reducing abnormal behaviors: The occurrence of some abnormal behaviors, such as regurgitation and reingestion, and coprophagy, has been linked to insufficient opportunities for foraging. Suggested approaches for reducing these types of abnormal behaviors include increasing the provision of browse, and decreasing the amount of processed food in the diet (Gould & Bres 1986a,b). A reduction in the amount of dairy food provided to gorillas has also been associated with a reduction in regurgitation and reingestion (Lukas et al. 1999).
2.2 Social Considerations.

2.2.1. Group Composition

Recent taxonomic revisions now classify gorillas into two distinct species, separated by roughly 900 km. The western species (*Gorilla gorilla*) is divided into the two subspecies: the Western Lowland Gorilla (*Gorilla gorilla gorilla*) and the Cross River Gorilla (*Gorilla gorilla diehli*). Similarly, two subspecies of the Eastern gorilla are currently recognized: the Virunga Mountain Gorilla (*Gorilla beringei beringei*) and Grauer’s Gorilla (*Gorilla beringei graueri*) (Groves 2001, 2003).

All appear to have a similar social group structure, with the primary social structure referred to as a troop. Schaller (1963) and Harcourt (1979a,b,c) established that most mountain gorillas live in cohesive troops led by a single dominant male (the silverback), together with a variable number of adult females, and immatures. Some multi-sex groups have more than one silverback; however, this has been commonly reported only for the Virunga mountain gorilla (Kalpers et al. 2003; McNeilage et al. 2001), and not for lowland gorillas (Robbins et al. 2004). Both male and female gorillas tend to emigrate from their natal group upon reaching maturity. Exceptions to emigration do occur, as males occasionally remain in their natal group and eventually inherit group leadership from their fathers (Fossey 1983). It is also apparent that some males, upon reaching sexual maturity, live alone or in bachelor groups of mature and maturing males (Harcourt 1987). Lone silverback males have also been reported for the eastern lowland and western lowland gorilla subspecies.

The housing of social animals in species-typical groupings is preferred in zoo settings, and is strongly recommended for gorillas, especially when breeding is recommended by the AZA Gorilla SSP. Further, even in instances where breeding may not be recommended, the formation of such groupings is preferred for the psychological well-being of captive animals. Captive social groupings, which closely approximate those found in the wild, will best promote the development of natural species-typical behaviors in gorillas.

2.2.1.1. Suggested age and sex structure of social group

Gorillas are polygamous. In the wild, most gorilla groups have a harem structure, with approximately 60% of mountain gorilla groups having only one adult male silverback and approximately 40% of groups containing more than one male (Stewart & Harcourt 1987). Multi-male groups are also common for the other subspecies.

In captivity, gorillas should be maintained in naturalistic social groups with a variety of age-sex classes. Groups should contain peers, unrelated adult females, and a dominant adult male. Multi-male heterosexual groups and all-male groups are also becoming a necessary way to group gorillas...
in captivity (see section 2.2.1.8 for more details on multi-male groups).

More information: For more information on social groupings, see the ‘Natural History Overview’ and ‘Behavioral Biology’ chapters of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

2.2.1.2. Temporary isolation of parturient females and young, or of males, and corresponding adequate and appropriate space for animals when removed
   Not applicable or recommended for this species.

2.2.1.3. Seasonal separation of sexes. For those species that are truly solitary, seasonal introduction of sexes
   Although males and females should be housed together in species-appropriate groups throughout the year, there have been suggestions that transferring animals into a group leads to increased copulation and conception. Reichard et al. (1990) reports that the addition of a new male resulted in pregnancies in three females who had been exhibiting no copulatory behavior with the previous male. Similarly, Watts (1990) reports that the sexual behavior of an older male was renewed when a female immigrated into the group. Unfortunately, little systematic data on this phenomenon exist, and more research is needed to determine whether the effect may be more perceived than real, at least in captivity.

2.2.1.4. Nursery groups (groups of mothers with most recent young)
   See section 2.2.1.6 for more details.

2.2.1.5. Forced “emigration” of adolescents
   Females: In the wild, both sexes usually disperse from their natal group, but females transfer directly to either another group or to a solitary silverback and never range by themselves (Stewart & Harcourt 1987). Transfer of females generally occurs around 8 years of age.

   Males: In the wild, emigrating males rarely join breeding groups directly. Males emigrate at around 11 years of age (Maple & Hoff 1982).

2.2.1.6. Multigenerational groups (e.g. many primates, elephants)
   Young gorillas require the presence of both conspecific adults and peers in order to exhibit maximum reproductive and parental competence at adulthood (Beck & Power 1988).
2.2.1.7. Groups deriving from cohorts (e.g., dolphin male pairs)

Cohort groups of apes are not typically found in the wild, with the exception of temporary groups of male gorillas. Cohort groups may be possible in captivity depending on the individual histories and personalities of the animals. Facility design and space may also be a factor in success or failure of these groups.

2.2.1.8. All male groups

All-male groups have been observed for western lowland gorillas in the wild (Gatti et al. 2004), but the prevalence of all-male and multi-male groups is lower for western gorillas than for eastern gorillas (Parnell 2002; Robbins et al. 2004). Typically, males emigrate from their natal group before they have bred, with emigrations of blackbacks, subadults, and even juveniles reported from the field (Gatti et al. 2003). The rate of emigration of males for western gorillas is higher than the rate for eastern gorillas than for eastern gorillas (Robbins et al. 2004), and the corresponding higher number of solitary males seen in western gorilla populations may be a reflection of this (Gatti et al. 2004).

No silverback (>13 years) has been observed to enter an all-male group, but males from 6-13 years have joined all-male groups without serious aggression (Harcourt 1988). Male groups can last for several years, but may be subject to frequent membership changes (Stokes 2002; Gatti et al. 2004) with stability affected by the abilities of individual males to leave the all-male group to attempt to obtain females and immigrations from new young males. Bachelor groups contain primarily immature males (Levrero et al. 2006), because reproductively mature animals move on to form family groups (Harcourt 1988). Once males reach an age to start seeking females and competing for them, and if they are not the resident dominant male, they depart the bachelor group and start to seek females alone. The arrival of females has a dramatic effect on the stability of the bachelor group. When females join, aggression increases and subordinate males often depart (Elliot 1976).

Captive management: Given the approximately equal ratio of males and females in the captive population and the female biased sex ratio of reproductive groups in the wild, zoos are being encouraged to form multi-male groups, or even all-male groups. Given the relatively large number of solitary males and the relatively small number of multi-male western gorilla groups in the wild, the formation of such groups can be quite complex and time consuming.
It appears that age may be the most important factor in the formation of multi-male or all-male gorilla groups in captivity. No silverback has been observed to join an existing all-male group, although juveniles will join groups that contain a silverback (Levrero et al. 2006). Therefore, as a male gorilla passes juvenile status, the introduction of this animal to any group that includes a silverback male becomes more difficult.

Given this information, it has been suggested that groups are most likely to be successfully formed when immature males are involved (Stoinski et al. 2004b). Stoinski and colleagues (2004b) also discuss a number of other factors that may be associated with the successful formation of all-male groups. These recommendations include forming groups of young, ideally related or familiar, animals. As a result, the AZA Gorilla SSP has recommended that males born into the same natal group within four years of each other should be kept together as a social unit and that males born into separate groups at the same institution should be integrated before the age of seven (Lukas 2007).

Data suggest that the groups are more likely to be successful if they consist of mother-reared animals and are housed outside of visual/olfactory access to females (Stoinski et al. 2004a). In cases where the maternal skills of a female are in question, institutions are advised to work with the AZA Gorilla SSP and the AZA Ape TAG handrearing committee prior to the birth of the infant to minimize the occurrence and length of hand rearing (Lukas 2007).

Exhibit characteristics can be particularly important in the management of all-male groups. All-male gorilla groups demand flexible management and exhibits and holding areas should include easy keeper access, multiple entry/exit points and circulation points, and the ability to separate individual animals, if necessary (Stoinski et al. 2004a). Exhibits should also include refuge for subordinate animals and visual barriers from other animals as well as from visitors (Kuhar, in press).

2.2.1.9. **Daily and life stage variation in patterns of social affiliation**

Infants will stay close to their mothers for the first 3-4 years, often nursing for three years. When they become juveniles, females tend to stay near their female relatives or the silverback and show great interest in new infants in the group. Males tend to engage in more rough and tumble play and also continue to interact with the silverback until approaching blackback status. The rate of adult-adolescent
male aggression increases as adolescents mature (Watts & Pusey 1993).

More information: For more information on social groupings, see the ‘Natural History Overview’ and ‘Behavioral Biology’ chapters of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

2.2.2. Group Size, including
   2.2.2.1. Minimum and optimum group sizes

Gorilla troop size in the wild reportedly varies between 3-42 members, with a mean between 7-15. The following table (Table 2) provides information on group size in the wild:

Table 2: Group size and range for wild gorillas:

<table>
<thead>
<tr>
<th>Sub-species</th>
<th>Group size range</th>
<th>Mean group size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern lowland gorillas</td>
<td>3-42</td>
<td>14.3</td>
</tr>
<tr>
<td>Mountain gorillas</td>
<td>3-32</td>
<td>9.15</td>
</tr>
<tr>
<td>Western lowland gorillas</td>
<td>3-26</td>
<td>7.21</td>
</tr>
</tbody>
</table>

1 Yamagiwa 1983; Stewart & Harcourt 1987; Aveling 1995

The size of groups held in captive environments varies from institution to institution. Groups range from pairs of animals to as many as 10, with the average group size being 4.45 individuals. Because more is now known about natural gorilla group sizes, the trend is toward exhibiting animals in larger groups that approximate those of their wild counterparts.

2.2.2.2. Inter-individual distances required

The amount and complexity of space are expected to increase as the complexity of the group increases. Thus, as more animals are added to a group or as a group goes from single male to multi-male, greater space and complexity are required. The recommendations of Stoinski et al. (2004b) for the management of all-male groups can be applied to all types of complex social groups. Some of these recommendations include visual barriers, vertical space, multiple entry/exit points into exhibits, lack of traps/corners, adequate number of resources, easy keeper access, and refuge for subordinate animals.
2.2.3. Conspecific groups, consider the need for/influence of adjacent groups, or similar taxa, on territorial species

Conspecifics housed in the same area may affect different groupings and individual apes. For example, the females in a family group of gorillas may initiate a disruption in relationships in a bachelor group of gorillas. Each situation must be carefully evaluated.

2.2.4. Mixed species groups

There has been some success with mixed-species displays with gorillas in both North American and European zoos (see Appendix B). In addition to some large indoor tropical enclosures that include free-flight areas for birds within the overall enclosures, gorillas have been housed with Old World monkeys (e.g., guenons, colobus monkeys).

2.2.4.1. Identify appropriate species

Although gorillas are sympatric with chimpanzees in many parts of their natural habitat, gorillas are most successfully exhibited with mid-sized Cercopithecine species in zoos. At Apenheul, Holland, a group of patas monkeys (Erythrocebus patas) has shared a two-hectare island habitat with two groups of gorillas. Innovation in the design of the divider moat between the two gorilla groups utilized topography, water, and electric fencing in combination to create a safe barrier for the gorillas, while allowing the patas monkeys to pass (Kopff & Mager 1990).

The Houston Zoo maintained a troop of guenons with a lone eastern lowland silverback gorilla, primarily to enrich his indoor environment. The National Zoo has maintained a troop of colobus monkeys with gorillas; again in an indoor exhibit. The evidence to date suggests the potential for mixed-species exhibits appears to be good with this species, given proper design considerations.

See Appendix B for a more complete listing of primate species that have been housed with gorillas.

2.2.4.2. Identify key environmental elements for each species

When considering mixed-species combinations, barriers need to be designed with the capabilities of each species in mind. Visual barriers, appropriate locomotion routes at multiple levels and separate holding should be provided for all species in the exhibit. The ability to separate and hold animals away from one another should exist, even if it is not used on a daily basis.

When planning a gorilla exhibit, designers may wish to consider the possibility of eventually housing other species in the exhibit and design barriers accordingly. This will lead to
a more flexible exhibit. Enclosure size, flight distance, environmental complexity, barrier safety for each species, and animal management facilities and access must all be carefully considered.

2.2.4.3. Identify interspecific inter-animal distances required

Inter-animal distances vary greatly depending on the tolerance levels of the individual. Factors to keep in mind include the arboreal vs. terrestrial preferences of each species in the exhibit, whether or not a creep can be employed, and the extent to which visual barriers exist and can be used successfully by the animals.

2.2.4.4. Address appropriateness of single-sexed groups

Because individuals of all ape species vary greatly in their tolerance of different situations, single sex groups may be feasible. As noted above, individual personalities and the capabilities of the facility must be carefully evaluated.

2.2.5. Introductions

The type of social group recommended (single-male harem groups) will affect the strategy for introduction. Introduction strategies will also be affected by factors such as the age and temperament of the animals involved and the experience of the staff. Knowledge of each gorilla’s behavior is vital during each introduction to ensure the safety of all individuals. Zoo staff should communicate with the "home zoo" to gain specific animal behavior information on the new individual prior to beginning any introduction. All introductions are individual and, to some extent, may be based on trial and error. However, the principles suggested by Lindburg (1986) in his cross-species guidelines for animal introductions can be applied. Lindburg suggests three guidelines for reducing conflict during introductions: 1) allow integration to proceed as far as possible before actual physical contact; 2) decrease the influence of dominant individuals; and 3) manage the physical environment to reduce negative interactions.

If a zoo has limited experience with introductions, it is recommended to contact people at other zoos who have successfully completed introductions. In general terms, the following steps are recommended for all introductions (Burks et al. 1998, 2001):

- Distal, visual, olfactory, and auditory contact.
- Limited tactile contact through socialization mesh, reducing the possibility of grabbing or biting. During this step, bedding and forage food can be placed on both sides of the mesh to encourage noncompetitive interaction.
- Limited tactile contact through cracked door (some institutions have eliminated this step because of the possible risk of injury).
- Full physical contact, including escape routes and complex physical environment.

**Introduction protocol:** Special cases of introductions (formation of all-male groups, introduction of hand-reared individuals) are described in detail elsewhere; see section 2.2.1.8 for bachelor group formation; section 4.5 provides details on hand-rearing and surrogacy strategies. Here, the focus will be on introducing juveniles and subadults to adults of both sexes, and introducing females to established groups. It is recommended to select an animal or animals from the primary group for the first phase of the full physical contact step of the introduction. Bonds should be established between younger, smaller individuals and older, larger females prior to introducing them to a silverback male. The bonding process will usually require separating out one or more animals from the primary social group for pre-socialization with the new individual. Care should be taken in doing this, so as not to cause significant damage to the social bonds in the primary group. Introducing the new animal to the subgroup for a few hours each day and returning the subgroup to the primary group for the rest of the day can minimize this. Increasing the number of animals present during an introduction may also diffuse possible aggression from dominant individuals.

The most difficult step of gorilla socialization is generally the introduction of the new member to the silverback male. The silverback should generally be the last animal introduced, and it is recommended that the introduction include a group larger than the male and the new member; other group members may aid the new member in defending against the male. Short-term use of behavior-modifying drugs, such as haloperidol, may be warranted in situations where the silverback is particularly inexperienced. In such cases, the drug should be administered several days to a week prior to physical introductions in order to assess its impact on the silverback. The drug is then tapered off after the introduction. When introducing a female and the silverback, doing so during estrus, when possible, may facilitate the introduction process.

Staff should have available items such as hoses, fire extinguishers, and even veterinary tools for possible anesthetization. Overuse of intervention tools, such as fire extinguishers or hoses, may serve to reinforce aggression, both by reinforcing halts to the socialization process and by punishing interaction. Aggression is a species-typical behavior during gorilla immigrations, and it may instead be better to allow an aggressive encounter to calm, and some reconciliation to occur before checking wounds.

