HUSBANDRY GUIDELINES FOR THE OKAPI SSP

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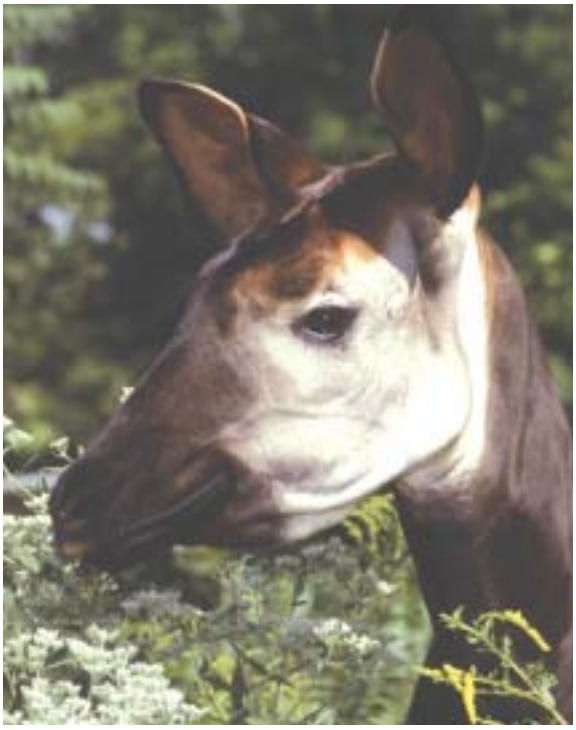
INTRODUCTION

The wild population of okapi is estimated at more than 10,000 animals in the Democratic Republic of Congo (East, 1998). Okapi are found in the rain forests of northern DRC. Their habitat is dense, damp forest. They grow to be 5 feet to 5.5 feet high at the shoulder. The males weigh 550 (249.47 kg) to 750 pounds (340.19 kg); females are larger than males. Their diet consists of 95% leaves (vines, stems, etc.). Their prehensile tongue is well adapted to plucking these items easily from branches. Okapi are in the family Giraffidae and share several characteristics with the giraffe. They possess high shoulders and sloping hindquarters, a prehensile tongue and large eyes; and the males have skin-covered horns.

Because of the remoteness of their habitat, as well as their elusive behavior, okapi were not known to science until 1900. Sir Harry Johnston set out to confirm the existence of a striped quadruped named okapi. After searching in vain for okapis, Johnston obtained the skin and two skulls of the species in March 1901. Having believed all along that he was searching for a new species of ass or zebra, Johnston was surprised, upon examining the skulls, to find that the okapi was a relative of the giraffe. He sent the material to the British Museum, where it was formally described by August 1902. The species was given the scientific name, *Okapia johnstoni*. The first live specimen reached Europe in 1918. The first okapi into the U.S. arrived at the Bronx Zoo in 1937 from the Belgian Congo (now the DRC).



Though this species reproduces relatively easily, the captive population has remained small in both the European and North American groups. The development of regional management programs has assisted with improved husbandry techniques and protocols, which in turn, have enabled the captive population to expand. Breeding units of more than a single pair has been the model in the American zoo management plan, which also strives to minimize inbreeding and maximize founder representation.

Photos:
Top: *male at Epulu in the Okapi Wildlife Reserve, 1998.*
Middle: *female at Brookfield Zoo.*
Bottom: *male at Brookfield Zoo.*

ENCLOSURE DESIGN

Ideal facility temperature is within the range of 66–78°F (19–26°C). The health and age of the animals sometimes makes the difference. Many facilities must routinely utilize some type of heating system during the colder months. In southern facilities, good ventilation in the summer months is equally important to minimize high temperatures. Though this species is not cold hardy, they can tolerate outside temperatures of 40–55°F (5–13°C) for short periods of time if given free access to a heated space. Temperatures below 40°F should be avoided unless the weather is calm, sunny and dry.

Humidity: Native to the equatorial African rainforest, okapis are accustomed to high humidity. It is beneficial to maintain 50-60% humidity indoors to minimize sinus conditions.

Illumination: Natural light intensity is more than sufficient for this forest dweller. Skylights are recommended for a portion of the space. Other areas can remain without skylights to moderate light levels. Additional artificial lighting will be needed and should be of sufficient intensity to observe all aspects of the animals and their behavior while indoors. Artificial lighting should be adjusted to match the normal day/night cycle.

Inside Facilities should be spacious. At most institutions, okapis spend more than 50% of their time on an annual basis inside, due primarily to weather concerns and to insure animal safety overnight. The design and square footage of interior space, therefore, should be given serious consideration. Optimal stall space for a single animal is 300 sq. ft. (28.1 sq. meters). Interior walls should be a minimum of 6 feet (1.83m) high. Vertical space should be high enough to allow mating to occur inside.

Outside Facilities should offer protection from strong sunlight. Shade is very important for this forest species. Calves in particular are intolerant of extreme heat and sun. The minimum area for two animals is 5412 sq. ft. (500 sq. m.). Exterior barriers 6 feet high (1.83m) will contain this species. Flight reactions are less severe and occur less frequently in enclosures, which are adequately sized and offer a good amount of cover or areas of retreat for the animals.

Photos:
Top: *inside exhibit at Brookfield.*
Middle: *keeper hallway by okapi stalls at Brookfield.*
Bottom: *exhibit yard at Oklahoma City.*

ENCLOSURE DESIGN

The location chosen for this species should consider traffic patterns and noise levels during routine operations. This shy, forest species fares better in quiet, low profile settings. Water features within the exhibit should not be deep. If animals have access to the water, easy access in and out of the stream should be provided. The streambed should also provide good traction to avoid animal injury.

Inter-individual Spaces: Okapis are not social. The most stable groups in a captive setting appear to be related females, or females who have been raised together from an early age. Multiple feeding stations should be available. Each animal should be provided with a bedded area. Males are often only with the females for mating purposes. The facility must be able to separate all individuals when necessary. An inter-individual space of 15 feet (4.6 meters) is sufficient.

Temporary Isolation: Individuals may need to be separated for a variety of reasons throughout their life. Breeding males are often maintained alone, but adjacent to the females. Females with young calves are maintained by themselves. Medical procedures require isolation to properly fast and recover the individual. Prior to shipment, individuals should be isolated to acclimate to the shipping container.

Furnishings within the space should be free from sharp objects, which might injure the animal. All items in the environment should have rounded corners/edges. Furnishings should not be placed directly in the animal's travel path or close to doorways. Placement of all furnishings should complement the layout of the overall space. Type of furnishings should not allow animals to become entangled. Visual barriers outside of the exhibit perimeter should be provided to minimize collision with the perimeter. Shade is very important for this species. Calves in particular are intolerant of extreme heat and sun. The space should be generally flat or gently sloping. Any slope should be no greater than a 3–to–1 grade. When in an excited state, okapis corner very close to objects when running, and occasionally spin in place. The design of the outside exhibit should keep these and other behaviors in mind.

Photos:
Top: *tall grasses used for cover at Brookfield.*
Middle: *planters adjacent to perimeter add security at Brookfield.*
Bottom: *calf running at Yokohama.*

Visual, Acoustic and Olfactory Barriers: The okapi's senses of smell and hearing are much keener than its vision. The most sensitive management situations include a female with a young calf, acclimation of a new individual to a facility, and an individual acclimating to isolation. Noises from mechanical equipment and small machinery should be kept to a minimum or eliminated in the immediate area. The use of a radio within the facility can be used to provide background noise and may minimize a startle response when unexpected noises occur.

Substrates and Nesting Materials: Floors should provide for good traction and abrasion for hoof wear. Additional non-slip substrate may be required prior to a birth depending on the nature of the original floor. Fine grade limestone or a very thick layer of absorbent bedding has provided good footing for newborns in facilities where the permanent floor does not provide adequate traction. This species will utilize an area of thick bedding on which to rest and as a latrine area. Wood shavings are commonly used, though other absorbent materials can be substituted. Each individual requires its own nesting area. In the outside areas, commonly traveled paths can be covered with abrasive material to promote hoof wear if needed.

Variation in the Environment: Occasionally, visual barriers may need to be installed if individuals appear to be bothered by an adjacent animal, or to give an individual more security. Hanging large branches within the space also provides "cover" in addition to being a treat to chew, strip and lick. Having multiple feeding locations and changing these locations occasionally provides an opportunity for animals to investigate the environment more thoroughly.

Photos:
Top: *bedded areas are utilized to rest on or as a latrine.*
Middle: *overhang offers security at Brookfield.*
Bottom: *hotwire product used to create exclusion areas at Oklahoma City.*

Scent Marking and Cleaning: Okapis have pedal glands and utilize scent marking to locate other okapis in the wild. In a captive setting, this should not preclude maintaining a sanitary space and cleaning on a regular schedule. Additionally, males will utilize small shrubs to mark with urine.

Air Quality: It is difficult to give a required number of air exchanges per hour since the size and design of any given facility varies. Enclosed facilities should maintain good ventilation at all times to minimize ammonia levels and to help alleviate extreme heat. Humidity levels should be monitored and maintained at a moderate level (50–60% minimum) year-round for this forest-dwelling species.