**Physical environments:** The physical environment can greatly affect the success or failure of an introduction. The environment can be
managed to decrease the influence of dominant animals. The introduction room should include visual barriers, as well as escape routes and retreats for new individuals or smaller animals. In particular, the introduction area should include circular “run-arounds”, and should not include places where animals can be trapped (Mager & Griese 1986; Jendry & Absi 1989). A "socialization area," such as two areas divided by a double-mesh screen to allow safe, limited tactile contact, may need to be added. The introduction area should be furnished with objects to encourage displacement, including browse, ropes, hay, straw, cardboard boxes, paper, forage food, etc. The environment should be complex, giving all animals many choices. If only a few items are included, aggressive or competitive behavior may result.

Proceeding from one phase of an introduction to the next may move quickly or slowly, depending on the responses of the animals. Systematic observations during this time (Burks et al. 1998) may aid in determining when to move to the next stage. However even informal observations, and efforts to identify positive and negative behaviors and responses (Jendry & Absi 1989; van der Nieuwenijk 2000) will be helpful.

It is generally preferable for an introduction to be conducted in an area that is neutral territory for all participants. Ideally, this would be an area that is not a home exhibit for any of the involved animals. However, this may not always be possible. In such situations, it is important that prior to the full physical introduction, all animals should have experience with the area, in order to ensure familiarity with escape routes. The full introduction may be conducted indoors or outdoors, depending on available facilities. In general, most staff prefer to use indoor areas, due to the increased control that they perceive in these environments.

Introductions in on-exhibit versus off-exhibit areas will be facility-dependent. In general however, off-exhibit areas may not be large enough or flexible enough to accommodate physical introductions. If introductions are done on-exhibit, it is advisable to exclude visitors from the exhibit area initially. Staff should observe at all times during this initial phase, and public access to the exhibit may be permitted, based on the progress of the introduction.

Introductions of hand-reared animals: Hand-reared animals should be part of a surrogate program to facilitate the introduction to a conspecific group (refer to section 4.5). Once the introduction is deemed successful, the infant must not be pulled from the surrogate for any reason other than severe health problems.

The introduction of a hand-reared gorilla begins the first day the animal is pulled from the dam. Caring for the infant via species-appropriate behavior is an integral part of the process. A gorilla that has been hand-raised with an early introduction in mind:

- has received 24-hour care
- is raised near conspecifics
- has staff that mimics species-appropriate care.

Once certain criteria are met, the introduction should ensue. No time limit is placed on an introduction. Successful introductions of an infant have occurred as early as 5 months of age. A recent report (Hoff et al. 2005) of an infant being introduced to a social group as early as 11 weeks of age suggests that introductions may occur even earlier; however, this was an unusual circumstance and care should be taken to assess the status of the infant, the surrogate, and the dynamics of the group before attempting an introduction. A successful introduction means that the infant is living with the surrogate 24/7. Once the surrogate is chosen she should be placed on birth control if she is not post-reproductive. Gorilla and hand rearing staff should agree on readiness of the surrogate and the infant. The infant and surrogate should have established a comfortable bond. The surrogate has to allow the infant to receive nourishment, and this may involve cooperative feeding, where either the infant is mobile and comes to the bottle, or the surrogate brings the infant to the mesh for a bottle. An introduction should not proceed with a potential surrogate that displays aggression. Contact the Surrogate Team of the AZA Ape TAG for assistance. The infant must be completely familiarized with routine and husbandry practices. A pre-introduction health assessment of infant and surrogate should be performed prior to the introduction. Prepare for a plan B if possible; this involves having an alternative surrogate if the introduction does not go as expected. The choice of an appropriate surrogate is not dependent on gender, but on the capabilities of the surrogate. The introduction of a hand-reared gorilla should not be disrupted by ‘Behind the Scenes Tours’, PR/Marketing Events, or the distraction of visitors.

More information: For more detailed information on introductions refer to the ‘Introductions and Socializations’ subsection in ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997) as well as sections 2.2.1.8 and 4.5 of these Standardized Guidelines.

2.2.6. Human-animal interactions
2.2.6.1. Identify acceptable forms of human/animal interaction

Positive interaction and development of trust between gorillas and their caretakers are imperative components of a successful gorilla husbandry/management program. These relationships should remain objective and professional, and gorillas should neither be overly dependent upon nor overly controlled by their caregivers. In general, strong human/gorilla bonds at the expense of or in place of bonds between the gorillas are not desirable, as strong attachment to humans may decrease the amount of social behavior exhibited toward other gorillas.
Protected contact: The AZA Gorilla SSP and AZA Ape TAG recommend ‘protected contact’ for managing adult apes; there should always be a protective barrier between the ape and the human caregiver. It is recommended that all training and conditioning for gorillas be performed under ‘protected contact’, involving a safe and voluntary interaction between trainer and gorilla (Desmond & Laule 1991; Ape TAG 2007). The reasons for recommending protected contact for all forms of gorilla management are threefold: safety concerns for the keeper (directed and accidental injuries), short- and long-term effects of extended human interaction on the apes (such as maternal, sexual, and behavioral effects), and the influence of human interaction on public perception of apes (and their feasibility as pets). Some facilities, both within and outside of AZA practice free contact with adult apes, but the AZA Gorilla SSP recommends that free contact not be part of the regular management strategy for adult apes.

Zoos that must hand-raise infant gorillas should consider doing so in off-exhibit areas. Zoos that do so in areas available for public viewing should use caution to avoid potential misinterpretation (e.g., that primates make acceptable pets). Thus, the traditional nursery, whereby hand-raised infant gorillas are used primarily for the entertainment of guests, and are not in proximity to other gorillas, is unacceptable. In areas where visitors can observe the hand-raising process, certain criteria must be met: 1) the howdy process to other gorillas for any hand-raised infant gorilla begins the 1st day the infant is pulled for hand-rearing; 2) the care of any hand-reared infant gorilla incorporates and demonstrates natural gorilla behavior; 3) the goal of the process is to introduce any infant gorilla with a surrogate as soon as possible (the hand-rearing process must not be prolonged because the infant is in public view); 4) the incorporation of a comprehensive education program (consider important aspects of interpretation, such as the use of docents and/or monitors with video detailing the history and goals of hand-rearing).

See section 5.1 for more information on training. The American Association of Zoo Veterinarians Primate Safety Guidelines are available at: www.aazv.org/associations/6442/files/primate_safety_guidelines.doc

2.2.6.2. Address both animal and keeper safety

Safety considerations: Animal security areas are those areas immediately adjoining areas containing animals. Since
animals occasionally escape into these areas, they should be designed to be as “ape proof” as possible. It is essential that staff have complete visibility of these areas before entering. “Dog legs” and “blind spots” must be avoided. Some facilities use parabolic mirrors or video cameras to compensate for these problems, but it is better to eliminate these areas. 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.

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 the rooms are empty and secure before they enter. Where secondary security areas provide access into large complex indoor or outdoor exercise or display areas, it may not be possible to insure complete visibility of the area before entering. Therefore, the following two precautions are essential: excellent visibility of the animal area immediately beyond the door including overhead space and 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 must be made to insure that animals will not be released into any area that is already occupied by another staff member both animal and keeper safety.

Direct interaction of caregivers with apes (in a protected contact setting) should be undertaken with caution. Many institutions implement a “two-person” rule when caregivers will interact with animals, such as during shifting procedures and during training sessions. The caregiver’s experience level and knowledge of the specific animals they will be working with should be taken into consideration when interacting with apes.

Zoonotic diseases: Viruses that cause upper respiratory infection, such as colds and influenza, may be easily transmitted from animal care staff to gorillas and vice versa. These can be an important cause of secondary respiratory disease, particularly in nursery-reared infants. Contact with a large number of keepers, very close contact (as in a nursery situation), and contact with keepers that have young children all increase the likelihood of upper respiratory infections in gorillas. Keepers that have active upper respiratory infections should not work in close contact with gorillas or prepare food
for them. Bacterial diseases, esp. those that affect the gastrointestinal tract such as *Salmonella sp.*, *Campylobacter*, *Yersinia*, etc., can also be spread from keeper to ape. As described below, proper personal hygiene and hand washing are essential to prevent the zoonotic spread of these agents.

Strong personal hygiene practices are a must when working with nonhuman primates. Care should be taken not to touch the face, especially the mouth, nose, and eyes. Inanimate objects such as pens, locks, and countertops can harbor pathogens. Hand washing is considered to be one of the most important preventative measures in reducing an individual's risk of infection. Hands should be washed after handling an animal, an animal's waste, soiled bedding and food, or tissues and diagnostic samples. There should be no eating, drinking, or smoking in the animal areas. Separate refrigerators should be utilized for storing animal food and human food. Animal bowls and utensils should be stored separately and not be used for preparing staff food.

Masks and gloves should be worn at all times when preparing or handling food, food utensils, dishes, or enrichment items.

**Protective equipment:** Protective clothing should be worn when in direct contact with the animal or animal secretions (blood, urine, feces, tissue infected or contaminated with microorganisms). Protective clothing includes coveralls, lab coats, gowns, gloves, goggles, and face masks. The protective clothing should be changed when it is soiled. Soaking the clothing in a chemical disinfectant is advisable when handling infectious material, and ideally a laundering service capable of handling contaminated material should be provided by the institution.

Protective clothing should be worn when cages are cleaned. Additionally, protective equipment should be worn when using hoses (both high pressure and standard pressure) or steam cleaners. Bedding, food, fecal matter, and other items in an animal's enclosure should be removed before cleaning to decrease the potential of aerosolizing infectious material and improve the effectiveness of the disinfectant agent.

**More information:** for more information about safety, see the ‘Keeper Safety’ and ‘Dangerous Animal Escapes’ subsections of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997) and the Primate Safety Guidelines produced by the American Association of Zoo Vets (AAZV, 2004).
3. Health and Nutrition

3.1. Diet

3.1.1. Identify existing standards for nutrient requirements for all life stages if available

Unfortunately, gorilla nutrient requirement data have yet to be established and development of these nutrient requirements remains a high priority for future research needs. Caloric needs of the gorilla 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 the average diet for apes at the Zoological Society of San Diego and Toronto Zoos and has been quite accurate for weight maintenance in the gorilla troops. Ideally, gorillas should be weighed regularly to determine their individual requirements as they may require more or less than the average gorilla to maintain body condition. Estimated nutrient requirements for gorillas are listed in Table 3.

Table 3: Mean macronutrient profile in diets offered to gorillas in North American zoos (adapted from Ogden & Wharton 1997)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Dietary concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein, %</td>
<td>15-22</td>
</tr>
<tr>
<td>Neutral detergent fiber (NDF), %</td>
<td>10-30</td>
</tr>
<tr>
<td>Acid detergent fiber (ADF), %</td>
<td>5-15</td>
</tr>
<tr>
<td>Ca, %</td>
<td>0.8</td>
</tr>
<tr>
<td>P, %</td>
<td>0.6</td>
</tr>
<tr>
<td>Mg, %</td>
<td>0.08</td>
</tr>
<tr>
<td>K, %</td>
<td>0.4</td>
</tr>
<tr>
<td>Na, %</td>
<td>0.2</td>
</tr>
<tr>
<td>Cl, %</td>
<td>0.2</td>
</tr>
<tr>
<td>Fe, mg/kg (or ppm)</td>
<td>100</td>
</tr>
<tr>
<td>Cu, mg/kg</td>
<td>20</td>
</tr>
<tr>
<td>Mn, mg/kg</td>
<td>20</td>
</tr>
<tr>
<td>Zn, mg/kg</td>
<td>100</td>
</tr>
<tr>
<td>I, mg/kg</td>
<td>0.35</td>
</tr>
<tr>
<td>Se, mg/kg</td>
<td>0.3</td>
</tr>
<tr>
<td>Vitamin A, IU/kg</td>
<td>8,000</td>
</tr>
<tr>
<td>Vitamin D₃, IU/kg</td>
<td>2,500</td>
</tr>
<tr>
<td>Vitamin E, mg/kg</td>
<td>100</td>
</tr>
<tr>
<td>Vitamin K, mg/kg</td>
<td>0.5</td>
</tr>
<tr>
<td>Thiamin (B₁), mg/kg</td>
<td>3.0</td>
</tr>
<tr>
<td>Riboflavin (B₂), mg/kg</td>
<td>4.0</td>
</tr>
<tr>
<td>Pantothenic acid, mg/kg</td>
<td>12.0</td>
</tr>
<tr>
<td>Niacin, mg/kg</td>
<td>25.0</td>
</tr>
<tr>
<td>Vitamin B₆, mg/kg</td>
<td>4.0</td>
</tr>
<tr>
<td>Biotin, mg/kg</td>
<td>0.2</td>
</tr>
<tr>
<td>Folacin, mg/kg</td>
<td>4.0</td>
</tr>
<tr>
<td>Vitamin B₁₂, mg/kg</td>
<td>0.03</td>
</tr>
<tr>
<td>Vitamin C, mg/kg</td>
<td>200</td>
</tr>
<tr>
<td>Choline, mg/kg</td>
<td>750</td>
</tr>
</tbody>
</table>
Gorillas are primarily herbivores, though they have been reported to consume some insects in the wild (Tutin & Fernandez 1992). Their primarily herbivorous diet may be essential for health. Elevated cholesterol concentrations (281-311mg/dL – McGuire et al. 1989) may lead to premature cardiovascular disease, which is reported to be the leading cause of mortality in captive adult gorillas (Meehan & Lowenstein 1994). Average total cholesterol concentrations in free-ranging, male lowland gorillas (n=4) were reported to be 167mg/dl. Total cholesterol concentrations for male and female mountain gorillas were 149 and 179mg/dl, respectively (Schmidt et al. 2006).

Mimicking the nutritional composition of the high fiber, low sugar diet of free-ranging gorillas will promote healthier gorillas. Feeding gorillas animal products, including dairy and eggs, is not recommended as they may promote obesity and increase cholesterol concentrations. The only exception to this would be when hand-raising gorilla infants. At those times human infant formulas supplemented with omega fatty acids are recommend for use over cow’s milk (see AAZK Infant Handrearing Notebook for more information).

More information: For more information on nutrition, see the ‘Nutrition’ subsection of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

3.1.2. Provide sample recommended diet(s) for all life stages based on nutritional requirements and identify body condition norms as determined from wild animals, if possible

Formulating diets based on the caloric needs of the animal is recommended over feeding animals a food amount based on a percentage of body mass. Free-ranging gorillas typically weigh 139-278kg for males and 82-98kg for females (Silva & Downing 1995).

Successful diets fed to captive gorillas at San Diego and Toronto Zoos consist of the following components on an as-fed basis: 7% fruits, 57% leafy green vegetables, 4% root vegetables, 17% other vegetables and 15% high-fiber primate biscuits. For example, the average amounts fed to a 100kg female gorilla, requiring 3162kcal, would be 350g fruit, 3000g leafy green vegetables (including browse), 225g root vegetables, 900g other vegetables, and 750g primate biscuits on a daily basis. The fruit portion of the diet is typically reserved for training. Since fruits and primate biscuits will be the most calorie dense items, feeding them to animals individually will help control caloric intake, especially for overweight individuals. Some zoos with obese animals may consider completely eliminating fruit from the diet of gorillas. Browse material is not readily available year-round at Toronto Zoo so the amount of vegetable material used for forage may be provided at comparatively higher levels than zoos in more temperate climates. On an as-fed basis the formulated diets of both institutions are broken down as follows: 10% primate biscuits, 10% leafy green vegetables, 5% root vegetables,
20% other vegetables and 5% fruit. While current diets contain fruit and vegetable produce equaling about 50% of total food offered, it is suggested that the proportion of fruit in diets be reduced, and vegetable produce increased. Vegetables appear to contain a more suitable nutrient composition than fruits for lowland gorillas, and also provide an economic alternative to fruit.

Green plant materials and/or low-starch vegetables can be fed in relative excess, but other diet items should be limit-fed. Though primate biscuits are important for providing balanced nutrients and ensuring adequate intake of macro and micro-nutrients, they contain a significant amount of calories and should not be free-fed to animals, especially those that are overweight. A minimum of about 20% of the diet should comprise nutritionally balanced primate diets, with possible substitutions/variety provided throughout the week in other food categories. Various types of high-fiber primate biscuits are available; offering animals a rotation of these high-fiber biscuits will not only increase the variety of foods available to the animals throughout the week, but may encourage better primate biscuit consumption.

**Browse:** Though browse may supply adequate levels of some of these nutrients, availability is seasonal in many locations. Browse should be considered an important component of captive gorilla diets, both physiologically and psychologically. Approved browse species should be offered to animals as often as possible (see Appendix A for a list of approved browse species for gorillas), but not to the extent that it limits appropriate primate biscuit consumption. More data and improved dietary recording of browse fed must be undertaken by each zoo.

3.1.3. As appropriate address the influence of the following variables on dietary requirements

3.1.3.1. **Age (infant, juvenile, reproductive adult, senescent adult)**

Wild gorillas acquire the basic adult feeding repertoire by the end of infancy (Watts & Pusey 1993). As infants decrease the amount of time spent suckling, interest in solid food appears to rise. Solid food consumption in captive gorillas usually begins between 2-6 months although they may not be weaned completely until over 1 year of age. Infants should become accustomed to primate biscuits, leafy greens and other vegetables first, before offering any fruit items. Offering fruit too soon may result in lower consumption of less preferred biscuits and vegetables.

Infants that are being mother reared indoors may be at risk for vitamin D deficiency and metabolic bone disease (Meehan 1993). It is advisable to train infants that are nursing exclusively to consume supplemental foods in order to allow the addition of an infant multivitamin supplement containing vitamin D₃. 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.

The energy requirement per unit of metabolic body weight is highest in young, growing animals however the ratio of primate biscuit to produce in the diet need not differ from the standard adult diet unless gut-fill is limiting so as not to allow adequate nutrient intake. For example a juvenile animal (i.e., 3-year-old) may receive 1/3-1/2 of the standard adult diet.

Energy requirements generally decrease as age increases. Females may also require diet increases during the last trimester of pregnancy through to weaning with the greatest requirement coinciding with peak lactation (NRC 2003). Therefore body weight and condition should be monitored to allow for dietary modifications depending on life stage (growing, maintenance, senescence), activity level, and reproductive status (pregnancy, lactation).

3.1.3.2. Body size

Free-ranging male and female gorillas weigh, on average, 139-278kg and 82-98kg respectively (Silva & Downing 1995). It is impossible to determine if an individual gorilla is obese based on their body weight alone, as their body composition is difficult to visually assess. Ideally, body condition scoring in conjunction with body weight assessments should be performed regularly to determine the optimal weight for a particular individual. For animals that are overweight, fat seems to be deposited in the abdominal region first. As animals become more obese, fat deposition begins to occur throughout the body. With their ability for extensive fiber fermentation, it is sometimes difficult to determine if an extended abdomen is due to added fat or ongoing fiber fermentation (as is seen in free-ranging gorillas). Standardized body condition indices need to be developed for gorillas.

3.1.3.3. Reproductive status

Pregnant females need to consume a nutritionally balanced diet. Some institutions provide vitamin and mineral supplementation (i.e., prenatal complete supplements) as a prophylactic measure. Any vitamin and/or mineral supplementation should be overseen by a nutritionist or veterinarian. Females may also require diet increases during the last trimester of pregnancy through to weaning, with the greatest requirement during peak lactation (NRC 2003).

Lactation is the most energy demanding process a body will encounter. For humans, an additional 500kcal ME per...
day is recommended for the first 6 months of lactation (FAO/WHO/UNU Expert Consultation, 1985). However, if the animal is overweight, this may be an opportune time to encourage gradual weight loss.

Iron-containing supplements are often provided to menstruating females. Iron can be stored by the liver leading to health problems and even death if accumulated in excessive amounts. As females age and menstruation stops, it is important to reassess the need for iron supplementation.

3.1.3.4. **Seasonal changes in ambient temperature**

Captive gorillas are generally housed in enclosures that allow them to maintain thermoneutrality year-round. Energy requirements increase outside the thermoneutral zone due to processes to regulate body temperature, such as panting, sweating, and shivering (NRC 2003). Temperature extremes may also suppress appetite further leaving individuals in a negative energy balance. Therefore, it may be difficult to sustain adequate feed intake and maintain body condition if exposed to extreme temperatures for long periods of time.

3.1.3.5. **Seasonal changes in body condition**

Food availability is the most likely cause of any seasonal variation in the body condition of free-ranging gorillas. Captive gorillas, fed a nutritionally complete diet, should be maintained at a body weight and condition to maintain optimal health year-round.

3.1.3.6. **Seasonal changes in nutritional requirements**

Gorillas in the wild show a seasonal variation in diets (Remis & Dierenfeld 2004), and the amount of fiber ingested by wild gorillas varies as gorillas shift between fruit-based diets and ones containing greater amounts of leaves and bark (Remis et al. 2001). This variation is likely due to lack of the preferred leaves and fruits and is necessary for survival. The benefit of altering foods to this level in captivity has not yet been researched.

Many captive facilities may provide diets that also vary on a seasonal basis (e.g., with varied access to produce and natural browse). For facilities that do not have year-round access to natural browse, an alternative approach may be to provide greater quantities of low-starch vegetable material that could be used for foraging. To mimic seasonal changes in wild gorilla, including a higher fiber biscuit during winter months when sources of produce and browse are less available is also a possible approach (Remis & Dierenfeld
2004). Several institutions also preserve browse through freezing or ensiling to maintain some level of browse in the diet year-round.

If activity levels change seasonally due to available enclosure space (i.e., animals not provided access to large outdoor yards during the winter in northern institutions), seasonal changes in caloric intake may be warranted.

### 3.1.3.7. Activity levels

Captive gorillas spend less time foraging than free-ranging gorillas, but there may also be certain individuals that are particularly active or sedentary in a group. Energy requirements increase with corresponding increases in activity level. Enrichment devices which motivate animals to forage may help to increase activity levels.

It is important to remember that activity levels, and the corresponding caloric requirements, vary by animal, and should be evaluated at an individual level.

### 3.1.3.8. Health status

Gorillas are primarily herbivores but have been reported to consume insects in the wild (Tutin & Fernandez 1992). Maintaining a herbivorous diet may be essential for health, as elevated cholesterol levels (281-311mg/dL, McGuire et al. 1989) in captive gorillas may lead to premature cardiovascular disease, which is reported to be the leading cause of mortality in captive adult gorillas (Meehan & Lowenstine 1994). Table 4 lists cholesterol, triglyceride, high-density lipoprotein (HDL) cholesterol, and low-density lipoprotein (LDL) cholesterol measured in free-ranging lowland and mountain gorillas.

Table 4: Cholesterol, triglyceride, high-density (HDL) & low-density lipoprotein (LDL) cholesterol concentrations (mg/dL) for free-ranging gorillas (Schmidt et al 2006)

<table>
<thead>
<tr>
<th>Species/sex</th>
<th>N</th>
<th>Cholesterol</th>
<th>Triglyceride</th>
<th>HDL</th>
<th>LDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.g.gorilla (m)</td>
<td>4</td>
<td>167 ± 18.5</td>
<td>85 ± 15.5</td>
<td>66 ± 7.6</td>
<td>70 ± 11.9</td>
</tr>
<tr>
<td>G.beringi (m)</td>
<td>3</td>
<td>149 ± 21.3</td>
<td>47 ± 17.9</td>
<td>65 ± 8.8</td>
<td>58 ± 13.8</td>
</tr>
<tr>
<td>G.beringi (f)</td>
<td>8</td>
<td>179 ± 13.0</td>
<td>99 ± 10.9</td>
<td>72 ± 5.4</td>
<td>63 ± 8.4</td>
</tr>
<tr>
<td>G.g.gorilla (m)</td>
<td>4</td>
<td>127-201</td>
<td>60-110</td>
<td>52-83</td>
<td>46-88</td>
</tr>
<tr>
<td>G.beringi (m/f)</td>
<td>11</td>
<td>140-244</td>
<td>57-136</td>
<td>50-92</td>
<td>38-91</td>
</tr>
</tbody>
</table>
Gorillas on relatively low fiber diets may also be prone to ulcerative colitis, an intestinal disorder (Scott & Kemer 1975). These intestinal disorders may be prevented by a fiber-derived short chain fatty acid, butyrate, which is a preferred energy substrate for colonic mucosal cells and has been shown to have antineoplastic properties (Roediger 1982; Weaver et al. 1988).

In humans, an increase in dietary fiber has helped manage obesity, sometimes lowers plasma lipid and cholesterol, improves large bowel function, and may decrease the incidence of colon cancer and diverticular disease. With most institutions having unreliable access to browse, the best way to increase the fiber concentration of the diet is for the animal to consume high fiber (~30% NDF) primate biscuits. Offering a rotation of primate biscuit types may encourage greater and more reliable consumption of an often less than favored food item.

Vegetables, and to some extent fruits, have many components that may play a major role in the prevention of disease, including dietary fiber, folic acid, antioxidant vitamins (vitamin C, vitamin E, carotenoids), flavonoids, and vegetable protein. In terms of coronary heart disease risk reduction, vegetarian diets and high fiber have been shown to be protective in various human studies. High fiber diets appear to decrease the risk for intestinal disorders such as colon cancer, and vegetables are a rich source of folate, which may also play a role in reducing risk of cancer and cardiovascular disease. Components of vegetables and fruits are not mutually exclusive; to achieve full benefit from these foods, whole foods must be consumed rather than simply nutrient supplements.

3.1.4. Address issues of palatability, texture, processing, etc. that will encourage species-appropriate appetitive behaviors.

The preparation of whole plants or branches for consumption allows the individual animal to express species-appropriate behaviors that provide an important degree of control over the environment. The animal has greater choice in what to consume, when to consume it, and how much to ingest or discard. Free-ranging gorillas generally select immature leaves over the mature ones, which usually contain less fiber, more protein, and less secondary components such as tannins (Hladik 1978a,b; Milton 1979; Rogers et al. 1990; Remis 2003). Shoots, flowers, and fruit are also preferred over mature leaves (Clutton-Brock 1975; Casimir 1975). However, these items are still higher in fiber than the produce and primate biscuits that are available to feed apes in captivity.
Other types of food can also be delivered in novel ways: given whole or in many small pieces, or items that are normally fed raw can be cooked (e.g., broccoli, cabbage, cauliflower, peppers, etc.). Cooking fruits or high starch items (e.g., potatoes, carrots, corn, etc) will increase the concentration of readily available sugars and should be used sparingly (if at all) with overweight animals. Cooking items may be used to encourage an ill or recuperating animal to eat. Spices can be used to change the flavors of foods. Select spices or condiments that are low in sugar and salt. Many gorillas relish bitter, sour, or even peppery tastes.

3.2. Medical management

3.2.1. Quarantine and hospitalization

Pre-shipment physical examination: Pre-shipment examinations should occur within 30-45 days of the anticipated shipping date. Any increase to this time interval should be approved by the veterinary staff of the receiving institution. It is recommended that pre-shipment examinations be conducted at the shipping institution to assure the receiving institution is not importing a potential transmissible disease, or that the individual animal does not have an underlying medical problem that has been progressive or has been previously undetected. This examination provides reasonable assurance that the animal will be able to withstand the shipment.

The following protocol recommends that specific baseline laboratory tests are performed for the purpose of evaluating the animal’s current health status. The final decision for specific pre-shipment testing procedures should be made in partnership between the shipping and receiving institutions. To facilitate this, complete veterinary medical records should be forwarded to the receiving institutions when a transfer is contemplated, and communication between the veterinary staffs of the shipping and receiving institution should occur prior to initiation of pre-shipment testing. Any abnormal findings discovered during pre-shipment testing should be communicated to the veterinary staff of the receiving institution in a timely manner.

The following is a list of recommended procedures for a physical exam and diagnostic laboratory tests to be performed prior to the transfer of a gorilla from one facility to another.

- Complete physical examination
- Body weight and rump-to-crown length
- Tuberculin skin test 0.1ml of mammalian tuberculin, human isolates (Colorado Serum Co., Synbiotics Corp.) administered intradermally & visually evaluated by veterinary staff for reaction at 24, 48 & 72 hours. Concurrent testing with avian tuberculin may be useful. Valuable ancillary tests include the use of a whole blood test to measure the gamma interferon
response to purified protein derivatives of *M. bovis* and *M. avium* (Primagam) or a lateral flow ELISA test for Tb antibodies that can be performed on serum (PrimaTB STAT-PAK).

- Blood pressure measurements & echocardiography. It is recommended that echocardiograms be obtained in any animal that is anesthetized for a pre-shipment examination, as there have been instances where sub-clinical cardiovascular disease has resulted in problems post-shipment (T.Meehan, personal communication, 2007).

- Complete blood count, serum chemistry panel including cholesterol, triglycerides


- Bank at least 5ml of serum at shipping institution, or offer serum to receiving institution if lacking space

- Fecal analyses parasite screen – direct, flotation, & sedimentation of feces for detection of endoparasites.

- Fecal culture for enteric pathogens (*Salmonella* sp., *Shigella* sp., *Campylobacter* sp., *Yersinia* sp.).

**Quarantine:** Quarantine is a minimum 30-day period, extended to 60 days in many institutions due to the potential of parasitic and infectious disease risk to the resident colony. Quarantine requires that an animal is held in isolation with no contact, either direct or indirect, with the resident gorilla population. This typically is conducted after the animal is transferred from one institution to another. The quarantine facility should be distinctly separate and isolated from the resident housing facility; it is not considered “quarantine” if an incoming animal is held in common facilities with the resident group(s). It is recommended that the keeper staff caring for the quarantined animals is different from the staff caring for the resident primate collection to prevent transfer of any disease either to or from the newly arrived gorilla(s).

During the quarantine period, parasitologic examinations should be conducted to enable detection and clearance of parasitic infection as appropriate prior to release from quarantine. It is recommended that a quarantine physical examination be conducted at the receiving institution. Prior to the completion of the
quarantine period, the following conditions should be met before integrating the new gorilla into the rest of the colony:

- Gorillas should have 2 consecutive negative tuberculin skin tests. The Center for Disease Control (CDC) requires 3 negative TB tests to be performed at 2-week intervals for apes coming into the USA from other countries.
- Gorillas should have 3 consecutive negative fecal examinations (for parasites) prior to release from quarantine.
- Recommended vaccination status should be reviewed and updated as needed prior to release (with sufficient time for immune response and protection). See section 3.2.2.

3.2.1.1. Identify problems arising from isolation of social taxa and suggest possible mechanisms for avoiding these problems

Social isolation in gorillas may result in psychological, and perhaps resulting physiological stress. However, it has been suggested that certain individuals may prefer to be singly housed. Given the social nature of gorillas as a species, any time an animal is individually housed it should be monitored for physiological and behavioral signs of stress.

Kuhar et al. (2005) found the highest salivary cortisol levels in a male gorilla in days during a separation after an injury and that cortisol levels returned to normal upon reintroduction to the group. Other symptoms of psychological stress in social isolation may include hair-plucking and rocking. These behaviors suggest stress, but a systematic examination of these behaviors and their relationship to physiology has yet to be conducted.

The AZA Gorilla Behavior Advisory Group has recommended extra training and enrichment sessions above the normal levels to provide additional social stimulation during these isolation periods. When individuals must be physically isolated, it can be beneficial to provide visual, olfactory, or auditory access to other conspecifics or even other species to reduce the impact of the isolation. Questions or concerns regarding techniques to mediate to impact of social isolation in individual situations should be directed to the coordinator of the AZA Gorilla SSP or the chair of the AZA Gorilla Behavior Advisory Group

3.2.2. Preventive medicine (testing, vaccinations, parasite control, etc.)

Preventive medicine protocols: A preventive medical approach to gorilla care is recommended, and should minimally include the following:
- An appropriate cleaning and disinfection protocol for all gorilla enclosure spaces, with the veterinary department fully aware of the chemical agents in use, their spectrum of action, designed dilution rate, frequency of use, and toxic properties of each agent.

- Establishment of appropriate diets, adherence to those dietary protocols (addressing both constituents and volumes), and a monitoring program that assures the designed diets are providing the intended nutrition and whether the diet is being consumed.

- Establishment of an effective and safe pest control program, with the veterinary staff aware of all pests present, all control methods & pesticides in use (for invertebrate & vertebrate pests), the placement & frequency of use, & the toxic potential of each product used.