Safety and Containment: Generally, animal care staff can work in with okapis. Occasionally, a difficult individual or situation is encountered. For that reason, it is recommended that shift doors be designed to allow remote operation. Animal door openings should be 4 feet wide (1.22m) at a minimum. No severe slopes should exist in the outside exhibit space. Deep water should be avoided. It is important for this species to have visual barriers to help outline the extent of the exhibit and minimize collision with the perimeter. Six-foot (1.83m) high barriers are sufficient to contain this species. Containment can be achieved through a variety of materials. Barriers need to be free of protrusions or sharp edges that may abrade or injure an animal. Barriers can be vertical bars with spacing of about 3 inches (7.6cm.), or solid below with bars or a sturdy wire mesh above. Cables and various types of mesh fence have also been utilized. Horizontal spacing in cables should be 6 inches (15cm) for the first 3 feet (90cm) of height; after 3 feet, 8 inch (20cm) spacing can be used. If other animals will be adjacent, a barrier with a solid bottom offers more security for young calves. Hot wire should not be utilized as a primary barrier, although it has successfully been used as a secondary barrier around plants, etc.

Photos: *Oklahoma City*
Top: *shifting through doorway.*
Middle: *moving to exhibit space.*
Bottom: *remotely operated shift doors.*

TRANSPORT

All individuals should be well acclimated to the shipping container in advance of the shipping date. Type of container depends on length of travel, availability of air flights, and personality of the animal being moved. Animals should also be acclimated to the presence of animal care staff in the event that the animal needs to be observed, fed, and/or watered. Experience has shown that they do well in either a properly sized crate or a properly modified trailer. They will often browse and drink during the trip and, if given the opportunity, rest comfortably.

Type of Container: The okapi travels well in a stall of a modified horse trailer. For long, overland shipments (2-3 days), this is a good option. For short trips, a narrow crate in which the animal cannot turn around is acceptable. For international shipments or for flighty individuals, a wide crate has been successfully used and is now encouraged. This wide crate allows the animal to turn around and comfortably lie down. It is less confining and offers more opportunity for the animal to rest. In all cases, IATA regulations must be met or exceeded.

Size of Container should match that of the individual. The animal should be able to stand in a normal stance. For short trips, a crate as narrow as 24 inches (61 cm.) for adults is adequate to prevent the animal from trying to turn around. On trips of longer than 12 hours in duration, the container should allow the animal to comfortably turn around and lie down.

Food and Water during Transport: Forage should be readily available during the shipment. If possible, following the animal's normal feeding/watering schedule is recommended. Grain is not necessary or should be fed at a reduced rate (1/4 ration) during shipment. Fresh produce may be provided to encourage eating and provide moisture. Small amounts of water can be offered. Food and water containers can be removable if an attendant is present, or rubber tubs secured to the ends or corners of the container.

Bedding: A thick layer of wood shavings covered with hay is appropriate. Or a 6 inch layer of dirt/sand covered heavily with hay is acceptable. This provides good footing, absorbs moisture during transport and gives the animal a cushion on which to rest. Deep bedding also absorbs moisture and helps separate the animal from urine and feces. Additional forage added enroute further protects the animal from its wastes. Bedding cannot be changed while enroute.

Photos:
Top: *crate training at Brookfield.*
Bottom: *food rewards and keeper encouragement are useful tools when training. Bronx.*

Appropriate Temperature Range: Temperatures should be maintained within the normal husbandry range for this species. Supplemental heat should be provided if the temperature falls below 55°F (13°C) and cooling should be provided if the temperature rises above 85°F (29.4°C). Increased ventilation may meet the need for cooling, especially during a truck transport.

Mitigation of Light and Noise: Trailers and crates should be constructed to minimize strong light and direct views. When crated animals are waiting to be loaded onto a transport vehicle, they should be placed in a location as remote from the hustle and bustle of the terminal as possible. An attendant should remain with the crate to assure disturbance is minimized. A radio may be utilized to mitigate unusual noises, which cannot be eliminated.

Group Size: Okapis are solitary and should be transported separately.

Access during Transport: Access to the animal during transport is limited to visual/tactile access through the established ports in the container. It is not possible to enter the container with the animal. The animal should not be removed from its container unless it can be contained in another acceptable area and extreme circumstances prevail.

Transport time: Routes and schedules should be predetermined and reviewed to minimize the length of the trip as much as possible. If an animal is acclimated and in a spacious container, lengthy trips are feasible with no apparent ill effects.

Timing of Release: Size and Type of Enclosure at Destination: It is preferable to release an animal into an interior space where locomotion, light, and visibility can be controlled.The animal care staff routine should be instituted immediately to assist the animal in acclimation to its new environment. It is helpful if a keeper familiar with the animal accompanies the shipment to assist with its acclimation.

Photos:
Top and bottom: *en route from Brookfield to Wuppertal.*

SOCIAL CONSIDERATIONS

The remoteness of the natural environment has made it difficult to study the behavior and social habits of the okapi in the wild until very recently. Studies indicate the okapi is solitary. Small groups of animals followed in the wild are thought to be a female with her most recent calf or calves, or a female in the company of a male. Biologists believe that a lactating female holds a territory at the exclusion of other okapis. Males are thought to move more freely in search of suitable browse and estrus females.

Group Composition: In captivity, small social units have been successfully kept together. The most stable groups appear to be related females or animals that have been raised together from an early age. A variety of social combinations can be successful depending largely on the personality, age, and/or reproductive status of the individuals involved, and the size and quality of space provided.

An adult male is often housed alone but adjacent to the female group. Two immature males can be introduced and housed together successfully through maturity prior to their introduction or close proximity to mature females. A female with a young calf should be housed alone in a location that is familiar and comfortable for the female.

Two females with calves may be successfully maintained together if the females have previously had a positive relationship. Timing of this is dependent on the experience and comfort levels of the dam and the individual temperament of the animals involved, and should be attempted after calves have left the nest.

Photos:
Top: *female with calf at Brookfield.*
Middle and bottom: *adult pair at Yokohama.*

SOCIAL CONSIDERATIONS

The Introduction Process is similar at all institutions. The only differences have been the length of time the animals have fence contact prior to being placed together and where the introduction takes place. Animals to be introduced are given fence contact before the actual introduction. This contact period lasts from 1-2 days to several weeks. After the initial contact, the animals should be introduced in an area that will allow quick access for separation in case there are any major problems. Institutions that introduce mother-calf pairs to another animal(s) usually introduce in a large pen to allow animals to move away from each other. When introducing calves without the dam present, most institutions introduce in a barn or small pen. If animals are being introduced in a more confined area, a neutral area may be a part of or the only introductory pen. This neutral area may decrease or eliminate aggressive behaviors. Likewise, when a weaned calf, either during the introduction process or newly introduced, is given access to a large pen the calf should be familiar with the area to decrease the possibility of injuries. During the introduction, the animal staff needs to be prepared to observe both aggressive and submissive behaviors. These behaviors include chasing, submissive lay, head butts/tossing, kicks, spin-in-place, etc. These behaviors may be allowed to continue for a short period of time without the danger of injury. The animal staff will need to judge the severity and duration of any aggressive or submissive behaviors to determine if separation needs to occur. Another possible problem is attempted nursing from the weaned calf. These nursing attempts usually do not occur until after the initial day of introduction. If the calf is persistent in its nursing attempts, the other animal may become aggressive which could result in need for separation. During the initial introduction period, okapi are separated during the night to assure safety. After several days, animals can be left together overnight as long as food intake can be monitored. Adult males are generally not left in with adult females overnight unless additional surveillance is provided

Since most institutions are housing more than one breeding pair of okapi, all calves should be introduced to another okapi for socialization. Introductions between calves and other okapis of every age and of either sex have been accomplished.

Photos:
Top: *yearling focussing on dam while en-gaged in play behavior, "pookie". Brookfield.*
Middle top: *yearling chasing adult during introduction at Brookfield.*
Middle bottom: *the lie/rise behavior during the first introduction of two animals.*
Bottom: *the submissive lie during a male/ male introduction.*

SOCIAL CONSIDERATIONS

Animal care staff should continue to monitor new introductions closely to insure they are progressing in a positive manner or to intervene as needed if negative behaviors begin to escalate.

Group size is usually dependent on the amount of available holding and exhibit space. Since this species is not highly social, group size is generally small. The facility must have the capacity to hold each individual separately if needed. The typical number of animals held at a breeding institution is 2.2.2 comprised of one adult male who mates with two females, a second male who acts as a back-up breeder, and the most recent offspring of the females. A facility that houses non-breeding individuals may hold as few as two animals.

Mixed Species Groups: Several duiker species as well as crane species and ground hornbills have been successfully exhibited with okapis. It is important to provide cover and security for all individuals maintained together.

Human-animal interactions: Most individuals are approachable, and acclimate to regular cleaning and operating routines without exhibiting a negative fear response. Some individuals tend to keep a larger distance from humans in the same space. Most allow and sometimes solicit tactile interaction with their usual keepers through a barrier. Staff from many institutions work in with individuals, particularly in large spaces. It is advisable to follow a regular routine so the animals learn what to expect. There are a small number of hand-raised okapis in the zoo community. Most of these individuals exhibit a normal range of behavior. There are several males however, that are fearless around people and as a result, require special daily operating procedures.

In some situations (i.e. aggressive or very bold animals), it may be advisable to shift the animal into an adjacent space prior to servicing. Special precautions should be taken when working around a dam with a neonate. It is advisable to shift the dam away from the neonate prior to servicing the area where the calf is. The period of time this change in routine continues depends largely on the individuals involved and the comfort level of the dam. Nesting calves can be acclimated to tactile interactions during this period, which often helps reduce flight response in an older calf.

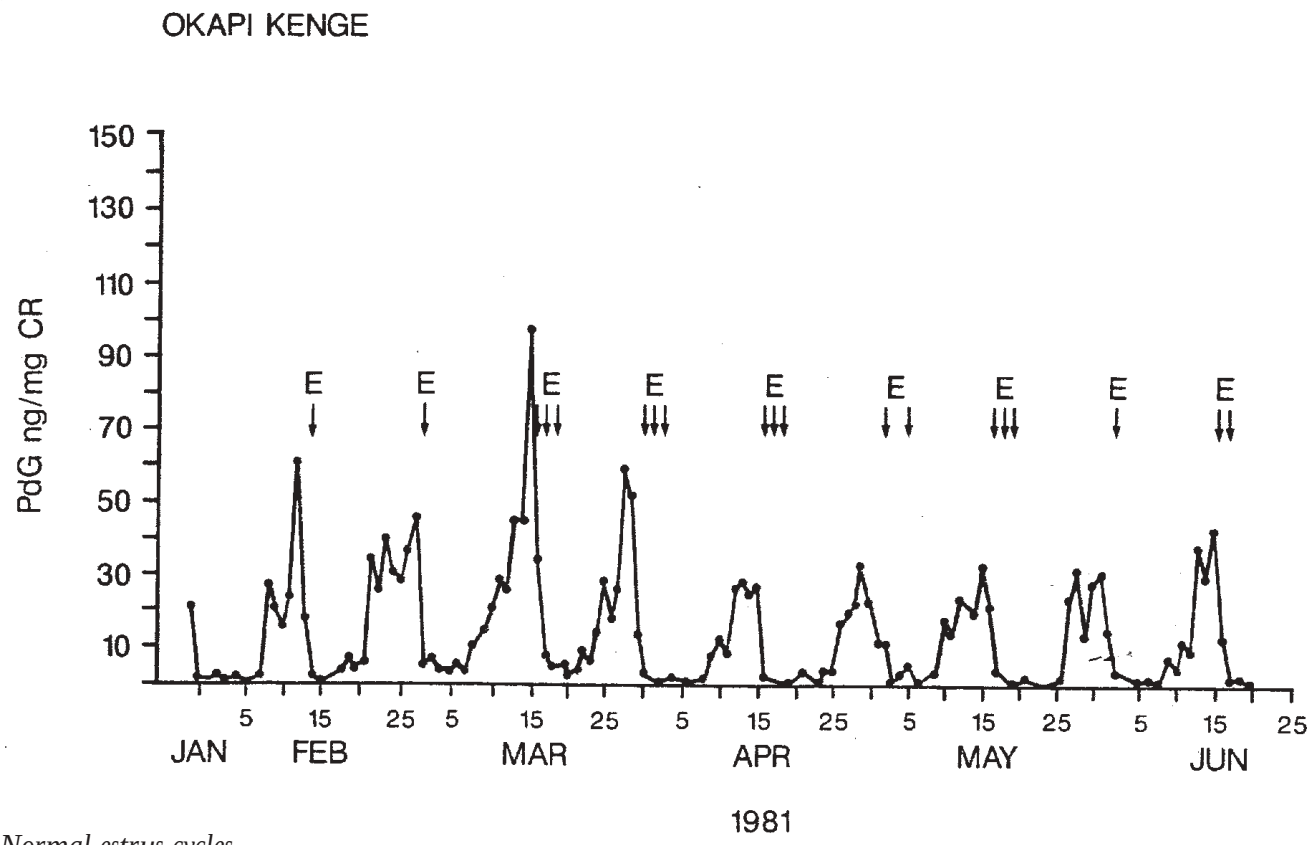
Photos:
Top: *ground hornbill shares exhibit with okapi at St. Louis.*
Middle: *yellow-backed duiker and okapi share exhibit at Disney's Animal Kingdom.*
Bottom: *remotely operated door at Brookfield.*

REPRODUCTION

Age at Maturity: Okapis become sexually mature at about two years of age and can continue to reproduce throughout old age, although aged females may encounter health problems with pregnancies and/or deliver weak calves. The youngest female recorded to have bred was 19 months of age. Gestation lengths from earlier data were recorded to range from 414 to 493 days. Average gestation lengths according to current records are 430 to 435 days, based on a total of 34 pregnancies from seven different females at two institutions (Brookfield and SDWAP), with a total range of 415 to 455 days.

Estrous Cycle and Hormone Tracking: The estrous cycle occurs every 13–16 days and estrus (receptivity or heat) lasts 2–5 days throughout the year with no seasonal variation. Signs of estrus vary depending on the female, but may include an increased level of general activity including pacing and licking; a slightly swollen vulva; posturing (lordosis) and stiffened front legs; and increased attention from the male (Flehmen, Laufschlag, and pursuit behaviors). Multiple breedings are common during estrus. Occasionally, breedings will continue into the first five months of pregnancy and this can create some difficulty for the animal care staff in determining accurate conception and subsequent parturition dates.

It can be difficult to detect estrus in females, even if a male is in the same building. Estrus behaviors seem to vary in intensity and duration. Naïve individuals are not as obvious and consistent in displaying sexual behavior as are experienced individuals. It is important for staff to become familiar with the individuals they are caring for since there appears to be considerable individual variation. Urinary and/or fecal hormone analysis can be a useful tool in determining the cycles and periods of estrus of a particular female which can then be compared to observed behaviors to provide more insight as to the particular behaviors associated with estrus in specific animals.



Normal estrus cycles.
Taken from Zoo Biology 1:45-53 (1982)

Analysis of urinary and/or fecal hormone metabolites may detect "possible" pregnancies by less than one month after conception (by a persistent elevation of progesterone metabolites at luteal phase levels). Less than one milliliter of urine or 3-4 fecal pellets per day for 30 days (frozen immediately after collection) are needed to diagnose pregnancy. However, it must be understood that since this method of analysis measures the female's ovarian steroids and not fetal-specific hormones, false positives can occur, especially in the case of infections or diseases of the reproductive tract which can result in similar hormone profiles. Currently, no fetal-specific hormones have been identified in ungulates in general to provide the basis for diagnostic methods for more accurate measures of pregnancy detection. Confirmation of pregnancy in okapis is possible via urinary or fecal progesterone metabolite measurements after the fifth month of gestation when levels can reach ten times those typically measured during ovarian cycles.

Breeding behaviors: Some elements of courtship and mating behaviors are similar to other ungulates: Flehmen, chin-resting, neck-thrusting, Laufschlag, and mutual circling. Often the male will vocalize a soft coughing or moaning sound, which is not heard at any other time. Copulation lasts no more than 10–20 seconds. Sometimes the ejaculatory thrust is noticeable.

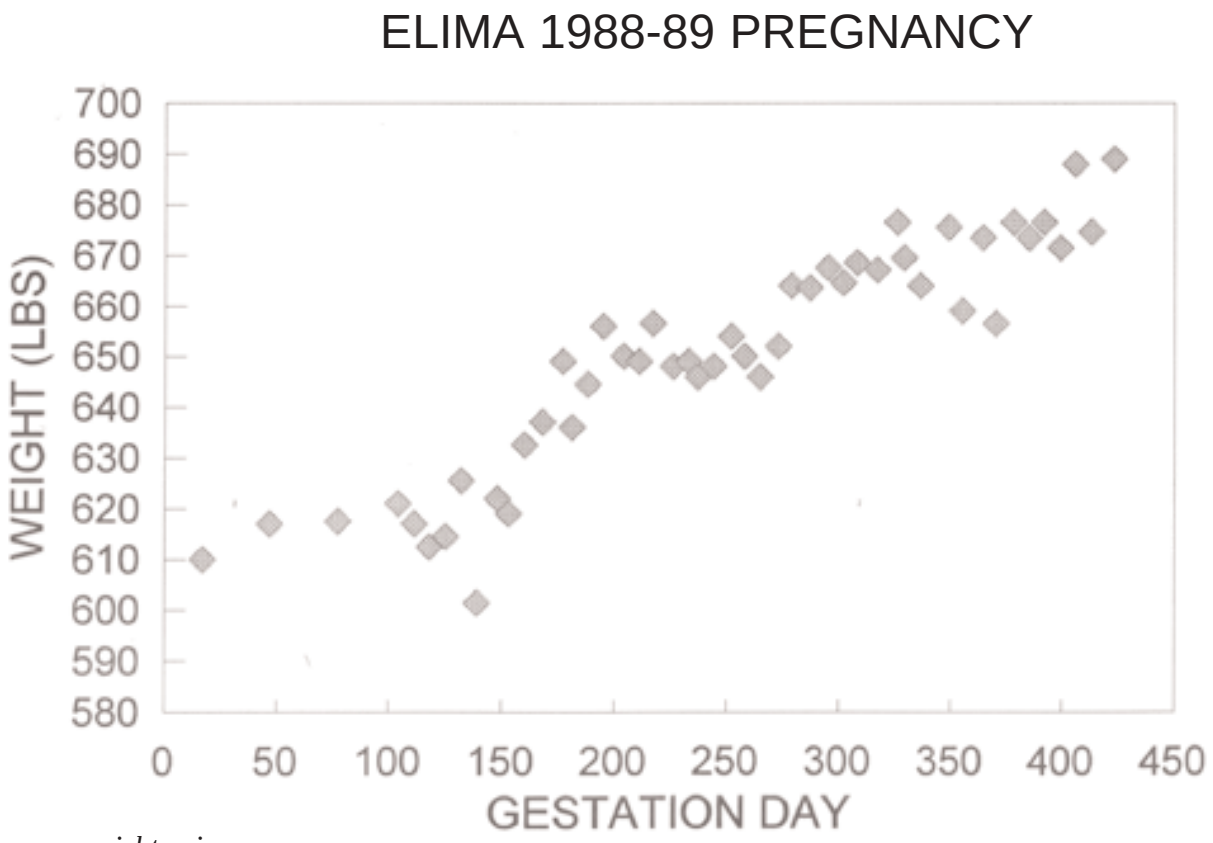
Breeding behavior can vary a great deal depending on the individuals involved. Males sometimes use their horns to hook and scrape an uncooperative female. In an effort to avoid male advances, a female may lie down in total recumbency for a minute or two. Experience has shown that a male may become aggressive, even with a familiar female; therefore, all introductions should be watched closely by experienced staff. Although serious physical injury is rarely inflicted, psychological damage can be substantial and may interfere with subsequent reproductive performance and success over the long term.