- Establishment of a parasite monitoring and treatment program, designed to lower parasite levels to be of negligible effect on the gorillas.

- Provision of a specific quarantine facility & program for all incoming animals.

- Development of and adherence to a planned, routine physical examination and health-screening program for all gorillas.

- Development of a program of immunoprophylaxis.

Routine exams: Routine health monitoring should be performed on all gorillas on a regular basis. The following protocol advises that specific baseline laboratory tests be performed for the purpose of evaluating current health status. Additional tests are recommended to increase baseline information on other diseases to determine their significance to ape health. The final decision for specific procedures and their frequency should be made by the institutional animal care and veterinary staff, and should be based on individual circumstances. The recommended protocol for routine physical exams includes the following procedures:

- Body weight and crown-to-rump length measurement
- Complete physical exam
- Blood pressure measurements & echocardiography.

Table 5: Table showing AZA Gorilla SSP recommendations for frequency of blood pressure and echocardiography exam based on age and health status

<table>
<thead>
<tr>
<th>Age/health status</th>
<th>Frequency of exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonate</td>
<td>During neonatal exam, if possible, to establish presence of any congenital defects</td>
</tr>
<tr>
<td>Age Group</td>
<td>Examination Frequency</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>9 years</td>
<td>Baseline exam</td>
</tr>
<tr>
<td>10-20 years</td>
<td>Every 3-5 years</td>
</tr>
<tr>
<td>&gt;20 years</td>
<td>Every 2-3 years</td>
</tr>
<tr>
<td>Animals with cardiac disease</td>
<td>Examination frequency should be determined on a case-by-case basis in order to monitor and manage treatment.</td>
</tr>
</tbody>
</table>

- Radiographs (thoracic and abdominal)
- Complete blood count, serum chemistry panel including cholesterol, triglycerides
- Bank at least 5ml of serum
- Fecal analyses Parasite screen – direct, flotation & sedimentation of feces for detection of endoparasites.
- Fecal culture for enteric pathogens (Salmonella sp., Shigella sp., Campylobacter sp., Yersinia sp.).
- Tuberculin skin test 0.1ml of mammalian tuberculin, human isolates (Colorado Serum Co., Synbiotics Corp.) administered intradermally & visually evaluated by veterinary staff for reaction at 24, 48 & 72 hours. Concurrent testing with avian tuberculin may be useful. Valuable ancillary tests include the use of a whole blood test to measure the gamma interferon response to purified protein derivatives of *M. bovis* and *M avium* (Primagam) or a lateral flow ELISA test for Tb antibodies that can be performed on serum (PrimaTB STAT-PAK).

**Vaccination:** A vaccine protocol should be developed with consideration of the following: 1) recommendations of the AZA Gorilla SSP and AZA Ape TAG; 2) regional prevalence of disease; 3) history and disease concerns of the institution; and 4) risk assessment of individual institution.

Modified live vaccines carry some risk of disease in vaccinated individuals. Protocols for groups that have not previously been vaccinated, or animals with concurrent illnesses, may require alterations of the recommendations listed below. The following vaccination schedules are recommended for captive gorillas:

- **Rabies:** Killed rabies 1ml intramuscular every 1-3 years, where applicable based on local rabies epidemiology and status.
- **Tetanus**: Tetanus toxoid 1ml intramuscular every 1-10 years.

- **Influenza vaccination**: Consideration should be given to administering the Influenza vaccination yearly in early fall, prior to influenza season. The true susceptibility of the gorilla to Influenza A & B is unknown. Several institutions have vaccinated animals yearly without any observed adverse effects.

- **Measles vaccination** (optional): The decision to administer the measles vaccine will be based on the specific needs of each individual colony.

- **Other vaccines**: Vaccinating gorillas using a human childhood vaccination schedule, including killed polio series and Haemophilus vaccination, should be considered. The CDC schedule is available at: [www.cdc.gov/vaccines/recs/schedules/printable](http://www.cdc.gov/vaccines/recs/schedules/printable).

### 3.2.3. Management of diseases or disorders

**Tuberculosis**: Tuberculosis is rare in great apes in North America; however, it has occurred in zoos. Nonhuman primates are susceptible to *Mycobacterium tuberculosis, M. bovis*, and *M. avium*, as well as the other mycobacteria (McLaughlin 1978; Thoen & Hines 1980). *M. tuberculosis, M. bovis*, and *M. kansasii* have been associated with the pulmonary form of the disease (McLaughlin 1978; Alvarado 1992). Tuberculosis is transmitted primarily through aerosolized, infected droplets from diseased individuals. Contaminated food, cages, tattoo needles, and bite wounds have all been incriminated as additional modes of transmission. Tuberculosis is a slowly progressive disease with subclinical signs in nonhuman primates until the disease is in advanced stages. Therefore, routine intradermal tuberculin testing of nonhuman primates and employees is recommended.

**Gastrointestinal Disease**: Gastrointestinal (GI) disease is the most frequent cause of nonhuman primate morbidity (Paul-Murphy 1993). Further investigation is needed to determine factors causing gastrointestinal disease. The following are organisms of concern in captive gorilla collections. For more information see the ‘Health’ chapter of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

*Balantidium coli*: *Balantidium coli* is a ciliate protozoan that is widely prevalent in great ape colonies (Swenson 1993). A classification of the types of infection with *Balantidium* has been suggested (Lee & Prowten 1990).

- **Asymptomatic carriage or commensalisms**: This is the most common condition.
- **Mucosal or superficial infection**: This is the most common clinical disease, and can lead to diarrheal syndrome (mucosal inflammation/irritation with frequent, mucous, semiliquid stools), or dysentery (erosive mucositis with rectal urgency, blood, and mucus).

- **Invasive enterocolitis**: This involves extension beyond the mucosa, and is rare. However, it can lead to ulceration, abscess formation, and perforation with local and metastatic spread (typhlitis)

It is recommended that animals coming from collections where *B. coli* is endemic be treated prophylactically for a course that includes the pre- and post-shipment period. This treatment should be in addition to the usual pre-shipment and quarantine parasite exams, and serves as a precaution in case the parasite is inapparent until shipping stress may lead to clinical disease. The following treatments (see Table 6) have been reported for *Balantidium* (Teare & Loomis 1982; Swenson 1993).

Table 6: Treatments for *Balantidium*

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetracycline 1</td>
<td>15mg/kg tid (infants &amp; juveniles)</td>
<td>10-14 days</td>
</tr>
<tr>
<td></td>
<td>500-1000mg tid (adults)</td>
<td></td>
</tr>
<tr>
<td>Metronidazole 2 (Flagyl)</td>
<td>12-15mg/kg tid (infants &amp; juveniles)</td>
<td>5-10 days</td>
</tr>
<tr>
<td></td>
<td>750mg tid (adults)</td>
<td></td>
</tr>
<tr>
<td>Benzoyl Metronidazole 3 chemical grade</td>
<td>mg dose is 1.6 times that of Metronidazole</td>
<td></td>
</tr>
<tr>
<td>Iodoquinol 4 (Yodoxin)</td>
<td>12-16mg/kg tid (infants &amp; juveniles)</td>
<td>14-21 days</td>
</tr>
<tr>
<td></td>
<td>650mg tid (adults)</td>
<td></td>
</tr>
<tr>
<td>Paromomycin 5 (Humatin)</td>
<td>10mg/kg tid</td>
<td>5-10 days</td>
</tr>
</tbody>
</table>

1 May act on *B. coli* by affecting the bacteria on which they feed
2 Probably the best drug but poorly accepted due to bitter taste. Acts systemically & in the intestine.
3 Available through some compounding pharmacies. Much better accepted than metronidazole due to taste.
4 Minimally absorbed and acts only in the lumen of the bowel.
5 Poorly absorbed from intestine. Use only in non-invasive disease.

Treatment should be accompanied by thorough disinfection, as well as treatment of any other animals that may serve as a source of organisms to the gorillas. Any animal with severe diarrhea should also receive supportive treatment, including fluid and electrolyte replacement.

**Other pathogens**: It is important that appropriate diagnostic tests and treatment with antiprotozoal agents are instituted promptly in the
case of diarrhea that is watery or contains any blood or mucus. Bacterial cultures should be done in addition to fecal flotation and wet mounts of direct stool samples. Bacterial pathogens such as *Salmonella*, *Shigella*, *Campylobacter* sp., enterotoxogenic *E. coli* and *Yersinia* spp. are all potential pathogens that need to be identified and treated appropriately. Animals that show signs of abdominal pain in addition to bloody stool should be immobilized and examined for any signs consistent with bowel penetration. A number of cases of bowel perforation requiring surgical resection have been reported (Lee & Prowten 1990; Lee et al. 1991), and prompt action in these cases is essential.

- **Pathogenic amoeba:** Pathogenic amoebae have been diagnosed in AZA Gorilla SSP institutions. *Entamoeba histolytica* is the most commonly diagnosed pathogenic amoeba. The clinical signs may range from inapparent infection to acute dysentery with bowel perforation and liver abscesses. Technicians unfamiliar with the characteristics of the various amoeba should refer samples to qualified labs or consult texts for identification characteristics and photographs of various species. Paromomycin (at the same dosage level when used to treat *Balantidium*) is a recommended treatment. Invasive cases must be treated with a drug that is absorbed, such as metronidazole, followed by a course of Iodoquinol.

- **Giardia lamblia:** *Giardia lamblia* is diagnosed occasionally in gorillas at AZA Gorilla SSP institutions. It can produce watery diarrhea and should be ruled out when no other cause for diarrhea is found. Diagnosis is by finding cysts on fresh, iodine-stained wet mounts of stools or trichrome-stained smears. Furazolidone at a dose of 100mg qid for adults and 5mg/kg qid for juveniles for 7 days is recommended (Swenson 1993).

- **Strongyloides stercoralis:** The most commonly diagnosed parasite in SSP institutions other than those previously mentioned is *Strongyloides stercoralis*. It has been reported as a cause of mortality (Benirschke & Adams 1980) and is certainly a potential pathogen, especially in mixed infections. Thiabendazole (Mintezol) appears to be effective if taken orally at the recommended human dose. This product comes as both a pediatric, flavored suspension and as flavored chewable tablets, making it more acceptable. Ivermectin at 0.2mg/kg daily orally for three consecutive days also appears effective.

- **Bacterial enteritis:** Bacterial enteritis is an important cause of morbidity and mortality in gorillas (Benirschke 1983; Hruban et al. 1986; Munson & Montali 1990; Janssen 1993; Paul-Murphy 1993), and *Salmonella/Shigella* infections were specifically noted as a disease of concern for gorillas by AZA
Gorilla SSP institutions. Shigellosis is only found in humans and nonhuman primates (Banish et al. 1993; Paul-Murphy 1993; Stetter et al. 1995) and is the most commonly reported bacterial enteric pathogen isolated from nonhuman primates (Stetter et al. 1995). Systemic treatment with antibiotics as indicated by sensitivity testing and supportive treatment for fluid and electrolyte loss is indicated. It is very important that cultures for *Salmonella*, *Shigella*, and *Campylobacter* be taken during routine health screening and pre-shipment and quarantine exams. This information in conjunction with diagnostic tests run during the course of any gastrointestinal disease will give the clinician a history of the pathogens that may be carried within a collection. Sharing this information prior to planned moves or introductions will help to anticipate problems, so that appropriate prophylactic or therapeutic treatment may be administered.

**Cardiovascular disease:** Cardiovascular disease is the cause of 41% of all mortality in adult and older adult gorillas from 1980 to 1994 (Meehan & Lowenstine 1994). It is noted as a clinical concern but is most often seen as sudden death without previously recognized clinical disease (Allchurch 1993). The majority of deaths due to cardiac disease are caused by two syndromes: fibrosing cardiomyopathy (Schulman et al. 1995) and aortic dissection (Hruban et al. 1986; Allchurch 1993; Kenny et al. 1994). Hypertension has been identified as an underlying cause of fibrosing cardiomyopathy in humans. Research is currently underway to investigate the relationship between fibrosing cardiomyopathy and hypertension in captive gorillas. Institutions are strongly encouraged to actively participate in training of gorillas to allow awake blood pressure monitoring. Active participation in AZA Veterinary Advisory Group (VAG) research investigating the diagnostics, treatment, prevention, and epidemiology of cardiovascular disease in captive gorillas is also encouraged.

3.2.4. **Appropriate capture, restraint and immobilization techniques and training for routine and non-routine procedures.**

The most basic method for defining the current health status of any animal, including the gorilla, is through a physical examination. In order for a physical examination to be complete and conducted safely on a gorilla, it is performed using general anesthesia induced typically by chemical immobilization; most routine, uncomplicated examinations can be completed using injectable immobilization agents alone, without the need for inhalation anesthesia supplementation. Simple neonatal examinations may usually be performed satisfactorily without anesthesia; however, if diagnostic procedures such as radiology, ultrasonography, or electrocardiography are indicated by initial physical findings, then inhalation anesthesia can be employed safely.
No immobilization is completely risk-free; however, gorilla immobilizations are not a significant cause of morbidity and mortality. There have been unexpected mortalities associated with immobilizations, and most of these have been associated with previously undiagnosed cardiac disease (T. Meehan, personal communication, 2007). There are also concerns regarding group social disruption caused by the separation and immobilization of a group member. An immobilization that is done opportunistically can be done following training to allow separation from the group and at a time that will minimize impact on the group. A planned immobilization is far less disruptive than an unexpected illness with a protracted course of treatment, or the death of a key social member of a gorilla troop.

Injectable anesthetics: It is recommended that animals be fasted prior to planned immobilization. The length of fast (including both food and water) may vary depending on institution and environmental restrictions. A variety of injectable anesthetic drugs and drug combinations have been used in captive gorillas. Table 7 lists commonly used doses of drugs used as single immobilizing agents in animals of various ages.

<table>
<thead>
<tr>
<th>Age/sex</th>
<th>Drug</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult males</td>
<td>Ketamine</td>
<td>8-11mg/kg</td>
</tr>
<tr>
<td></td>
<td>Telazol</td>
<td>2-5mg/kg</td>
</tr>
<tr>
<td>Adult females</td>
<td>Ketamine</td>
<td>4-16mg/kg</td>
</tr>
<tr>
<td></td>
<td>Telazol</td>
<td>2-3mg/kg</td>
</tr>
<tr>
<td>Juvenile males</td>
<td>Ketamine</td>
<td>5-10mg/kg</td>
</tr>
<tr>
<td></td>
<td>Telazol</td>
<td>2.5mg/kg</td>
</tr>
<tr>
<td>Juvenile females</td>
<td>Ketamine</td>
<td>5-10mg/kg</td>
</tr>
<tr>
<td></td>
<td>Telazol</td>
<td>2-5mg/kg</td>
</tr>
<tr>
<td>Neonates</td>
<td>Ketamine</td>
<td>4-10mg/kg</td>
</tr>
</tbody>
</table>

Inhalant anesthetics: The inhalant anesthetic of choice is isoflurane gas. In adults, this is administered during longer procedures following immobilization with injectables. In neonates, depending on the animal's size and cooperation, it may be used for induction and general anesthesia. For induction, the isoflurane is delivered at a concentration of 3-5% and then maintained at 0.5-1.5% as necessary. The gas is administered either via facemask or via endotracheal tube following
intubation. Animals are routinely fasted prior to planned immobilization. The length of fast (including both food and water) may vary depending on institution and environmental restrictions.

**Anesthesia techniques and best practices:** When using injectable drugs alone, without intubation, supplemental oxygen supplied via facemask will improve blood gas values. It is also critical to make sure the animal has an open airway. Animal positioning can make a critical difference in the animal’s oxygenation level. Gorillas should not be allowed to sit with their chin tucked in for any length of time. If they are on their back, the tongue may fall back into the throat and cause a partial airway obstruction. If animals fall asleep on their backs during an immobilization, they should be turned on their side, and the tongue pulled out as soon as it is safe to do so (K.Kearns, personal communication, 2007). It is also a good idea to transport and keep animals on their side with their necks extended whenever possible. Thick oropharyngeal tissue and mucous secretions are other factors that may cause airway obstruction that should be monitored. Care should be taken when intubating gorillas because they have a short tracheal length before bifurcation. Also, if examination requires them to be on their backs, keeping the upper body at an angle of approximately 45° can lessen the pressure on their lungs and improve oxygenation.