Introductions for Breeding: Breedings often occur inside holding facilities because some institutions plan them during the winter so that calves will be born in the spring-summer months, and for better control in the event that the introduction becomes aggressive. Ample space, good footing, and sufficient height within the interior enclosures are vital for successful introductions and breedings. Regardless of where the introductions take place, the animal care staff should watch the animals closely.

Top to bottom: *Typical courtship behaviors seen at Cincinnati.*

The intended breeding pair should be placed adjacent to one another, or at least within visual access of one another, for some time prior to the actual introduction. This species is solitary in the wild, so individuals would not have prolonged contact with one another outside of a situation where a female is in estrus. It is not important for the female to be in estrus for an introduction to occur. Some adult pairs get along very well regardless of the female's reproductive state. Experienced keeper staff should be in the area for the duration of the introduction to closely observe and be prepared to separate the animals if necessary. The female may be cautious or uncooperative in the male's presence; especially if she is naïve or not in estrus. Her comfort level in the presence of the male should be evaluated carefully. It is important that she is not overly stressed at the introduction, which should end sooner than later if it is determined that tension is increasing between the two animals. Introductions should be continued on a regular basis, especially if the male is behaving in a gentle manner. Sometimes it is easier to assess the female's reproductive status by watching the male's behavior towards her than the behavior of the female herself. If no sexual interest or mating has occurred within 90 minutes of pairing, it is not likely to occur and animals can be separated until the next day. If a male is overly aggressive towards a female or if the female appears to regularly become overly stressed in the presence of a male, introductions should occur only during the female's estrus period in an effort to minimize aggressive/fear behaviors.

Post-partum estrus can occur in okapis, but this varies between individuals. Studbook records indicate that an estrus of 1–2 days following parturition is possible but this occasion for breeding is rarely utilized if the female's calf is viable since it will likely interfere with cow/calf bonding. (In fact, based on reports on domestic livestock, this period is associated with lower fertility due to the condition of the uterus at that time.) Lactating females tend to resume cycling within 2-8 months post-partum. Managers often utilize the 6–8 month post-parturition estrus periods to re-breed the female, which does not appear to be problematic for the female or the calf.



Pregnancy weight gain.

Pregnancy can be determined via urinary and fecal hormone analysis (a confident diagnosis can only be expected after five months of gestation when the measurements rise up to ten-fold higher than those observed during cycling profiles) or trans-abdominal ultrasound. If the animals have access to a floor scale, body weights can also be an indicator of pregnancy as well as the general health of females. Certainly, the later stages of pregnancy especially in experienced females, are more easily recognized by staff. However, since gestation in okapis is fourteen and a half months long, it takes some time and experience before casual observations can determine that a particular animal is pregnant; especially in the case of primiparous females. It is more prudent to have urinary and/or fecal hormone measurements performed to gain more conclusive results (as soon as one month after breeding with confirmation only after five months of gestation), rather than lose valuable time in case a female has not conceived as expected.

Hormone therapy has been utilized to assist in maintaining pregnancy in females with a history of abortions and also to stimulate estrous cycles for females that do not appear to be cycling on a regular basis and are not conceiving as expected. Our Reproductive and Veterinary Advisors will have the most up-to-date information on recommended treatment protocols for these situations. **Contraception** has not been employed with okapis as yet.

Provisions for Parturition and Management of the Female: Okapis generally exhibit a good level of maternal care. However, the birthing process can be very startling for primiparous females. Females have been known to injure or kill the newborn if in an excited or confused state. It is critical for the female to be in familiar surroundings, without the distraction of other animals or people in the immediate area. If a pregnant female is to be moved to a different stall/area, this should be completed as early in the pregnancy as feasible. This will allow the female time to become comfortable in her new surroundings. Any additional substrate should be added to the interior flooring approximately 3–4 weeks prior to parturition, which will give enough time for the female to become familiar and to avoid the new substrate from becoming too soiled. Adult males should not be housed next to expectant females. Information on vaccinations and other veterinary issues for pregnant females can be found in the **Health** section.

Photos:
Top: *regular weights are a useful management tool. (St Louis)*
Middle: *Newborn taking first steps at Brookfield.*
Bottom: *young calf investigates while female rests at Brookfield.*

Calves are born after a gestation of 430–435 days (range of 415–455 days in 34 cases). Labor is 3–4 hours in length. If a female is uncomfortable in her surroundings, she may delay the progress of her parturition for a period of time. It is preferable to watch this event from a distance or remotely via a video monitor. A single calf is normal. A healthy calf usually stands within thirty minutes of birth, and generally nurses within two hours of parturition. Extensive maternal grooming and a high frequency of contact between the dam and calf are characteristic of the period immediately following parturition. Nursing bouts are frequent, averaging two bouts per hour during this initial phase. This initial phase of mother-infant bonding lasts from 2 to 7 days.

Maternal trauma immediately after parturition occurs most commonly in primiparous females; however, certain females have shown a tendency to traumatize their calves on successive births. Plans should be in place to observe primiparous and problem females and intervene if aggression to the calf begins or is suspected. Calves from "repeat offender" females may have to be pulled for hand rearing immediately after birth to prevent trauma. Calves up to 4 months of age have been attacked by their dams, resulting in serious injury or death. These attacks tend to be precipitated by novel or unfamiliar disturbances and noises or exaggerated maternal response to a calf's behavior. It is recommended that calves be monitored closely to document dam/calf interactions and ensure that good maternal care is exhibited by the dam and to document nursing bouts and early development of the calf.

Nesting behavior: The okapi is a "hider" species of ungulate. A female may leave her calf in its "nest" and not see it again for twelve hours or more (documented in Epulu). In the zoo setting, experience has shown that the female is likely to be located as distant as is possible from her calf while it is in this nesting stage. One change in behavior during this nesting stage is the frequency of nursing which decreases greatly to 2–3 times per day. This nesting behavior is an aspect of their natural behavior that must be given some thought when preparing space for a birth. It is vital for the female to be able to move out of visual contact with the calf. This can be achieved by offering multiple stalls within a barn. If this is not possible, a hide wall can be added within an enclosure. A barrier of approximately four feet high is sufficient to visually block the calf while it is on its nest.

Photos:
Top: *Both female and neonate rest. (Brookfield)*
Middle: *remote monitoring system reduces disturbance to the animals. (Brookfield)*
Bottom: *Yokohama calf resting.*

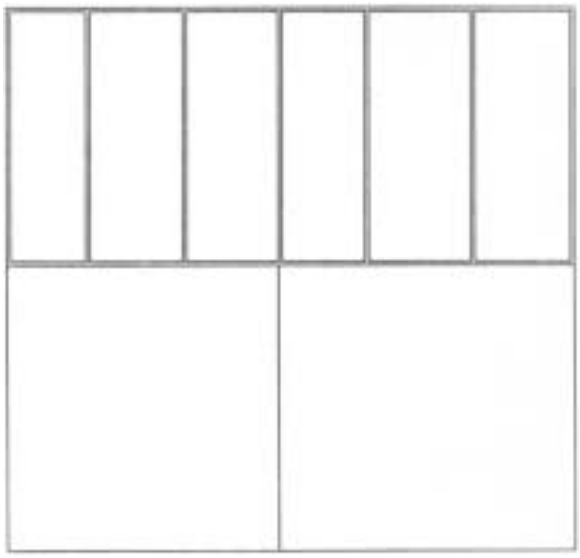
Several holding facilities have used hay/straw bales secured atop one another to form such a barrier. A creep partition/ gate has also been successfully used to allow the calf into a stall or small yard, without giving access to the dam. Or the dam can be separated daily from the calf during the nesting phase, allowing the dam to have access to an outside area for several hours each day. It has also been possible to manipulate the choice of nest location by attaching a small object on the otherwise flat wall for the calf to sit under. Any changes that need to be made in the area should be accomplished well in advance of the calf's arrival, allowing time for the female to become familiar with these changes.

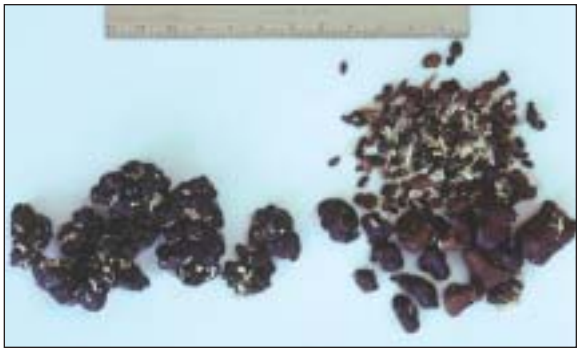
During the nesting phase, calves commonly double their birth weight in 3–4 weeks and triple it by 8 weeks. Okapi calves generally delay their first defecation (meconium passage) until they are 4 to 10 weeks old.

The well-baby exam should take place 24–72 hours after parturition depending on the temperament and experience of the dam, assuming the calf appears healthy. Only staff familiar to the dam should handle the calf; strange scents should be masked prior to re-introducing the pair, as with used bedding. The dam should be able to see the calf from a distance prior to their re-introduction.

Okapi calves do not thermoregulate well until they are about 51-60 days of age so barn temperatures should be monitored closely.

Maternal Neglect and Obsessive Behavior: If the dam is not allowing the calf to nurse, and the calf is otherwise in good health, the calf could go ~24 hours without needing some nutritional support. It is conceivable that the calf could go longer than this with fluid and dextrose supplementation. It is important to determine why the dam is reluctant to nurse the calf. Haloperidol has been used successfully in a very small number of cases to calm the dam enough to allow nursing to occur.





Photos:
Top: *diagram of creep used in doorway at San Diego to give calf a stall of its own.*
Top middle: *overhang attached in stall corner to encourage calf to nest under it. (Brookfield)*
Middle bottom: *typical first stool.*
Bottom: *Brookfield calf in layout position.*

Maternal over-grooming of calves has led to tail sloughing and rectal and vaginal trauma, and is a result of compulsive behavior by certain females and/or management schemes that keep dams and calves in constant close contact during the nesting phase. Much of this abnormal behavior can be eliminated by providing as much space as possible so the dam and calf can be out of site of one another, by using a creep system so the calf can separate itself from the dam, or by locking the dam away from the calf while it is nesting during the day, as the female would normally be browsing away from the calf at this time.

Weaning and Introduction of calves

A survey was sent to every institution participating in the SSP in 2001. The focus of the survey was okapi calf management in regards to weaning and introductions to conspecifics. It has been deemed important by the SSP that calves are socialized. Socialization can occur prior to, or after, weaning from the dam.

Weaning of calves can be allowed to occur naturally or weaning can be forced by separating the dam and the calf. The choice is being made by individual institutions and is equally divided on how weaning is accomplished. When institutions force weaning, calves have been separated from dams as early as 5 months and as late as 10 months of age with the average age of separation being 8–9 months. The decision to separate calves from their dam is usually based on the declining body condition of the female as older calves continue to nurse and/or overgrooming of the calf by the dam. Each female and calf needs to be monitored individually to determine the necessity of separating.

Calves should be monitored for food intake prior to and during the weaning process. Institutions have not used grain and hay consumption as an indicator of calf readiness to wean. This is a possible indicator that needs to be considered if weanings are going to occur prior to 8-9 months of age. During the weaning process, separation from the dam has not resulted in calves refusing feed. There is likely to be a decrease in consumption, but that decrease should not be more than 60% and should not last for more than three days.

Calves are usually separated from the dam during a portion of the day to start the weaning process. This partial separation lasts from one week to a month.

Photos:
Top: *weighing calf helps monitor health at Brookfield.*
Bottom: *calf investigating what dam is eating at Brookfield.*

Calves may be separated during the day or at night. Calves may have visual contact with dams during the separation, but this should be limited contact. Contact on a chain link fence line can lead to pacing, increased vocalizations, and other stress-induced behaviors. Some institutions have had to move calves to other areas away from the dam to decrease the level of stress behaviors exhibited. Although calves may appear stressed due to separation, few institutions have thought that the level of stress was excessive (no more than stress caused by natural weanings). After a period of approximately one month, calves are no longer put back in with their dams.

Introduction of the calf to other conspecifics occurs at different ages, depending on the institution and the availability of companion animals. Most institutions will introduce mother-calf pairs to other okapi. Certain criteria are suggested prior to introductions occurring. First, calves should be old enough to be off their nest. Second, introductions to either adult males or adult females should occur only if the dam has been housed with the other adult prior to calving. Adults normally are very tolerant of young, but can be aggressive toward other adults so it is recommended that adults be introduced prior to pregnancy and calving. There have been two incidents of aggression from an adult female directed towards a calf. Regardless of how smoothly most introductions proceed, all introductions need to be closely monitored by animal staff.

When introductions do not occur until after the calf has been weaned, a calf can usually be introduced to any okapi including a mother-calf pair, adult female, adult male or similar aged conspecific. All of these scenarios have been successful at one or more institutions. Adult males can work as a companion animal for weaned calves age 6 months up to 2 years of age. A possible problem when introducing weaned calves is attempted nursing. These nursing attempts usually do not occur until after the initial day of introduction. If the calf is persistent in its nursing attempts, the other animal may become aggressive which could result in the need for separation. Institutions need to be aware that there have been some problems with males as the companion animal. To avoid some of the problems already encountered, males should not be housed too closely to cycling females as this can result in aggressive and/or breeding behavior directed towards the calf.

The need for handrearing is determined by analysis of the interactions between the dam and her calf and the continued development of the calf based on the information which has been correlated over multiple captive births. Due to the small population size and limited breeding of this species, all planned births are important to the population, thus handrearing, if necessary, is warranted. Experience has proven that handreared adults exhibit normal behavior.

Introducing the handreared individual to conspecifics can occur as early as 6–8 months, but in some cases may be more successful when the calf is older. This will vary depending on the personality of the individuals involved. Some handreared youngsters are very persistent in attempting to nurse from their companion.

Photo: *handrearing calf at Brookfield.*

Okapi SSP Handrearing Protocol updated March 2002

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The SSP recommendations are based on the following information and experience obtained with 5 hand-reared okapis and limited okapi milk data. The SSP okapi handrearing formula has been used successfully at Brookfield Zoo for 5 handreared calves. However, several other Zoos have raised calves with other formulas. That information is outlined in section **IX. Other Zoo Experiences**. In those situations calf health and circumstances varied quite a bit, which created the need to change the formulas.

I. Nutrient Composition

It has been documented in a number of species that milk composition and output change over time and with sampling method (Oftedal, 1984). Thus, published values are greatly dependent on the time taken during lactation as well as the methodology used. This may be the reason for variation in published values. Since relatively few samples of okapi milk have been published; it is necessary to consider general trends at this point. Below are published values for okapi milk and final formula used.

Source	Kcal /100ml (as fed)	% Solids	% of Solids			% As Fed		
			Fat	Protein	Lactose	Fat	Protein	Lactose
Faust (1968)	109.5+	24.1	39.4	24.9	?	9.5	6.0	?
Crandall (1964)	78	18.5	10.8	54.1	27.0	2.0	10.0	5.0
Senft (1978)	91.2	20.1	19.9	48.3	20.4	4.0	9.7	4.1
Gregory (1965)	106+	28.2	15.6	58.9	?	4.4	16.6	?
Final formula	106.3	19.3	34.9	29.8	29.9	6.7	5.7	5.8

? = unknown.

II. Okapi handrearing formula (ALL MEASUREMENTS ARE BY WEIGHT AS FED)

DAYS 0 –2

If the calf is pulled before it is able to receive its mother's colostrum, it can receive cow colostrum, if available, or a commercially available product, such as Colostrix (See manufacturers information below).
50% cow colostrum (or a commercially available product) and 50% water

To make 4000 g (141 oz. by weight)
2000 g (70.5 oz.) cow colostrum
2000 g (70.5 oz.) water
Feed at 10 to 12% calf body weight.

PRE-FINAL FORMULA - DAYS 2-8

48.25% canned evaporated milk
48.25% water
3.5% powdered Esbilac

To make 4000 g (141 oz. by weight):
1925 g (68 oz.) water
1925 g (68 oz.) evaporated milk
140 g (4.9 oz.) powdered Esbilac
Poly-vi-Sol (or pediatric vitamins) 40 drops
Fer-in-sol 40 drops
Lactaid (use bottle directions)
Feed at 10 to 12% calf body weight.

FINAL FORMULA – DAYS 9+

46.25% canned evaporated milk
46.25% water
7.5% powdered Esbilac

To make 4000 g (141 oz. by weight):
1850 g (65.2 oz.) water
1850 g (65.2 oz.) evaporated milk
300 g (10.6 oz.) powdered Esbilac
Poly-vi-Sol (or pediatric vitamins) 40 drops
Fer-in-sol 40 drops
Lactaid (use bottle directions)
Feed at 6 to 10% calf body weight.
This formula should be used for the remainder of the handrearing period.

III. Formula supplementation

There is no need to use distilled water. Boiled water (stored refrigerated) is fine. To avoid diarrhea, lactaid (liquid) should be added as per the directions on the bottle. Also supplement with an infant multi-vitamin (Poly-vi-Sol - See manufacturers information below) and an iron supplement (Fer-in-sol - See manufacturers information below). Supplement at one drop (of each) per 100 g of formula.

IV. Feeding Apparatus

Lamb's nipple and bottle

V. Feeding regimen

Timing: Since it has been observed that mother-reared okapis suckle primarily in daylight hours, the feedings should be divided evenly among 5 or 6 feedings in primarily daylight hours. For five feedings, an appropriate schedule would be: 0600, 0930, 1300, 1530, and 1930.