If equipment is available to monitor blood gases (e.g., Istat monitor), arterial blood may be obtained from the tibial artery. This artery can be palpated along the cranial surface of the tibia. The sample can be obtained using a 25 ga needle and 1ml syringe while stabilizing the artery between the fingers (K.Kearns, personal communication, 2007).

Ketamine alone is probably the safest immobilizing agent for sick animals (K.Kearns, personal communication, 2007). Benzodiazepenes and other adjuncts should be used with caution when using telazol as the primary immobilizing agent, as they may cause prolonged recovery times. Recovery positioning should be in lateral recumbency with the head extended and down arm extended. The animal should be on well-padded surface (e.g., straw beds, etc.) and placed where climbing will not happen until completely awake, if possible. If prolonged recovery is anticipated, additional padding may be necessary around extremities of bigger males especially.

### 3.2.5. Management of neonates and geriatric animals

**Neonates:** Neonatal physical examinations should preferably be conducted within seven days of the birth to detect congenital defects, parturition trauma, neonatal disease, malnutrition, or maternal neglect. This also incorporates the initiation of the scheduled administration of the vaccination protocol for neonates and juveniles (see section 3.2.2). Individuals that are being mother-reared may be difficult to gain access to for physical examination, and pre/post birth training for the mother is
recommended (see sections 5.1 and 5.2). Close monitoring of these infants for activity, nursing, skin turgor (hydration status), strength, and the progressive development of the infant should indicate problems that require immobilization of the dam for examination of the infant. This is especially true over the first 72 hours after birth.

**Geriatrics**: The majority of deaths due to cardiac disease are caused by two syndromes: fibrosing cardiomyopathy (Schulman et al. 1995) and aortic dissection (Hruban et al. 1986; Allchurch 1993; Kenny et al. 1994; Murphy 2005). Both diseases occur predominately but not exclusively in males. They both occur primarily in the older age groups. Older gorillas may need more in-depth cardiovascular system exams to determine the presence of cardiovascular disease. Cardiac hypertrophy may be identified with ECG or ultrasound. Blood pressure measurements by standard techniques must be taken to determine normal values.

Arthritis has been reported in gorillas due to a number of causes, including *Mycoplasma*-associated rheumatoid arthritis, ankylosing spondylitis, Legg-Calve-Perthe disease, osteoarthritis, and reactive arthritis (Brown et al. 1980; Douglas 1981; Adams et al. 1986; Raphael et al. 1995). Studies need to be undertaken to determine the prevalence and causes of arthritis in the gorilla population.

### 3.2.6. Management during pregnancy

Exams of pregnant animals have allowed the discovery of malpositions, multiple fetuses, and other factors that present a risk to the healthy development of the fetus. Routine examinations may not be necessary in all pregnancies. However, review of medical records and the literature has not demonstrated undue risk to the fetus or dam. Health problems that may affect nursing, especially engorged breasts and sore nipples, need to be treated (Miller-Schroeder & Paterson 1989).

A pregnant gorilla may exhibit one or more of the following symptoms: 1) an increase in weight, 2) breast enlargement; 3) nipple enlargement; or 4) milk expulsion. An increase in abdomen size is frequently observed during pregnancy in gorillas. In some cases, a weight increase has been noticed about 3-4 months prior to birth (Lotshaw 1971; Fisher 1972; Mallinson et al. 1973).
4. Reproduction

For more information on the reproductive biology of gorillas, refer to the ‘Behavioral Biology’ chapter of ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997).

4.1. Identify seasonal changes in physiology and behavior associated with reproduction and address management implications of such changes

**Males:** Males between 8-12 years are considered blackbacks; those 12-15 years old are young silverbacks, indicating that they are silvering but not yet fully mature, and full maturity occurs at about 15 years.

The average age of siring an infant is 10 years, 1 month (Cousins 1976), with the youngest male siring an infant at 8 years old in the wild (Schaller 1963; Fossey 1982), and 9 in captivity (Beck & Power 1988).

**Females:** Harcourt et al. (1981) reported that wild female mountain gorillas reach menarche at 7-7.5 years, based on the timing of the first observed swellings. Watts (1991) has suggested that menarche is reached somewhat earlier, at 6-7.5 years, using age of first observed swelling and/or first complete copulation as the criteria. Although there are few reports in the literature, it appears that captive lowland gorillas may begin sexual cycling even earlier. Keiter & Pichette (1979) described labial tumescence and copulatory activity in two captive females, ages 5-6 and 6-7. In both females, estrus first occurred at age 5½.

In captivity, the average age of a female at first birth is about 9 years, 10 months (Cousins 1976), with the youngest conception at 6 years (Beck & Power 1988). The oldest female to give birth in North America was 41 years.

In chimpanzees, it has been noted that adolescent females exhibiting their first sexual swellings are often irritable and difficult to manage (Keeling & Roberts 1972). There are no reports in the literature documenting such behavioral changes in gorillas. However, Keiter & Pichette (1979) do mention that they observed two subadult females to initiate increased playful and affectionate behaviors toward human caretakers during estrus. According to Keiter & Pichette (1979), during estrus the females were also more vigorous toward the males, initiating 80% of the courtship play and engaging in activities that attracted the males’ attention.

**Copulation:** Gorillas exhibit no obvious breeding season (Schaller 1963; Cousins 1976; Fossey 1979; Harcourt et al. 1980). As is typical for nonmonogamous mating societies, the majority of gorilla copulations are restricted to a brief period of 1-4 days during the periovulatory phase of the cycle (Nadler 1976; Harcourt et al. 1981, Mitchell et al. 1985). Copulation occurs for an average of 2-3 days for adults and adolescents respectively (Harcourt et al. 1980, 1981).

While breeding is generally confined to estrous periods, housing constraints may lead to increased mating. When access is constrained and animals are introduced to each other suddenly, inappropriately timed copulations
are more likely (Nadler 1981, 1982, 1983), and mating occurs more frequently than the species-typical pattern. Housing in these instances prevents the females from achieving spatial separation from males, and males initiate the majority of copulations (Nadler et al. 1983). There is a possibility that some fertility problems in zoos might be attributed to the unnatural condition of proximity between male and female gorillas, which might lead to an unnatural frequency of mating and thus sperm depletion. This may be contradicted by the consistent appearance of breeding primarily during estrus. In any case, an important consideration in promoting captive breeding of gorillas may be to provide options to the female to regulate the frequency and timing of mating (Nadler 1984, 1989).

4.2. Address hormonal tracking as a mechanism for identifying reproductive state, and assessing feasibility of introduction for solitary species

Gorilla hormonal patterns during the menstrual cycle are similar to those in humans (Gould 1982; Nadler & Collins 1984). Hormonal analysis reveals cycle lengths ranging from 21-49 days, with an average length of about 33 days (serum: Nadler et al. 1983), 32 days (urine: Mitchell et al. 1982a,b), and 30 days (urine: Czekala et al. 1987). The menstrual cycle begins with the shedding of the endometrial lining of the uterus. This event may be monitored in captive gorillas’ urine using "Hemastix" (Upjohn Company), which detects blood in the urine (Reichard et al. 1990). The increase in luteinizing hormone (LH) stimulates ovulation and may be monitored in gorillas’ urine using a commercially available test, such as Ovuquik (Quidel, San Diego, CA). The period of positive response to this test may occur subsequent to masturbatory behavior (Gould & Faulkner 1981). During this time, estrous behavior is exhibited.

Complete menstrual cycles and their components in the gorilla may be defined by the evaluation of total urinary immunoreactive estrogens (follicular phase: 19.5 +/-1.0 days) and the progesterone metabolite pregnanediol-3-glucuronide (luteal phase: 12.3 +/-0.3 days) (Mitchell et al. 1982b). These values are comparable to those of Czekala et al. (1987), who, by measuring urinary total estrogens, found the follicular phase to average 17.1 +/-2.0 days and the luteal phase to average 13 +/-1.1 days. Nadler (1986) report the luteal phase of the cycle to average 12.2 days.

Beck & Power (1988) suggest the use of diagnostic techniques on reproductively unsuccessful adult gorillas. Such diagnostic procedures for female gorillas might include: urine examinations for cyclical changes in hormonal metabolites (Mitchell et al. 1982b), laproscopic ovarian exams, and exams for presence of fallopian tubes (Wildt et al. 1982). Readers may refer to the AZA Gorilla SSP Management Group’s Reproductive Advisory Group, or to AZA Advisory Groups, such as the Contraceptive Advisory Group (Wildlife Contraception Center) for a list of diagnostic techniques.

In a recent survey of nine female gorillas at the Brookfield Zoo dating back to 1983 (T.Meehan, personal communication), it was found that blood luteinizing hormone (LH), follicle-stimulating hormone (FSH), estradiol and progesterone concentrations cycle in very similar patterns to humans and
correlate with behavioral data. Based on 59 samples, prolactin levels are higher in gorillas than in humans in nearly every phase of the menstrual cycle (range: 50-168ng/ml) and does not appear to affect menstrual cycling as it does in humans. Also as in humans, gonadotropins are low during the postpartum period when the average prolactin level is 148ng/ml. Therefore, higher prolactin levels in gorillas may be compatible with fertility. However, in a case report by Chatfield et al. (2006), a 17-year-old primiparous female with hyperprolactinemia (associated with low fertility compared to siblings) was found by MRI to have a pituitary adenoma. This female was treated for 8 months resulting in prolactin levels within normal limits and she subsequently became pregnant and gave birth.

**Geriatric females:** Tracking concentrations of progestogens through fecal hormonal analysis over the course of at least three months can provide an assessment of reproductive cycling. To assess cycling patterns, a baseline value of progestogens can be calculated in order to distinguish very high from very low levels of progestogens (see Brown et al. 2001; Atsalis et al. 2004; Atsalis & Margulis 2006). If the baseline is too low to see cycling patterns, a threshold (exceeding baseline by 50%) may be used instead. Previous research on a sample of 30 gorillas determined cumulative threshold values of progestogens at or above 290ng/g feces. A pattern exhibiting regularly occurring luteal and follicular phases will be expected in normally cycling females. Luteal phases are manifested as sustained (at least two days) rises above threshold followed by sustained (at least two days) decreases below the threshold. Previous research has shown that concentrations of progestogens in females under 30 may be expected to average approximately 350ng/g (Atsalis & Margulis 2006). In comparison, concentrations of progestogens in females over 35 who are still cycling may be expected to average approximately 285ng/g. Females over 35 who have ceased to cycle exhibit erratic hormonal profiles with no clear pattern of luteal and follicular phases and noticeably lower concentrations of fecal progestogens. They may be expected to have low concentrations of progestogens averaging 180ng/g (Atsalis & Margulis 2006). Abnormal or irregular cycling patterns may be evident in geriatric females paralleling perimenopausal patterns observed in humans (Margulis et al., in press).

Concentrations of progestogens may be characterized by considerable interindividual and interlaboratory variation so that baseline and threshold values may differ from those noted above. Sexual proceptive behavior is closely tied to hormonal cycling but noncycling (menopausal) geriatric females might not display estrus behaviors. Thus, absence of estrus behavior may be indicative of menopause, even in the absence of hormonal information.

This particular hormonal assessment is not sufficient to evaluate a female’s ability to conceive, but low progestogens have been associated with diverse symptoms in human females. Although the physiological consequences of low levels of progestogens have not been examined in aging gorillas, progestogens in humans stimulate bone building, help use up fat for energy, facilitate thyroid action, and normalize blood sugar. If older females exhibit
symptoms that are usually associated with low progestogens in humans, checking concentrations of progestogens may aid in evaluating their etiology.

Pregnancy tests: Gestation ranges from 237-285 days, with a mean of 255 days, or 8.5 months (Cousins 1976; Fossey 1979, 1982; Harcourt et al. 1980, 1981). Urinary estrogen measurements may be used to monitor gestation and approximate stages of gestation (Czekala et al. 1983). Some human pregnancy test kits, which detect chorionic gonadotropin (e.g. Clearblue® Easy, Inverness Medical, Inc.), crossreact with gorilla CG and may be used to detect pregnancy (Czekala, personal communication, 1994).

4.3. Address timing of introductions for individuals of solitary species

Not applicable for these species.

4.4. Address provision of and describe facilities for parturition and as appropriate, management of females during isolation or denning.

Pregnant animals may become less active, quieter, and withdrawn and may seek seclusion, as evidenced by greater social spacing from their group members (Carpanzano & Ogden, personal communication). Decreased intolerance of other troop members may also occur during pregnancy (Rumbaugh 1967; Lotshaw 1971). However, the AZA Gorilla SSP recommends that females remain in their social groups during pregnancy, following birth, and during infant rearing. The presence of other group members may serve as a buffer against stress (Miller-Schroeder & Paterson 1989). Groups should be maintained intact during parturition, as this has been found to be associated with increased maternal care.

Following a birth, close monitoring of the mother and infant is vital and should be conducted by staff members familiar with gorilla behavior and the behavior of the particular female. Remote viewing via video may have a positive effect on the outcome of parturition and rearing compared to the physical presence of animal care staff. Competent maternal care improves with practice. It is therefore incumbent on the staff to carefully evaluate the mother/infant relationship.

4.5. Address what, if any, circumstances might warrant hand-rearing and identify acceptable hand-rearing and reintroduction protocols.

The AZA Gorilla SSP recommends that in virtually all circumstances, mothers have the opportunity to rear their infants themselves and without human intervention. The rare circumstances of human intervention include maternal abuse, neglect, and significant illness or injury to the mother or infant. In these conditions, where the life of the mother or infant is in danger, managers may be forced to intervene. In some circumstances, the infant may be able to be reintroduced to the mother soon after the initial separation, and mother-rearing may be continued. However, in cases of life-threatening abuse or neglect, alternative rearing strategies must be considered.

A birth management plan should be established as early as possible, starting from when breeding recommendations have been received. This should
include a review of social reproductive and medical history of the pregnant female, staff assignments, determination of due date, pre-partum plan, birth day plan, and other considerations relating to the birth. It should also include history of the expectant female, discussion of intervention types, record keeping or documentation, housing situations, previous maternal skills, labor and delivery, problems associated with birth and delivery, physical appearance of the newborn, postpartum behavior, diet and supplementation during lactation. A local OB/GYN and neonatologist should be recruited for the mother and infant. Training, monitoring and medical intervention needs, as well as planning for a rapid retrieval of the infant, should be established if it becomes necessary. Each birth event and neonate/mother relationship should be evaluated on a case by case basis, but if the mother does not clean the membranes from the face, hold the infant soon enough to prevent hypothermia, or if nursing is not confirmed within 72 hours, the infant should be given a thorough examination. In most cases, this will require at least light sedation of the mother. During this time the infant can be placed on her breast and allowed to suckle and the breast can be further manipulated by hand or via breast pump, in an attempt to stimulate milk production. The results of the exam should be used to determine what level of further medical/nutritional attention is needed.

Often, one or more reintroduction attempts can be made, once the infant’s condition is stabilized through intensive care. Reintroduction attempts of neonates can generally be accomplished safely by placing the youngster on bedding in a warm enclosure and giving the mother access. If the mother does not respond appropriately, the youngster should be removed within a short period of time to prevent chilling.

Care should be taken against the premature removal of infants due to anticipated or perceived maternal incompetence. Inexperienced gorillas have proven to be competent mothers, and many gorillas show improvement in maternal care during the first few days of an infant's life. According to Bahr (1995), physical and psychological stress can potentially inhibit the initiation and early maintenance of lactation. Milk letdown may not occur until 72 hours postpartum, although increased fluid intake may help to stimulate milk production (Bahr 1995). Drugs such as oxytocin and metaclopramide may also aid in milk letdown (Gabay 2002).