Quantity: The calf should be fed between 10-12% of its body weight in formula (as fed basis) when it is consuming either colostrum or the more dilute formula. This is through day 8. Body weight gain should progress similarly to other calves (Figures 1 & 2.) After that the calf should be offered between 6–10% of its body weight in formula (as fed basis). It has been found that okapi calves (n=5) can maintain an adequate growth rate while consuming the final formula at 6% of body weight per day. Average daily formula intake as a percent of body weight for handrearing calves (n=5) is attached in Table 2. Typical conversions for 10% body mass are shown in Table 3. Example formula to convert kilograms of body mass to grams of formula: (10% of Body mass in kilograms/# feedings/day) X1000 grams/kg=quantity offered per feeding.

Regardless of the amount or number of feedings offered per day, each feeding should not exceed 3% of calf body weight. This avoids the probability of GI tract stress if fed too much, too fast.

Actual quantities to be fed should be monitored by weight gain and (sometimes) stool condition. Usually a healthy okapi calf does not defecate for 30–60 days post partum. Too much formula or too concentrated a formula may cause GI distress. It is important that diarrhea be avoided. As the dam does not stimulate the calf to urinate or defecate, no stimulation is needed and it is normal for the first defecation to be several weeks after birth.

The formula and feeding schedule above will provide adequate energy and nutrients to the calf. Too little energy will not provide for weight gain. Don't force the calf to eat too much and judge the final quantity offered by increase in weight gain. A 9-month growth chart of Brookfield Zoo's 9 okapi calves (4 mother-reared and 5 hand-reared) is attached in Figure 1. Figure 2 provides a growth chart for the first 30 days for 16 okapi calves.

VI. Special Considerations

The calf should have shelter and be held in moderate temperature conditions.

DO NOT stimulate calf to urinate and defecate. Provide a “nest” area bedded with hay. Most calves lick the floor while they nest. Make sure the floor substrate is safe for consumption.

The handreared okapi calf should be “wet groomed” over its body with a wet, warm cloth after each feed to simulate being groomed by its mother. The calf should be encouraged to exercise outside once or twice per day for about 20 minutes per session, weather permitting.

VII. Other foods

Fresh water should be available at all times beginning at birth. Foods that are included in the regular adult okapi diet should be available to the calf early on to acclimate the calf to these items and eventually prepare for weaning. A salt block should be made available but, if usage is high, access should be limited to 2–3 days per week.

VIII. Weaning process

The weaning process might need to be individualized for each calf. Weaning depends on solid food consumption, weight gain, and general health of the calf. Weaning is best performed by keeping the formula at a constant amount (not increasing formula with body weight increases) while the calf continues to grow and consume more of its adult diet. This will encourage the calf to eat more of the adult diet. At approximately 20 weeks of age a mother-reared calf will begin to be weaned. Thus at about 19 weeks, it is appropriate to discontinue the formula increases and keep the quantity of formula at a constant level to encourage the calf to begin consuming more solid food. The calf should not lose weight but may plateau for up to six days during this weaning process. Once the calf is consuming additional solids and is gaining weight, the quantity of formula can be gradually decreased. The calf may be completely weaned by 6 to 8 months of age. Care should be taken to ensure that the calf is consuming its nutritionally complete pelleted diet so that it obtains the nutrients it needs.

Photo: *St. Louis calf with fractured leg due to maternal trauma.*

IX. Other Zoo's Experience

Cincinnati Zoo, Marwell Zoo (England), and Oklahoma Zoo have all handreared okapi calves. Calf health and circumstances varied quite a bit, which created a need to change the formulas. Table 1 provides a comparison of the nutrient analysis of the formulas

Cincinnati Zoo:

List of Ingredients Used:

1. Cow's colostrum (high quality according to dairy standards), from a dairy herd in New York
2. Carnation Evaporated Milk, Carnation Company, Los Angeles, CA 90036
3. Esbilac, Pet-Ag, Inc. (Division of Milk Specialties), Elgin, IL 60120
4. Water, boiled and cool/refrigerated
5. Fer-n-sol, Meade Johnson Nutritional Division, Bristol-Myers Co, Evansville, IN 47721
6. Poly-vits Pediatric vitamins, Major Pharmaceutical Corp., Chicago, IL 60612
7. Lactaid, Lactaid Inc., Pleasantville, NJ. 08232
8. Pedialyte, Ross product division of Abbott Laboratory, Columbus, OH 43215
9. Milk Matrix 42/25. Pet-Ag, Inc. (Zoologic), Elgin, IL 60120
10. Nonfat dry milk

Formula Preparation:
Summary: Poucet (1.0, 1999), On day 0 (day the calf was born and removed from the dam), the cow's colostrum was given. On day 1 the SSP Protocol was followed. On day 6 and 7 the calf was given Pedialyte. On day 8 he was offered a mixture of a dilute formula (25% cow colostrum to 75% pedialyte) with Equine Beneac (beneficial gastrointestinal bacteria) to help re-establish gut flora. At that point the formula was changed to Milk Matrix 42/25 (made by Zoologic, a product line of Pet-Ag, Inc).

Details: The calf was separated from its dam two hours after birth (day 0) due to his inability to stand. The calf was very small (10.8 kg or 24 lbs.) and weak. After being warmed the calf was stomach-tubed with cow's colostrum to help ensure passive transfer of immunoglobulins. This procedure was done three times during the first 12 hours of life. He nursed from the bottle two times on day 0. The next day, blood drawn indicated no transfer of immunoglobulins. He was fed the SSP protocol pre-final formula mixture (see Table 1) on days 2–5. On day 6 the calf presented with bloat and refused his bottle. He was stomach-tubed with Pedialyte. On day 6 he was immobilized for IV administration of okapi plasma from San Diego Wild Animal Park (200 cc plasma IV and 60 cc SQ). After the procedure he was fed only Pedialyte for 12 hours. On day 7 he was fed by bottle a dilute formula (25% cow colostrum to 75% Pedialyte). Equine Benebec (beneficial gastrointestinal bacteria) helped re-establish gut flora. At that point the formula was changed to Milk Matrix 42/25, Nonfat dry milk and Pedialyte (see Table 1). The formula was kept dilute thinking it would be easier for him to digest. His weight gain was monitored closely and appeared adequate. The quantity of formula fed was ~10–12% body mass. He defecated during the first week and throughout handrearing had some problems with loose stool. Around his defecation periods he would refuse his milk bottle but usually take Pedialyte without hesitation. He also would act as though he was uncomfortable during these periods. He was successfully weaned at 32 weeks.

Marwell Zoo

Details: Elila (0.1, 1997) was handreared from day of birth. She was separated from its dam due to aggression. She was given colostrum via a stomach tube due to initial lack of interest in the bottle. The calf was offered formula 5x/d formula unknown. The calf took the bottle well once established. She had a little trouble with wanting the bottle from only one keeper. Weight gains were similar to mother-reared calves.

Oklahoma City Zoo

Ingredients Used:

1. Evaporated Milk
2. Esbilac, Pet-Ag, Inc. (Division of Milk Specialties), Elgin, IL 60120
3. Water, "sterile" and tap
4. Vitamins
5. Lactaid, Lactaid Inc., Pleasantville, NJ. 08232

Formula Preparation:

Summary: Iosi (0.1, 1998) The first the formula offered was 50% Evaporated milk and 50% "sterile" water. Esbilac was added so the second formula was 45% Evaporated milk: 45% "sterile" water: 10% Esbilac. Once the Esbilac was added to the formula Lactaid was added as well. Vitamins were added to the formula at four weeks of age.

Details: The calf was separated from its dam two weeks after birth (day 0) due to pneumonia. The calf appeared weak, and blood and tissue were seen in the rectum area. At intermittent times throughout handrearing Iosi was offered Resorb (an electrolyte solution made for calves manufactured by Pfizer) for scours (diarrhea). The calf was offered a formula of 50% Evaporated milk: 50% Water from day of age 11 to 13. The calf was offered a formula of 45% Evaporated milk: 45% Water: 10% Esbilac from day 14 to week 5. From week 5 on the SSP protocol final formula (see Table 1) was offered. She was offered formula at 8–11% of body mass.

Table 1. Nutrient content of the Okapi handrearing formulas.

		Dry Matter, %			As-Fed, %		
Formula	Energy, kcal/100 ml	Fat	Protein	Lactose	Fat	Protein	Lactose
Current SSP Protocol Pre-final formula: 48.25% Evap Milk: 48.25% Water: 3.5% Esbilac	85.55	32.7	28.4	33.6	5.3	4.6	5.4
Current SSP Protocol Final Formula: 46.25% Evap Milk: 46.25% Water: 7.5% Esbilac	106.26	34.9	29.8	29.9	6.7	5.7	5.8
Cincinnati (1999) Formula: 22.44% Milk Matrix 42/25:11.56% Nonfat dry milk: 66% Pedialyte	154.9	20.0	41.8	30.9	6.5	13.8	10.2
Oklahoma (1998) Formula: 50% Evap. Milk: 50% Water	39.70	0.96	35.7	53.5	0.1	3.7	3.6
Oklahoma (1998) Formula: 45.0% Evap Milk: 45.0% Water: 10% Esbilac	92.89	22.1	35.1	34.0	4.2	6.7	6.5

X. Products and Sources for SSP Protocol

Colostrix
Protein Technology, Inc.
Santa Rosa, CA 95403

Carnation Evaporated Milk
Carnation Company
Los Angeles, CA 90036

Esbilac
Pet-Ag, Inc. (Div. of Milk Specialties)
30W432 Route 20
Elgin, IL 60120-9527

Poly-vi-sol
Mead Johnson Nutritionals
Bristol-Myers Company
Evansville, IN 47721

Fer-in-sol
Mead Johnson Nutritionals
Bristol-Myers Company
Evansville, IN 47721

Lactaid
Contains lactase, an enzyme that breaks down lactose.
(Distributor) McNeil Consumer Healthcare
Division of McNeil-PPC Inc.
Fort Washington, PA 19034

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Table 2. Average Intake of formula (as fed) as a percent of body weight for handrearing calves (n=5).

Week	Ndura	Sefini	Sudi	Tano	Makuti
1	12.9	7.9		8.1	6.7
2	12.4	9.4		9.5	9.8
3	10.8	9.5		9.2	9.7
4	9.0	9.9	6.6	9.2	9.6
5	7.9	8.5	6.1	9.3	9.3
6	7.0	6.9	6.7	9.4	8.3
7	6.2	7.1	6.3	8.7	7.9
8	5.7	6.8	5.9	7.9	7.7
9	5.2	6.5	6.0	6.3	7.5
10	5.4	6.4	6.0	6.7	6.0
11	5.6	6.4	5.7	5.8	7.1
12	5.6	6.4	5.5	5.1	6.8
13	5.2	6.0		5.5	6.1
14	4.5	5.9		5.2	5.9
15	1.4	5.8	5.1	4.9	5.6
16	5.1	5.7	4.9	4.7	5.2
17	5.2	5.5	4.3	4.7	4.9
18	6.0	5.4	4.2	3.7	4.7
19	5.6	5.4	4.3	3.9	4.5
20	5.3	5.3	3.5	4.1	4.3
21	4.9	5.0	3.3	3.2	4.2
22	4.6	4.7	2.5	3.6	3.0
23	4.4	4.6	2.6	3.3	3.1
24	4.3	4.3	2.2	3.1	3.0
25	3.7	4.1	1.9	3.0	3.0
26	3.2	4.1	1.9	2.5	2.4
27	2.9	3.9	1.8	2.3	2.3
28	2.4	3.1	1.5	1.9	2.2
29	2.4	3.1	1.3	1.7	1.6
30	2.0	3.0	1.1	1.7	1.6
31	1.7	2.9	1.0	1.4	1.6
32	1.4	2.6	0.7	1.2	1.6
33	1.1	2.3	0.8	1.2	1.2
34	1.1	2.3	0.6	1.0	1.2
35	1.1	1.7		0.8	0.7

Table 3. Conversions for 10% body weight to total formula quantities (by weight, as fed); 5 feedings/day

Body mass, kg (lb.)	Quantity per feeding, g (oz.)	Total quantity per day, g (oz.)
13.6 (30)	273 (10)	1,356 (50)
15.8 (34)	318 (11)	1,590 (55)
16.8 (37)	345 (12)	1,725 (60)
18.2 (40)	363 (13)	1,815 (65)
20.4 (45)	409 (14)	2, 045 (70)
21.3 (47)	427 (15)	2,135 (75)
22.7 (50)	454 (16)	2,270 (80)
24.0 (53)	481 (17)	2,405 (85)
22.4 (55)	499 (18)	2,495 (90)
27.2 (60)	545 (19)	2,725 (95)
28.6 (63)	572 (20)	2,860 (100)
29.5 (65)	590 (21)	3,950 (105)
31.8 (70)	636 (22)	3,180 (110)
33.1 (73)	663 (23)	3,315 (115)
34.0 (75)	681 (24)	3,405 (120)
35.0 (77)	699 (25)	3,495 (125)
36.3 (80)	726 (26)	3,630 (130)
38.6 (85)	772 (27)	3,860 (135)
39.5 (87)	790 (28)	3,950 (140)
61.3 (135)	1,226 (43)	6,130 (215)
62.2 (137)	1,244 (44)	6,220 (220)
77.1 (170)	1,544 (54)	7,720 (275)
79.4 (175)	1,589 (56)	7,945 (280)

Okapis are ruminant browsers. As such, they require high quality alfalfa hay and other food items, which are highly digestible and when combined, offer a nutritionally complete diet based on what we know about okapis and other ruminant, browsing species. Given this species' special adaptations for procuring and digesting food, manipulation of browse and rumination are important considerations in selecting the physical form of food items offered. This highlights the importance of offering forage items that can be manipulated by the tongue, and long fiber fractions, from hay and browse conducive to proper rumination.

The okapi is a **selective browser** with a preference for high quality tender foliage in the wild. (Hart and Hart, 1988) The consumption of plant fruit has not been reported. Comprehensive data on the total diet is lacking and little is known about the actual nutrient composition of the total diet consumed in nature. With respect to the various food groups offered, the diet should consist of at least 25% pelleted diet and at least 50% alfalfa and browse. Zero to no more than 25%, by weight, of the total diet intake should consist of produce. It is important for the hay to be analyzed on a regular basis to verify levels of available protein, fat, vitamins and minerals. Specifications of the pelleted diet should complement the usual results of the hay to provide a balanced diet for this species. Browse can be an important component of the diet and can replace some of the forage component if chemical composition is known and appropriate quantities are consumed. Salt blocks, which also complement the rest of the diet as offered, should be provided on a regular basis. Young individuals sometimes become obsessive lickers of salt, so access may need to be limited and monitored in these situations. Water should be provided ad lib under normal circumstances.

Amount and Type of Feed: Okapis should consume at least 1.8% of their body weight (in DM) daily. This means they must be offered more than this, from 2–2.4% of body weight. Depending on the quality of the hay, they may need more or less. If hay quality is poor with respect to either nutrients or digestibility, more food must be consumed. However, since there is a limit to gut capacity, a high quality diet is important for this species.

Photos: *Brookfield*
Top: *male browsing.*
Middle: *browse and alfalfa hanging in stall.*
Bottom: *large branches in center of stall.*

Water bowls and food containers should be placed in several areas throughout the space, located away from high-traffic areas to minimize the possibility of animals accidentally running into them or fouling them. Their design should be smooth and rounded to minimize animal injury. Their design should also minimize the risk of animal entanglement. These containers should be raised off the floor to a height of ~30 inches (76 cm.). As browsers, they rarely eat from the forest floor, as this is physically difficult for them. This height gives animals of all ages easy access to contents, including young calves, which need to reach to investigate and sample the diet. Additional hay and browse can also be placed higher than 30" to accommodate adult animals. Automatic drinkers are commonly used. Drinkers should be serviced daily to maintain sanitary conditions and freshness. Both water and food containers should be scrubbed on a regular basis to maintain sanitary conditions.

Food Schedules and Presentation: Forage and water should be present at all times unless otherwise directed by the veterinary staff. High-quality alfalfa hay should be renewed at least twice a day. The pelleted portion of the diet, along with any produce, can be split into a number of smaller portions and fed throughout the day as decided upon in the daily routine. Feeding various parts of the diet in novel locations or in dispensers which make the animals work to obtain the food will lengthen the feeding time for the animal and may promote natural behaviors. Offering browse when available also provides an opportunity for the animals to strip leaves and tender bark from the branches.

Body condition can be assessed as in other ungulates. Prominence of bony joints (hips, pelvis) or noticeable vertebrae, sunken flanks, noticeable ribs or bony heads, and poor coat condition are signs of declining condition. Acquiring regular weights helps assimilate seasonal or life-function weight variations.

Additional food quantities may be needed to maintain good condition in growing, lactating and active animals. Young animals grow fast. Lactation is known to be a serious drain on most females. Acquiring weights on a regular basis in addition to visual inspection provides animal care staff with the information they need to assess individual situations and respond accordingly.

Photos:
Top: *built in feed compartments at Oklahoma City.*
Middle: *feed box raised off floor at Brookfield.*
Bottom: *a 4' x 6' scale is adequate for weighing adults.*

Sample Recommended Diet:
Recommended nutrient profile for captive okapi diets.

Suggested Diet %

50% prime quality alfalfa hay (minimum)
25% nutritionally complete pellets (minimum)
0-25% produce/browse (maximum)

Intake as % Body mass: 1.8% Dry matter diet

Nutrient	Concentration range dry matter basis
Protein, %	17-20
NDF, %	20-35
ADF, %	13- 18
Vitamin A, IU/g	1.5-2.2
Vitamin D, IU/g	0.4-0.5
Vitamin E, IU/kg	120-178
Thiamin, mg/kg	-
Riboflavin, mg/kg	-
Calcium, %	0.70-0.97
Phosphorous, %	0.36-0.40
Magnesium, %	0.18-0.24
Potassium, %	1.6-1.8
Sodium, %	0.10-0.44
Iron, mg/kg	126-139
Zinc, mg/kg	54-68
Copper, mg/kg	10-12
Manganese, mg/kg	54-57
Selenium, mg/kg	0.12-0.18
Iodine, mg/kg	0.3-0.4

Please note that the micro-nutrient levels suggested are simply a summary of data from other non-domestic ruminants that appears to be adequate.
NDF= neutral detergent fiber; ADF= acid detergent fiber

HEALTH

Medical management of the okapi is similar to other medium/large ruminants. Okapis are susceptible to many of the diseases common to domestic ruminants. Digestive disorders, rotavirus, jaw abscesses, trauma and overgrown hooves are a few of the most common problems encountered in the zoo community.