The Lincoln Park Zoo (Rosenthal 1987) has developed a 72-hour, postpartum observation protocol for gorillas based on their experience that an infant can be pulled and successfully hand-raised after 72 hours of not nursing. The protocol lists four aspects that should be checked immediately after a birth:

- The ability of the infant to cling to its mother. Fossey (1979) reports that a 1-day-old infant can cling, unsupported, for 3 minutes.
- The presence of mucus and placental membranes that could obstruct the mouth and/or nose of the infant.
- The care the mother provides the infant. Has she cleaned the infant? Does she keep the infant with her, and in what position does she carry the infant? Is she protective of the infant?
Whether the placenta has been passed. Some, but not all females, eat the placenta. If the umbilicus remains attached to the infant, it should dry and detach by the third day.

Another useful guide is the continuum developed by Rogers & Davenport (1970) to evaluate maternal behavior in chimpanzee mothers in the first 12 hours postpartum. However, it should be noted that even successful chimpanzee mothers exhibited in appropriate behaviors early on (Bloomsmith et al. 2003) and that these monitoring methods should be used with caution.

Some institutions have the capability of remote observations, thereby allowing the mother and infant more privacy. This method may be particularly useful for situations in which the female or other group members become nervous when observed. An additional benefit is that volunteers (i.e., "strangers" to the gorillas who may disturb the mother) could be used if remote monitoring is in place; increasing the amount of time the mother and infant could be observed.

Promoting appropriate maternal care: If females have a history of poor maternal care, or in situations where proactive measures are taken to ensure females show appropriate care, one possible management strategy involves incorporating an ‘at-risk female’ into a breeding group where she can observe other mothers raising their infants (Meder 1989).

See section 5.2 for information on behavioral training approaches that can be used to promote appropriate infant care. Females that have shown a range of appropriate maternal behaviors, but have failed to raise an infant due to an identifiable behavioral deficiency, may prove to be good candidates for a training program. This approach could be used in tandem with the management strategies discussed above.

Aspects of the physical environment that may also influence maternal competence include, an established daily routine, cage size and amount of vertical space; access to privacy; opportunities for activity, play, and exploration to reduce stress and boredom; access to live vegetation; access to nesting material and diet. Important social factors may include group composition, maternal rank and temperament, access to familiar companions, experienced staff and relationship to human caretakers.

Alternatives to hand-rearing: If observations indicate that the infant gorilla is not nursing after 72 hours, and human intervention is necessary, the following alternatives to hand-rearing should be considered.

- Additional time and close monitoring: If the mother is exhibiting aspects of maternal care, but the infant has not been observed to nurse during the 72 hours, it may be appropriate to provide the mother and infant with more time to coordinate nursing behavior by removing the infant, rehydrating it, and returning it to its mother.

- Promoting natural nursing: With a female that prevents an infant from nursing, it may be possible to sufficiently distract the mother to allow the infant to nurse. The prior development of a positive and flexible relationship with the female by one or more members of the caretaking
staff would be beneficial. Alternatively, anesthetizing the female to permit the infant to suckle may stimulate further nursing. Such a procedure may be particularly helpful if the female’s breasts are very full and tender, as milking will relieve her discomfort.

- **Supplemental feeding:** If the female gorilla exhibits acceptable to good maternal behavior, prevents the infant from adequately nursing or has insufficient milk, a supplemental feeding program may be possible (e.g., distracting the mother with hand-feeding while supplementing the infant with a bottle). This innovative method can allow the infant to be raised within the social group. This method must be established during early pregnancy.

- **Surrogate lactating mother:** An alternative to hand-rearing is possible if a surrogate mother is available to adopt the infant. A lactating female would be ideal, but the timing of such occurrences is mostly chance. Communicating with the AZA Gorilla SSP, and initiating a nationwide search may improve chances.

**Negative consequences of hand-rearing:** Hand-reared infants have often been observed performing a range of abnormal behaviors, including digit sucking, lip sucking, and rocking (Meder 1989). These behaviors generally declined by the third year of life, but the time spent engaged in stereotypies increased “strikingly” under stressful conditions (e.g., during introductions). Gould & Bres (1986a) find that the abnormal regurgitation and reingestion habit occurs more frequently in hand-reared versus parent-raised gorillas. The consequences are far reaching, because not only does this habit affect the health and educational/display value of the individual, other members of the group can observe and learn to perform the behavior.

Even as sub-adults, Meder (1989) found that hand-reared animals showed significantly more aggression and less social play than mother-reared ones, especially when raised in pairs as opposed to groups. It was also found that hand-reared gorillas, especially males, frequently directed aggression indiscriminately against conspecifics when later introduced to them.

Stoinski et al. (2004b) found that hand-rearing negatively affects a male’s ability to succeed in an all-male group. Hand-rearing may affect long-term success in a group because of a lack of affiliative social behavior initiated by hand-reared males. All-male groups should contain at least one mother-reared male to promote positive social interactions.

According to Beck & Power (1988), hand-reared gorillas, especially those with limited access to conspecifics early in life, experience moderate to severe social deprivation. Hand-rearing can detrimentally affect the intellectual, behavioral, and social development of the gorilla. Additionally, Ryan et al. (2002) found that mother reared gorillas were more likely to become nurturing mothers themselves and produced more offspring than hand reared mothers. Therefore, it is strongly recommended that gorillas be raised by their mothers, and that they be hand-reared only in life-threatening situations (e.g., inadequate maternal care, including rejection of and/or mutilation of the infant). The AZA
Gorilla SSP also strongly recommends that all institutions develop management programs that increase the likelihood infants will be mother-reared within a social group.

Criteria of hand-rearing protocol: The following components of hand-rearing are necessary to ensure an early successful introduction to a surrogate. Gorilla-holding institutions that might need to hand-rear should contact the AZA Ape TAG’s Hand-Rearing Committee. The following protocol is based on a non-lactating surrogate.

- 24-hour or continual care is needed to be responsive to the infants needs at all times, until the successful introduction of a surrogate takes place. The infant is not to be left alone or placed where there is a physical barrier from the caregiver.
- Dedicated space is provided for hand-rearing solely a gorilla.
- The infant is raised by a caregiver that simulates age appropriate mother rearing at all times.
- The infant is raised next to conspecifics from the day it is pulled, to the day of introduction.
- The institution’s management must commit to the philosophy of the program.
- Accurate, consistent record keeping is an important part of the hand-rearing protocol. The records should include description of formula, amount fed and actual consumption, stool amount and consistency, daily weight of infant, and vitals. In addition, notes on veterinary care, description of infant activity levels, response to specific stimuli, description of the infant’s general development, notes on the hand-rearing methods used, times next to conspecifics, interest shown from infant to the group and group to the infant, should be included.

The infant must be raised with an early introduction in mind. Two precursors must be met prior to the physical introduction. The first precursor is to identify an appropriate surrogate. Staff must evaluate the suitability of surrogate or gorilla groups to accept hand-reared/surrogated infants. Since the infant is raised next to conspecifics, the caregiver will be able to observe the interactions between the infant and the group. This will help to determine the surrogate. The second precursor is that the infant meets the following criteria: 1) bond between infant and surrogate is established; 2) infant is trained to come to the mesh for bottle, or surrogate is trained to bring infant to mesh; 3) infant is familiar with exhibit and husbandry; and 4) veterinary/curator approval is given for the next step.

A hand-rearing protocol must meet the physical, psychological, and social needs of the infant. Upon determination of confirmed pregnancy of the female, a hand-rearing protocol must be in place.

Table 8: Recommended elements of a hand-rearing protocol for captive gorillas
<table>
<thead>
<tr>
<th>Rearing protocol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical environment</td>
<td>- Dedicated hand-rearing space next to conspecifics, and preparation of area.</td>
</tr>
<tr>
<td></td>
<td>- Auditory, visual, olfactory, supervised tactile access</td>
</tr>
<tr>
<td></td>
<td>- Retro-fitting adjacent facilities, and any area that holds gorillas</td>
</tr>
<tr>
<td></td>
<td>- Means of maintaining records</td>
</tr>
<tr>
<td></td>
<td>- Adequate supplies/devices (scale, available sanitation/disinfection, food storage, incubator)</td>
</tr>
<tr>
<td></td>
<td>- Proper ambient temperature</td>
</tr>
<tr>
<td></td>
<td>- Age and species-appropriate stimulation/environment, including that for locomotion (mesh)</td>
</tr>
<tr>
<td>Hand-rearing staff training</td>
<td>Selection of staff is based on prior experience, availability, primate knowledge, and ability to follow protocols. Trainees work with an experienced hand-rearing keeper prior to being on their own. The trainee must be knowledgeable with the protocol, the infant, conspecifics, and equipment.</td>
</tr>
<tr>
<td>Veterinary care</td>
<td>- Veterinary assessment</td>
</tr>
<tr>
<td></td>
<td>- Routine health monitoring/assessment (vitals according to protocol)</td>
</tr>
<tr>
<td></td>
<td>- Vaccinations (see section 3.2.2)</td>
</tr>
<tr>
<td>Psychological needs</td>
<td>Simulating 24-hour mother-rearing next to conspecifics (see ‘Human-animal interactions’ below)</td>
</tr>
<tr>
<td>Formula</td>
<td>Many formulas have been successful. Using a formula containing docosahexaenoic (DHA) and arachidonic (ARA) omega fatty acids is strongly recommended. Milk and/or soy-based formulas (20k/cal) have been used with good results. Special formulas including 24k/cal can be used if there are problems. Specific ones can be formulated (see NRC 2003). Determine the amount and strength of formula. Start at 10% of infant’s body weight. If the infant tolerates the formula, and is not gaining weight, then go to 15% of the infant’s body weight. The formula is: Infant weight (ounces) x 0.15% (15% body weight) x 30ml. Divide by # of feeding in a 24 hour period. This formula can also be used for 20% body weight (bw), 30% bw, etc.</td>
</tr>
<tr>
<td>Bottle feeding and frequency</td>
<td>The infant is bottle-fed formula every 2 or 3 hours for approximately 3 months. If the infant becomes hungry betweenfeedings, small amounts of Pedialyte or water (about ½ the volume of the formula) should be fed. As solid foods are added, it is possible to stretch the feedings to once every 4 hours. The infant should be fed a bottle through the mesh as early as 2 months old, and mesh-feedings should be continued until the infant becomes relaxed with this method. This is the only way the infant can be fed after the introduction to the surrogate. Night bottles are discontinued before the introduction. Depending on the age of the infant, gorilla keepers may stay to give an evening bottle after the introduction. Formula should be the basis</td>
</tr>
</tbody>
</table>
of the diet for the first 12 months, but the infant should be given solids foods as soon as teeth erupt and interest is shown.

### Solid foods

Having food around to be smelled and touched, even if not eaten, is part of a learning process. Before solid foods are offered, let the infant observe the keeper eating. The infant can smell the food and the keeper’s breath to inspire his curiosity. Solids foods are offered when interest is shown and teeth begin to erupt. The first solid items are large pieces of raw carrot and celery for teething, but infants should be watched for choking. Solids may be cooked to soften food and put into small bites (1-2g for easier chewing). No baby food or baby cereal should be offered as this prolongs the introduction process. Food items offered to the infant should be the same as the adult diet. Offer vegetables before fruits, as fruit is a favorite item and easily consumed. A three-day time span is used with the introduction of each new food item to avoid allergic reactions. Always use gorilla food vocalizations while eating or feeding. Food should be placed close to the infant and also next to conspecifics in adjoining cages. The infant can watch the gorillas eat and listen to them vocalize while eating near them.

---

**Human-animal interactions**: The infant is raised by a caregiver that simulates age appropriate mother rearing at all times. Eye contact, appropriate gorilla vocalizations, tactile and olfactory stimulation, locomotion, feeding, play behavior, and discipline, are all important components of the program. For the first few weeks of life, the infant should be carried constantly to provide warmth and contact. The infant should be held close to the keeper’s chest. The keeper must hold or stay in close contact with the infant while performing tasks. If anything necessitates removing the infant from the keeper’s body (diaper change, weighing etc.), the infant should be placed in a safe location on the infant’s stomach, holding a fuzzy toy or blanket. As the infant becomes older and aware of the surroundings, the infant should be given the choice to climb off and move around. Even then, the keeper should remain close through touching and voice contact. When there is a staff change, the transfer should be calm and slow. The infant will become more accepting of any new experience or situation because of close contact with the keeper. When interacting with the infant, the animal keepers should be quadrupedal as much as possible. This allows the infant an opportunity to grab the keeper’s arms or legs so they can locomote together. As the infant grows older, the infant can be carried on the keepers’ backs as they crawl around. Constant contact without a barrier between a keeper and the infant occurs from the day the infant is pulled to the day it is introduced to a surrogate. Never being alone gives the infant a sense of security. It does not instill a bond with a keeper as much as it does a bond to the comfort and attention.

**Criteria for an early introduction**: Staff should agree on readiness of the surrogate and infant. As time passes, a female may spend more time and often displace other females from sitting near the infant, or it may be more subtle and the female may watch from afar. This is called “gorilla choice”. It is helpful in the selection of the surrogate. Once the surrogate is chosen she should be placed
on birth control if she is not post-reproductive. A surrogate must be able to focus on the young gorilla, not a possible mate. An adult male gorilla might also be considered to be a surrogate in the correct circumstances.

Ideally the infant and surrogate have established a comfortable bond. The infant feels secure beside the surrogate. The surrogate reacts if the infant shows distress. The surrogate has to allow the infant to receive nourishment. Cooperative feeding may exist. Either the infant is mobile and comes to the bottle, or the surrogate brings the infant to the bottle.

An introduction should not proceed with a potential surrogate that displays aggression. If affiliative behaviors are not observed, contact the hand-rearing, surrogate team of the AZA Ape TAG for possible relocation of the infant. Have a pre-introduction health assessment on the infant and adult by the vet staff. Prepare for a “Plan B” if possible. This involves having an alternative surrogate if the introduction does not go as expected.

**Introduction of infant to surrogate:** The following introduction protocol (Table 9) is based on introducing a 5-month-old hand-reared gorilla to a surrogate animal.

Table 9: Description of introduction protocols on the day of introduction, and after the introduction has been completed

<table>
<thead>
<tr>
<th>Time</th>
<th>Introduction protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction day</td>
<td></td>
</tr>
<tr>
<td>- Daily routine for feeding and cleaning is normal.</td>
<td></td>
</tr>
<tr>
<td>- Surrogate is separated from the group, and placed in an area next to the infant.</td>
<td></td>
</tr>
<tr>
<td>- Keep observers to a minimum (remote cameras can be used to facilitate observations).</td>
<td></td>
</tr>
<tr>
<td>- While the infant is offered a bottle through the mesh, the hand-rearing keeper attending the infant leaves quietly.</td>
<td></td>
</tr>
<tr>
<td>- The door is opened for the surrogate to enter.</td>
<td></td>
</tr>
<tr>
<td>- Be patient. Surrogate and infant will determine contact time. There may be variations in care from a surrogate that may affect the timing.</td>
<td></td>
</tr>
<tr>
<td>- In a successful introduction, surrogate and infant are never separated.</td>
<td></td>
</tr>
<tr>
<td>- Allow time for a strong bond to develop between surrogate and infant before integrating other group members. Infant or surrogate should seek each other in times of stress. Infant and surrogate should sleep, play, transfer, and rest together. Observation datasheets are available from the AZA Ape TAG Hand Rearing Sub-committee that allow for detailed, quantifiable recording of surrogate-infant behavior.</td>
<td></td>
</tr>
<tr>
<td>- Carefully select which group member(s) will be introduced next, and allow time to adjust and solidify a level of comfort before integration of more group members. This should be the animal that the surrogate</td>
<td></td>
</tr>
</tbody>
</table>
is most comfortable with, and may be a silverback.

- Once the silverback and all group members are spending 24 hours a day together, the introduction is considered complete.

After the introduction

Once the infant is introduced, it is important for the infant to stay on schedule. A daily visual inspection is necessary to determine the infant’s physical appearance and demeanor, food intake, stool and urine output, behaviors and bonding with the surrogate. In this scenario the surrogate is taking care of the psychological needs and some of the physical needs. The human caregiver is responsible for feeding the infant formula and solid foods. The infant is never taken from the surrogate, but fed through the mesh.