Perinatal and Neonatal Care of Okapi

It is recommended that female okapi near term be monitored closely for signs of impending parturition. To reduce stress, this can be done through the use of remote video cameras. Parturition averages 3 to 4 hours and generally proceeds rapidly once a foot is seen at the vulva (1.5 to 2.5 hours). Progression of parturition should be monitored closely so dystocias and other problems can be detected as early as possible. Dystocias resulting from uterine inertia and posterior presentation have been reported, and have been successfully corrected by manual manipulation and extraction, using either standing or full chemical restraint. Calves born through assisted births are more at risk for maternal neglect or trauma and neonatal problems, so careful consideration should be given to the introduction of these calves to their dams and to monitoring their health.

The birth of a single calf is the norm, but twinning has occurred rarely. Normal birth weights are in the 14.6 to 31.6 kg range with a mean of 22.5 kg (32 to 69.5 lb with a mean of 49.5 lb). Low birth weight calves or calves exhibiting evidence of immaturity have a much higher prevalence of neonatal problems and should be evaluated and closely monitored. Calves commonly double their birth weights in 3 to 4 weeks and triple it by 8 weeks.

Some behavioral landmarks for assessing neonatal health include:
1) time from birth to sternal recumbency (within 15 minutes – mean, 8 minutes),
2) time from birth to attempts to stand (within 18 minutes – mean, 12 minutes)
3) time from birth to standing (within 45 minutes – mean, 29 minutes)
4) time from birth to attempts to nurse (within 2 hours – mean, 38 minutes)
5) time from birth to first successful nurse (within 6 hours – mean, 77 minutes).

Calves that reach these behavioral landmarks slowly should be carefully evaluated and monitored. The birthing area should have a substrate that provides good footing for the calf to allow standing without struggling or exhaustion and to prevent injury from slipping and splaying. Okapi calves do not thermoregulate well until they are about 51 to 60 days of age (rectal temperatures vary from 37.0° to 39.2°C and average 38°C (98.6° to 102.6°F and average 100.4°F) for the first 90 days of life), so barn temperatures should be regulated. Okapi calves generally delay their first defecation (meconium passage) until they are 4 to 10 weeks old. Calves which defecate early should be observed closely for signs of illness.

Additional behavioral landmarks for calves include:

1) first ingesting solid food	14 – 25 days	mean, 20 days
2) first rumination	27 – 41 days	mean, 33 days
3) regular defecation (occurring daily or every other day)	101 – 135 days	mean, 120 days

The neonatal mortality rate of okapi in the North American captive population is about 20%—contributing factors include maternal neglect and trauma, and infectious disease. Maternal neglect or inadequate maternal care can lead to failure to nurse and failure of passive transfer of maternal immunoglobulins. Such calves will be prone to infectious disease, and if intake remains inadequate, will quickly become hypoglycemic and dehydrated.

Diarrheal diseases can cause severe problems in okapi calves, with the principle pathogen being a rotavirus that is endemic in the captive okapi population. Other common causes of enterocolitis in okapi calves are *E. coli* and coronavirus. The younger the calf, the more serious the risk of severe disease or death from diarrheal disease. Omphalophlebitis, polyarthritis, meningitis, fungal meningoencephalitis, bacterial, viral, and fungal pneumonia, septicemia, and enterotoxemia have also caused morbidity and mortality in okapi calves.

Veterinary neonatal care is recommended to identify health problems early, guard against specific pathogens known to affect okapi, and build the database of available okapi neonatal information. Since okapi dams have been known to traumatize calves following handling, it is imperative that any procedure involving a calf be carefully thought out, discussed, planned and considered worthy of the risk.

Perinatal and Neonatal Procedures:

Isolation and Hygiene: Okapi dams and calves should be kept as isolated as is possible from other okapi and other species. Increased hygiene and sanitation should be instituted to prevent transfer of pathogens to the calf and dam – **Nothing substitutes for good hygiene and sanitation.** Enteric viruses are easily spread from enclosure to enclosure by fomites (i.e., boots, cleaning utensils, tires, etc.). Use of footbaths and dedicated boots, coveralls, and utensils are indicated. Calving barns and enclosures should be cleaned and fed first before keepers enter other enclosures—reduce entry into calving enclosure as much as possible. **Common sense is paramount when designing a sanitation program—don't do anything that will endanger the calf or calf-dam bond.** (Over-cleaning and disturbing the calf's nest may disorient and stress the calf, new smells from disinfectants may disturb the dam, etc.) Keepers should concentrate on preventing introduction of pathogens into the calving enclosure rather than over-cleaning or sanitizing the calving enclosure. Keeping calving barns warm reduces rotavirus and coronavirus survival in the environment. Humidifying the air in calving barns also reduces rotavirus survivability. Proper ventilation in barns reduces aerosol spread of pathogens. Phenolic disinfectants are most effective against rotavirus—dams should be acclimated to the smell of these disinfectants well before calving so the smell is not new.

Photos: *Brookfield*
Top: *rotavirus treatment.*
Bottom: *rear leg fracture caused by maternal trauma.*

Vaccinations:

1. Rotavirus and Coronavirus: Rotavirus and coronavirus are significant enteric pathogens that have caused diarrheal disease in several okapi collections and death in young calves. A modified-live virus vaccine (Calf-Guard®, Pfizer Animal Health, Exton, PA 19341, USA) and a killed virus vaccine (ScourGuard 3®, (K), Pfizer Animal Health, Exton, PA 10341, USA) are commercially available for prevention of rotavirus and coronavirus infections in calves and both have been used in okapi. Both vaccines contain only one group A bovine rotavirus serotype (atypical rotaviruses are typically seen in okapi) so the efficacy under field conditions of both of these vaccines has been seriously questioned. However, clinical impressions suggest that vaccination does reduce the prevalence of serious clinical infections with rotavirus and coronavirus in collections in which these enteric viruses are endemic.

Ideally, Calf-Guard®, must be given orally to calves immediately after birth, before they suckle colostrum, to provide active mucosal immunity, but this is impractical and can put okapi calves at risk for maternal aggression or rejection. Calf-Guard® can safely be used intramuscularly in okapi, but its efficacy by this route is unknown. ScourGuard 3®, (K) was developed for intramuscular use and has been used in both okapi adults and calves. This vaccine has induced moderate to severe muscular swelling, edema, and pain in individual adult okapis after multiple vaccinations. It is recommended that okapi that experience a vaccination reaction to ScourGuard 3® (K) not be vaccinated again with this vaccine (reactions appear to worsen with each successive vaccination). ScourGuard® reactors can be switched to vaccination with Calf-Guard®, if deemed necessary.

Recommended intramuscular vaccine schedule for rotavirus and coronavirus: Initial vaccination of dams, twice, 3–4 weeks apart followed by a preparturient vaccination given 4-6 weeks before each parturition to boost colostral and lactogenic antibodies. Calves should be vaccinated at their neonatal examination and at 4, 8, and 12 weeks of age.

2. *E. coli*: For collections that experience problems with neonatal colibacillosis, dams should be vaccinated during pregnancy with ScourGuard 3®, (K) as described above. An Escherichia coli monoclonal antibody product (Genecol, 99, Shering-Plough Animal Health Corp., Omaha, NE 68103, USA) has been given orally to okapi calves during the first 12 hours of life to prevent adherence of pathogenic *E. coli* to the intestinal mucosa.

3. Other Vaccines: Other vaccines can be used in okapi calves based upon health risks at each institution and the experience of each veterinarian. Other vaccines which have been given to okapi calves include tetanus antitoxin, tetanus toxoid, and polyvalent clostridium bacterins-toxoids.

Neonatal Examination:

This examination should take place within 24 to 96 hours after birth. The exact timing of the examination should take into account the dam's birth history and post-parturient behavior, the calf's attitude and perceived health, and the institutions history of neonatal problems.

Adequate time should be given for good maternal-calf bonding. Each impending examination should be thoroughly discussed between managers, veterinarians, and keepers to reduce the risk of maternal rejection or aggression and trauma to the calf. Risk of maternal aggression is reduced if the neonatal examination is delayed until the calf establishes nesting behavior and the dam willingly leaves the calf alone (generally 48 to 96 hours). The dam can then be locked away from the calf, when she leaves it on her own, and left separated from the calf until the calf calms down and lays down normally in its nest. The examination should be performed as quickly and efficiently as possible using minimal staff. Care should be taken not to apply medications topically to the calf that have abnormal scents (e.g., alcohol, etc.), and to remove human scent from the calf. The re-introduction of the dam should be done with minimal staff present and in a routine manner, so the dam can see the calf in its nest from a distance when she enters the barn. The examination should consist of the following:

1. Complete physical examination (including body weight and rectal temperature).

2. Blood Collection:
   a. CBC* (WBC generally < 10,000 with normal diff, PCV generally > 30%)
   b. Chemistry Profile* (Glucose generally > 90 mg/dl)
      *See in-house or ISIS normals for neonates
   c. Passive Immunoglobulin Transfer Determination
   - Total Solids (generally > 6.0 gm/dl)
   - Total Protein (generally > 6.0 gm/dl)
   - Globulin (generally > 3.0 gm/dl)
   - Glutaradehyde Coagulation Test (generally < 2 minutes)
   - Sodium Sulfite Turbidity Test (14%, 16%, and 18% solutions all positive)
   - Protein Electrophoresis
   - Serum GGT