- 6 months: Infant is offered approximately ¼ of the adult diet throughout the day.
- 1 year: Formula, which is given 3 times a day, is gradually changed to whole milk as long as the infant can handle cow’s milk.
- 3 years: Bottles are decreased to 2 times a day
- 4 years: Infant is given 1 bottle a day
- 5 years: Infant is weaned. Hydration is important. Juices are offered and water is always available.


4.6. Recommend means and duration of contraception for taxon; include all acceptable alternatives and identify the benefits and drawbacks of each

The three general approaches to prevent reproduction are: 1) separation of the sexes, 2) reversible contraception, and 3) permanent sterilization. Since gorillas are a social species, separation of the sexes for contraception is not generally recommended. The following information summarizes reversible contraception and permanent sterilization methods for gorillas. More details on products, application, and ordering information can be found on the AZA Wildlife Contraception Center (WCC) webpage: [www.stlzoo.org/contraception](http://www.stlzoo.org/contraception).

Reversible contraception (females): 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 gorilla.

- **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. To date, consumption of birth control pills has not been reported to be problematic in gorillas. Table 10 presents a list of birth control pill brands reported to the WCC that have been used in gorillas. In animals that are lactating, a progestin-only birth control pill is recommended until the infant is 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 continuous use is available (Seasonale, Duramed Pharmaceuticals, Inc.) or Lybrel (Wyeth Pharmaceuticals, Inc.) for a full year.

- **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. 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 two 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 2.5-5mg/kg body weight every 2-3 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.

- **Norplant®**: Norplant® is no longer being manufactured for sale in the U.S.

- **Gonadotropin Releasing Hormone (GnRH) Agonists**: GnRH agonists, such as Suprelorin® (deslorelin) implants or Lupron®, reversibly suppress 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 treatment with a progestin or birth control pills for 2-3 weeks.

- **Porcine Zona Pellucida Vaccine (PZP):** The immunocontraceptive porcine zona pellucida vaccine has not been shown to be reliably contraceptive or reversible in primates, and so is not currently recommended.

**Administration, side-effects, and reversibility:** Progestins, but not combination birth-control pills, are safe to use during lactation, and are probably also safe during pregnancy. GnRH agonists should not affect lactation once it is well established, and they are not likely to affect pregnancy. Neither the synthetic progestins nor the GnRH agonists have been tested in pre-pubertal gorillas. However, future reproduction was not affected in domestic cattle (MGA) or domestic cats (GnRH agonist), so they may be safe in other species as well.

Weight gain is a common side effect associated with synthetic progestins and GnRH agonists, but less so with combination birth-control pills. Because obesity can have serious health consequences, weight should be carefully monitored and diet managed as necessary.

Extensive data from humans, and the limited data from the WCC Contraception Database, indicate that birth-control pills and the synthetic progestin products should be reversible in gorillas. Although the GnRH agonists (Suprelorin and Lupron) are reversible, reversal time cannot be easily controlled, since the implant is difficult to remove and the injection cannot be withdrawn. 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.

**Table 10. Birth control methods used in female gorillas reported to the WCC.**

<table>
<thead>
<tr>
<th>Female</th>
<th>Method</th>
<th>Completed bout</th>
<th>Ongoing bout</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ovrette*</td>
<td>11 mo</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Lo-Ovral 28*</td>
<td>40 mo</td>
<td>-</td>
<td>Used for behavioral reasons, not contraception; female never reproduced</td>
</tr>
<tr>
<td>3</td>
<td>Ortho-Novum1/50*</td>
<td>-</td>
<td>34 mo</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Demulen*</td>
<td>1 mo</td>
<td>-</td>
<td>Used to regulate cycle</td>
</tr>
<tr>
<td>4</td>
<td>Demulen*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Demulen*</td>
<td>1 mo</td>
<td>-</td>
<td>Used to regulate cycle</td>
</tr>
<tr>
<td>6</td>
<td>Ortho-Novum 1/50*</td>
<td>16 mo</td>
<td>-</td>
<td>To prevent reproduction</td>
</tr>
</tbody>
</table>
**Reversible contraception (males):** The following methods have not been tested in gorillas, but have been successful in other species.

- **Reversible vasectomy:** A surgical technique has recently become available for a reversible vasectomy. The open-ended vasectomy can be performed by any veterinarian, and Dr. Sherman Silber, St. Luke’s Medical Center in St. Louis, MO, offers to perform the micro-surgical reversal. Arrangements can be made through the WCC. Dr. Silber’s success rate with humans is near 80% if sperm is detectable in the vas fluid (Silber 1989).

- **GnRH Agonists:** The GnRH agonists, such as Suprelorin\(^\text{®}\) (deslorelin) and Lupron\(^\text{®}\), can be effective in males as well as females, but male primates appear to require a much higher dosage than females, based on WCC experience with lion-tailed macaques and mandrills. The GnRH agonists may also be effective in reducing aggression in bachelor male groups. Although not tested yet with gorillas, deslorelin has successfully controlled aggressive interactions in multi-male groups of lion-tailed macaques and mandrills.

**Permanent sterilization (males & females):** Permanent sterilization of gorillas must be based on specific recommendations from the AZA Gorilla SSP. Table 11 lists permanent contraception possibilities for gorillas.

### Table 11: Permanent contraception methods for gorillas.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castration (male)</td>
<td>Surgical removal of testes that also removes source of testosterone</td>
<td>Behavioral effects will be partially dependent on the age at which the male is castrated.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Description</td>
<td>Outcome</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Vasectomy (male)</td>
<td>Permanent chemical or surgical procedure that spares testosterone production</td>
<td>Normal male behavior, including breeding behavior, is not affected.</td>
</tr>
<tr>
<td>Tubal Ligation (female)</td>
<td>Surgical blockage of the oviducts prevents fertilization, but spares production of the ovarian steroids</td>
<td>Females will continue to exhibit normal menstrual cycles &amp; associated sexual behavior.</td>
</tr>
<tr>
<td>Hysterectomy (female)</td>
<td>Surgical removal of the uterus but no ovaries</td>
<td>Females will not menstruate but should exhibit normal sexual behavior.</td>
</tr>
<tr>
<td>Ovariohysterectomy (female)</td>
<td>Surgical removal of the uterus and the ovaries.</td>
<td>Females will not menstruate and may not exhibit sexual behavior.</td>
</tr>
</tbody>
</table>
5. Behavior management

5.1. Identify procedures that have been successful in managing the taxon for routine husbandry.

In an effort to create consistent animal training programs, the AZA has adopted the SPIDER process or framework for animal care professionals to develop, initiate and maintain enrichment and training programs at their institutions (SPIDER is an acronym of the first letters of each of the framework components). The components of this framework are setting goals, planning, implementing, documenting, evaluating, and re-adjusting desired programmatic and behavioral goals. The framework helps provide structure to the behavioral management program, and is taught as part of an AZA course, Managing Animal Enrichment and Training Programs (see the AZA website for further details – www.aza.org).

It is recommended that gorillas be involved in a positive reinforcement training program to assist in the daily management and care of these animals. Mellen and Sevenich MacPhee (2001) recommended implementing an inclusive program that focuses on safety, staff training, and an integrated approach to training as an animal management tool.

Behaviors to be trained should be prioritized based on the goals of the animal care, veterinary, and research teams. Priority behavior to train as part of a behavioral management program include: having gorillas shift from one room or area to another, sit at a station, and target to an object. After these behaviors are established additional behaviors can be added. It is important to realize that gorillas can be trained for a number of behaviors that can facilitate veterinary medicine and research. For example, behaviors which facilitate the inspection of body parts for wound treatment and administration of medications can aid health management, while training can also facilitate urine collection and artificial insemination procedures.

The following trained behaviors are recommended for all gorillas, as these can be used as the basis of a training program, and as integral components of many husbandry and veterinary procedures:

- Target (see section 5.5.) - Hold
- Come here - Give
- Stand - Retrieve
- Sit - Shift

More information: For more information on the development of a positive reinforcement training program involving gorillas, see the ‘Implementation of Positive Reinforcement Training’ subsection in ‘The Management of Gorillas in Captivity’ (Ogden & Wharton 1997), as well as other materials on the development of training programs (e.g., Mellen & Sevenich MacPhee 2001; Colahan & Breder 2003).
5.2. Identify procedures that have been successful in managing the taxon for non-routine husbandry.

Gorillas have been trained to open their mouths, show their hands and feet, allow tympanic temperature to be taken, and present various body parts for inspection. Some institutions have been successful at training gorillas to accept injections or oral birth control pills.

**Infant care:** Infant care training is a priority for animals that are first time mothers, or that have a history of poor maternal care. Infant assessment and supplementation are the primary goals, with the ultimate goal being to keep the infant with its social group. Training includes desensitizing the pregnant female to a variety of objects such as bottles, cooperative feeding, as well as training the female to pick up an object and bring it to the front of the enclosure. The goal is to establish an infant care training program that will take into account the individual animal’s particular deficiencies in maternal care (Philipp et al. 2001; Richards et al. 2001). Suggested primary training goals for pregnant females are:

- **Separation:** In case temporary removal from the group is required or a closer assessment of the infant is needed;
- **Pick up object:** To develop the behavior of picking up her offspring if she should place it on the ground;
- **Pick up object and present the object at the mesh:** To develop the behavior of allowing the animal care staff to get a close visual inspection of the infant to assess health status;
- **Pick up object and hold ventrally:** To develop the behavior which encourages the female to place the infant in a proper nursing position;
- **Breast manipulation:** To allow animal care staff to assess if the female is lactating, and desensitize the breast to a nursing infant;
- **Appropriate hold:** Bridge and reward the female for holding the infant appropriately.

Soon after birth, a training program is suggested for the infant to complement the female’s training, as well as to assist with the medical needs of the infant. Although the specific behaviors of this program require the infant’s participation, it is critical that the female allow her infant to be interactive with animal care staff. Suggested primary training goals for infants are:

- **Station:** Once the infant is mobile, the infant comes to the front of the holding area where the trainer is to participate in the session;
- **Body part presentations:** These can be prioritized based on medical needs;
- **Separation:** Infant can be separated from the female if needed for medical care;
- **Administering oral medication:** Infant takes liquid from a syringe, such as oral polio vaccine or cold medicine;
- **Bottle feeding:** Infant can be fed without removing it from the female;
- **Injections**: Infant positions body part for injections, such as pediatric vaccine series.

  See sections 4.4 and 4.5 for further details around birth management in captive gorillas.

**Training for veterinary care**: It is recommended that animal care staff work with their veterinarians to discuss priority medical behaviors to be trained. These include behaviors that will facilitate immobilizations such as injection or an “open mouth” behavior for an oral anesthetic agent. Both of these behaviors are also useful in administering medications. Additional training can help avoid immobilizations in many cases. Presentation of body parts, desensitization to medical instruments and treatments often allow the veterinarian to assess the gorilla without immobilizing. Integrating veterinarians into the training program is an important factor in successfully training medical behaviors. While this requires an additional time commitment from them, the veterinarians and technicians can better assess the animals when the animals no longer react to them negatively and the animal care team benefits from the feedback the veterinarians can provide on some topics, i.e. injection techniques (Siever et al. 2001).

  Individual animals with specific medical concerns may require additional behaviors to be trained (Colahan et al. 2001). Ultrasound training is a priority for pregnant animals, as well as individuals with other medical conditions. Gorillas requiring regular medication should receive additional focus on injection or open mouth behaviors. Unforeseen injuries may also create new training priorities, such as a gorilla with an injured hand that may be trained to position for a portable x-ray machine, avoiding additional immobilizations via anesthesia.

5.3. Identify procedures that have been successful in facilitating introductions. These may include separation of individuals from group, stationing, tolerance while feeding, “howdy” units, visitation gates, etc.

  Shifting, stationing, and targeting are basic husbandry behaviors (see section 5.2) that can be utilized in facilitating the successful introduction of new group members. The ability to reliably move an animal between rooms or exhibit features allows more freedom in preparing introduction situations. Additionally, the ability to station or target an animal in an area can be used to build tolerance during feeding, and allow for other group members to be trained without physically separating all group members. These basic behaviors provide flexibility in management and the number of situations in which they can be applied is almost limitless. As such, these behaviors should be training priorities in any training program.

5.4. Identify facility design considerations, husbandry training techniques, and implementation plan that can be used to elicit desired behaviors in a way that is safe for both caretakers and animals.

  Consideration for training opportunities should be designed into all facilities. Laule (1995) recommends the following components:
- Good visual access for keepers to animals
- Multiple access points for interaction
- Built-in mounts for husbandry apparatus
- Good lighting
- Multiple and connected off-exhibit spaces with no dead ends for enhancing introductions and supporting easy separation of socially housed animals.

5.5. Identify those techniques that have been shown to be most effective.

**Targeting**: Any object used to focus attention or lead an animal to a specific behavior is known as a ‘target’. After training an animal to touch an object for reinforcement, using targets can be an effective, timesaving way to train an animal to hold a position at a station, to allow keepers access to a body part, or to encourage an animal to perform a specific motion.

5.6. Identify technical skills and competencies needed by staff

The most effective caregivers have earned the trust and acceptance of the gorillas in their care through patience, compassion, and consistency. Knowledge and understanding of the natural history of gorillas, as well as each animal’s individual history, is mandatory. Keen powers of observation are also necessary to detect both medical problems and even slight changes in individual behavior or group social dynamics.

5.7. Appropriate methods of enrichment for the taxon should be identified if not included in categories 1-3 above.

Environmental enrichment has been defined as a husbandry principle that seeks to enhance animal care by providing stimuli necessary for optimal psychological and physiological well-being (Shepherdson 1998). Through the use of environmental enrichment, the concepts of variability, choice, and environmental control must be maximized within great ape facilities. Environmental enrichment for gorillas covers a wide variety of topics, which can be broken down into two broad categories:

- **Social**: relationships with other gorillas, relationships with caretakers.
- **Physical**: living space, diet, browse, substrate, and manipulable, nonfood objects.

Environmental enrichment is truly effective when it increases the choices available for individuals (Shumaker 1989), and includes diversity and change. The amount of control that an individual animal is able to exercise over its environment, both social and physical, is directly proportional to the number of behavioral choices that it can utilize within it environment. Individuals that possess a sense of control based on positive, species-typical activities are more behaviorally competent than those that do not (Markowitz 1982; Novak & Suomi 1988; Novak & Drewson 1989). In a social setting, enrichment is a powerful force to give each member of a group the maximum amount of choice, and therefore control, possible. Appropriate enrichment techniques can serve as the
social catalyst that promotes positive and constructive interactions between individuals.

Built-in opportunities for the animals to change lighting levels, vary light intensity or color and activate "basking lights," activate fans, etc., as well as foraging, feeding and watering devices, need to be integrated into any overall plan for exhibit construction/renovation.

In an effort to create consistent enrichment programs, AZA has recommended the SPIDER framework (see section 5.1) to develop, initiate, and maintain these programs at their institutions. More information on how the framework can be applied to environmental enrichment can be found at www.animalenrichment.org.

Evaluating enrichment effectiveness: Evaluation of the effectiveness of environmental enrichment (i.e., effect on psychological well-being) is a very complex task. Several general measures of psychological well-being are often suggested, including an increase in species-typical behaviors, an increase in activity levels, a decrease in abnormal or undesirable behaviors, an increase in behavioral competence, and a decrease in “stress” hormones (e.g., Novak & Suomi 1988; Novak & Drewson 1989; Clark et al. 1997).

The SPIDER model helps to make evaluating enrichment easier by clearly defining the goals of the enrichment prior to implementation. In this model, vague goals such as “increased welfare” are avoided and specific measurable actions are provided. The importance of this model lies in the development of specific, measurable goals to be achieved by the enrichment. It is important to note that the secondary question of the welfare impact of the enrichment item is much more complicated to assess (see Barber & Mellen, in press, for a discussion of the challenges of assessing animal welfare).
6. Documentation

References:


Coe, J.C., Scott, D., & Lukas, K.E. (Submitted). Facility design for captive bachelor gorillas.


Murphy 2005 [reference to be added]


Seier et al 2005 [reference to be added]


**Personal communications:**

Bruner

Carpanzano
Czekala, Nancy: San Diego Zoo

Kearns, K

McManamon, Rita: Veterinarian, University of Georgia

Meehan, Tom: Veterinary Advisor (AZA Gorilla SSP), Brookfield Zoo

Ogden, Jackie: Disney’s Animal Kingdom
# APPENDIX A

## Browse list

The following were taken from the 1998 Association of Zoological Horticulture Animal Browse Survey and browse lists at the Columbus Zoo, the Louisville Zoo, the San Francisco Zoo, and the National Zoo. This list should not be taken as exhaustive. It is recommended that institutions consult with their veterinary services and/or animal nutrition team before beginning the use of any of these browse items.

<table>
<thead>
<tr>
<th>Acacia (Acacia spp.)</th>
<th>Elaeagnus (Elaeagnus spp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Olive (Olea africana)</td>
<td>Elm (Ulmus spp.)</td>
</tr>
<tr>
<td>Alder (Alnus spp.)</td>
<td>Escallonia (Escallonia spp.)</td>
</tr>
<tr>
<td>Alfalfa (Medicago sativa)</td>
<td>Eucalyptus (Eucalyptus spp.)</td>
</tr>
<tr>
<td>Amelanchier/shadbush (Amelanchier spp.)</td>
<td>Eugenia (Eugenia spp.)</td>
</tr>
<tr>
<td>American Beech (Fagus grandifolia)</td>
<td>Fig (Ficus spp.) - not lyrata</td>
</tr>
<tr>
<td>Apple (Malus spp.)</td>
<td>Forsythia (Forsythia spp.)</td>
</tr>
<tr>
<td>Aralia (Polyscias balfouriana marginai)</td>
<td>Fragrant honeysuckle (Viburnum spp.)</td>
</tr>
<tr>
<td>Arborvitae (Thuja spp.)</td>
<td>Giant Reed Grass (Arundo donax)</td>
</tr>
<tr>
<td>Artillery plant (Pilea microphylla)</td>
<td>Gloxinia (Sinningia spp.)</td>
</tr>
<tr>
<td>Ash (Fraxinus spp.)</td>
<td>Grapevine (Vitis spp.)</td>
</tr>
<tr>
<td>Aspen/Poplar/Cottonwood (Populus spp.)</td>
<td>Grass/Bamboo family (Graminae spp.)</td>
</tr>
<tr>
<td>Bamboo (multiple genus/species)</td>
<td>Greenbrier (Smilax spp.)</td>
</tr>
<tr>
<td>Banana/Plantain (Musa spp.)</td>
<td>Hackberry (Celtis spp.)</td>
</tr>
<tr>
<td>Barberry (Berberis spp.)</td>
<td>Hawthorn (Crataegus spp.)</td>
</tr>
<tr>
<td>Bean foliage (Vicia spp.)</td>
<td>Hazelnut/Filbert (Corylus spp.)</td>
</tr>
<tr>
<td>Beech (Fagus spp.)</td>
<td>Hibiscus (Hibiscus spp.)</td>
</tr>
<tr>
<td>Birch (Betula spp.)</td>
<td>Hickory (Carya spp.)</td>
</tr>
<tr>
<td>Blackberry (Rubus spp.)</td>
<td>Himalayan Honeysuckle (Leycesteria formosa)</td>
</tr>
<tr>
<td>Black Fern Tree (Cytisus medlarisis)</td>
<td>Honey Locust (Gleditsia spp.)</td>
</tr>
<tr>
<td>Black willow (Salix nigra)</td>
<td>Hornbeam/Ironwood (Carpinus caroliniana)</td>
</tr>
<tr>
<td>Burmese Rosewood (Pterocarpus indicus)</td>
<td>Horse Tamarins (Leucocarpa glauca)</td>
</tr>
<tr>
<td>Bush Honeysuckle (Lonicera spp.)</td>
<td>Iceplant (Mesembryanthemum crystallinum)</td>
</tr>
<tr>
<td>Butterfly bush (Buddleia spp.)</td>
<td>Jade plant (Crassula argentea)</td>
</tr>
<tr>
<td>Canna (Cannas spp.)</td>
<td>Japanese Blueberry (Eleocarpus spp.)</td>
</tr>
<tr>
<td>Cardoon (Cynara cardunculus)</td>
<td>Japanese Silver Grass (Miscanthus spp.)</td>
</tr>
<tr>
<td>Carob Tree (Ceratonia siliqua)</td>
<td>Japanese Zelkova (Zelkova serrata)</td>
</tr>
<tr>
<td>Catalpa (Catalpa speciosa)</td>
<td>Kaffir Plum (Harcephyllum carrum)</td>
</tr>
<tr>
<td>Cattails (Typha spp.)</td>
<td>Karo/Lemonwood/Kohuhu (Pittosporum spp.)</td>
</tr>
<tr>
<td>Chicory (Cichorium intybus)</td>
<td>Kerria (Kerria spp.)</td>
</tr>
<tr>
<td>Coffee plant (Coffee arabica)</td>
<td>Kudzu (Pueraria lobata)</td>
</tr>
<tr>
<td>Coleus (Coleus spp.)</td>
<td>Lindenwood/Basswood (Tilia spp.)</td>
</tr>
<tr>
<td>Comfrey (Symphytum spp.)</td>
<td>Loquat (Eriobotra japonica)</td>
</tr>
<tr>
<td>Corn plant (Dracaena fragrans massangeana)</td>
<td>Magnolia (Magnolia spp.)</td>
</tr>
<tr>
<td>Coprosma (Coprosmula)</td>
<td>Mahonia (Mahonia spp.)</td>
</tr>
<tr>
<td>Cotoneaster (Cotoneaster spp.)</td>
<td>Maple (Acer spp.), not red or silver maple</td>
</tr>
<tr>
<td>Crabapple (Malus spp.)</td>
<td>Mesquite (Prosopis spp.)</td>
</tr>
<tr>
<td>Dandelion (Taraxacum officinale)</td>
<td>Mock orange (Philadelphus spp.)</td>
</tr>
<tr>
<td>Daylily (Hemerocallis spp.)</td>
<td>Monkey Apple (Acmena smithii)</td>
</tr>
<tr>
<td>Dogwoods (Cornus spp.)</td>
<td>Mulberry (Morus spp.)</td>
</tr>
<tr>
<td>Dragon tree (Dracaena draco)</td>
<td>Nasturtium (Nasturtium spp.)</td>
</tr>
<tr>
<td>Dwarf rose (Cryptanthus roseus pictus)</td>
<td>Oak (Quercus spp.)</td>
</tr>
</tbody>
</table>
Mahonias (*Mahonia* spp.)
Palms (*Palmae family*)
Papyrus (*Cyperus papyrus*)
Passion Vine (*Passiflora jamesonii*)
Pear (*Pyrus* spp.)
Peperomia (*Peperomia* spp.)
Photinia (*Photinia* spp.)
Pickerelweed (*Pontederia cordata*)
Pineapple Guava (*Feijoa sellowiona*)
Poplar (*Populus* spp.)
Primrose (*Primula* spp.)
Puka (*Meryta sinclairii*)
Purslane (*Portulaca oleracea*)
Queensland Itch Tree (*Davidsonia pruriens*)
Rain Tree (*Koelruteria* spp.)
Raspberry/Blackberry (*Rubus* spp.)
Redbud (*Cercis canadensis*)
Rose (*Rosa* spp.)
Rose Apple (*Syzygium jambos*)
Rosewood (*Tipuana tipu*)
Saltbush (*Atriplex polycarpa*)
Sassafras (*Sassafras albidum*)

Shield Ferns (*Polystichum* spp.)
Sorghum (*Sorghum* spp.)
Spineless Cactus Pad (*Opuntia* spp.)
Sugarcane (*Saccharum officinarum*)
Sunflower (*Helianthus* spp.)
Sweet Corn (*Zea mays*)
Sweetgum (*Liquidambar styraciflua*)
Sycamore (*Platanus occidentalis*)
Timothy Hay (*Phleum pretense*)
Tree Lucerne (*Tagasaste* spp.)
Tulip Tree (*Liriodendron tulipifera*)
Umbrella Grass (*Cyperus alternifolius*)
Viburnum (*Viburnum* spp.)
Violet (*Viola* spp.)
Water Hyacinth (*Eichornia* spp.)
Wax Myrtle/Bayberry (*Myrica* spp.)
Weeping fig (*Ficus benjamina*)
Weeping Lilly Pilly (*Waterhousea floribunda*)
White Rockrose (*Cistus salvifolius*)
Willow (*Salix* spp.)
Xylosma (*Xylosma congestum*)
Zinnia (*Zinnia* spp.)
**APPENDIX B**

Institutions that have successfully housed gorillas with other primate species

<table>
<thead>
<tr>
<th>Institution</th>
<th>City, state, country</th>
<th>Primate species</th>
<th>Historic or current</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apenheul Primate Park</td>
<td>7300 AB Apeldoorn, Gelderland, Netherlands</td>
<td>Patas monkeys (<em>Erythrocebus patas</em>)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>Artis Zoo</td>
<td>Amsterdam, Netherlands</td>
<td>Sykes guenons (<em>Cercopithecus albogularis</em>)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>Bristol Zoo</td>
<td>Bristol, England, UK</td>
<td>DeBrazza's monkeys (<em>Cercopithecus neglectus</em>)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>Brookfield Zoo</td>
<td>Chicago, Illinois, USA</td>
<td>Sykes guenons (<em>Cercopithecus albogularis</em>)</td>
<td>Current</td>
<td>Guenon group lived with solitarily housed adult female gorilla</td>
</tr>
<tr>
<td>Calgary Zoo</td>
<td>Calgary, Alberta, Canada</td>
<td>Guerezas (<em>Colobus guereza</em>)</td>
<td>Current</td>
<td>Indoors only</td>
</tr>
<tr>
<td>Cologne Zoo</td>
<td>Koln, N Rhine-Westph, Germany</td>
<td>Guerezas (<em>Colobus guereza</em>)</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>Detroit Zoo</td>
<td>Detroit, Michigan, USA</td>
<td>Diana monkeys (<em>Cercopithecus diana</em>), mandrills (<em>Mandillus sphinx</em>)</td>
<td>Current</td>
<td>0.2 mandrills &amp; 1.1 dianas live with 1.1 adult gorillas</td>
</tr>
<tr>
<td>Edinburgh Zoo/Scottish National Zoo</td>
<td>Edinburgh, Scotland, UK</td>
<td>Diana monkeys (<em>Cercopithecus diana</em>)</td>
<td>Historic</td>
<td>-</td>
</tr>
<tr>
<td>Espace Zoologique de St-Martin-la-Plai</td>
<td>42800 Rive-de-Gier, France</td>
<td>Guerezas (<em>Colobus guereza</em>), Roloway monkeys (<em>Cercopithecus diana roloway</em>), redtail guenons (<em>Cercopithecus ascanius ascanius</em>)</td>
<td>Current</td>
<td>One gorilla male w/ colobus, one gorilla male w/ roloway monkeys, &amp; two gorilla groups w/red-tailed monkeys</td>
</tr>
<tr>
<td>Fuengirola Zoo (Rain Forest SL)</td>
<td>Madrid, Malaga, Spain</td>
<td>Greater spot-nosed guenons (<em>Cercopithecus nictitans</em>)</td>
<td>?</td>
<td>-</td>
</tr>
<tr>
<td>GaiaPark/Kerkrade Zoo</td>
<td>Kerkrade, Limburg, Netherlands</td>
<td>Black mangabey (<em>Lophocebus albigena</em>)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>Granby Zoo</td>
<td>Granby, Quebec, Canada</td>
<td>Diana monkeys (<em>Cercopithecus diana</em>), guerezas (<em>Colobus guereza</em>)</td>
<td>Historic (dianas) &amp; current</td>
<td>Two silverbacks are currently housed with four guerezas</td>
</tr>
<tr>
<td>Gulf Breeze Zoo</td>
<td>Gulf Breeze, Florida, USA</td>
<td>Guerezas (<em>Colobus guereza</em>)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>Institution</td>
<td>City, state, country</td>
<td>Primate species</td>
<td>Historic or current</td>
<td>Comments</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Henry Doorly Zoo</td>
<td>Omaha, Nebraska, USA</td>
<td>Diana monkeys (Cercopithecus diana), DeBrazza's monkeys (Cercopithecus neglectus)</td>
<td>Current</td>
<td>All three species together</td>
</tr>
<tr>
<td>Houston Zoo</td>
<td>Houston, Texas, USA</td>
<td>Lowe's guenons (Cercopithecus campbelli lowei)</td>
<td>Historic</td>
<td>Guenon group lived with solitary housed silverback</td>
</tr>
<tr>
<td>Howlett's Wild Animal Park</td>
<td>Hythe, Kent, England, UK</td>
<td>Lesser spot-nosed guenons (Cercopithecus petaurista)</td>
<td>Current</td>
<td>1.1 non-breeding pair of monkeys with an 11-gorilla group (monkeys with accessible creep area)</td>
</tr>
<tr>
<td>Kolmarden Djurpark AB</td>
<td>Kolmarden, Norrkoping, Sweden</td>
<td>Guerezas (Colobus guereza)</td>
<td>Current</td>
<td>-</td>
</tr>
<tr>
<td>La Vallee des Singes</td>
<td>Romagne, France</td>
<td>Schmidt's guenons (Cercopithecus ascanius schmidti), guerezas (Colobus guereza)</td>
<td>Current</td>
<td>All three species together</td>
</tr>
<tr>
<td>Louisville Zoo</td>
<td>Louisville, Kentucky, USA</td>
<td>Patas monkeys (Erythrocebus patas)</td>
<td>Current</td>
<td>0.3 patas live with 0.2 older gorillas (monkeys with accessible creep)</td>
</tr>
<tr>
<td>National Zoo</td>
<td>Washington DC, USA</td>
<td>Guerezas (Colobus guereza)</td>
<td>Historic</td>
<td>-</td>
</tr>
<tr>
<td>Riverbanks Zoo</td>
<td>Columbia, South Carolina, USA</td>
<td>DeBrazza's monkeys (Cercopithecus neglectus)</td>
<td>Current</td>
<td>Outdoors only</td>
</tr>
<tr>
<td>Touroparc</td>
<td>71570 Romaneche-Thorins, France</td>
<td>DeBrazza's monkeys (Cercopithecus neglectus), drills (Mandrillus leucophaeus)</td>
<td>Historic</td>
<td>Gorilla pair lived with two female drills and a DeBrazza's</td>
</tr>
<tr>
<td>Zoo Duisburg AG</td>
<td>Duisburg, N Rhine-Westph, Germany</td>
<td>DeBrazza's monkeys (Cercopithecus neglectus)</td>
<td>Current?</td>
<td>-</td>
</tr>
<tr>
<td>Zoo Parc de Beauval</td>
<td>4110 St Aignan, Cher, France</td>
<td>Patas monkeys (Erythrocebus patas)</td>
<td>Current</td>
<td>-</td>
</tr>
</tbody>
</table>
Standardized Animal Care Guidelines for Gorillas

SG draft review checklist

SG facilitator review: Completed by Joseph Barber (4 May 2006)

Contraception Advisory Group notified about completed 1st draft: 16 March 2007

Internal review: Completed by Gorilla SSP Management Group and Advisors (6 January 2008)

- Nutritionist: Ellen Dierenfeld (Jul 2006)
- Veterinarian: Tom Meehan (Feb 2007)
- Other TAG/SSP members: Kristen Lukas & Sylvia Atsalis (Mar 2007)
- ApeTAG Hand Rearing Subcommittee: Dusty Lombardi et al. (Jun 2007)
- Contraception and Reproduction Advisors: Sally Boutelle and Naida Loskutoff (Aug 2007)
- Nutrition Advisors: Debra Schmidt, & Michelle Shaw (Aug 2007)
- Veterinary Advisory Team: (Sep 2007)
- Gorilla Behavior Advisory Group: Chris Kuhar, Roby Elsner Sue Margulis, Jeannine Jackle, Christine Mazzela, (Sep 2007)

External review:

- Reviewer 1:

- Reviewer 2:

- Optional additional reviewers:

Final draft received by Animal Welfare Committee: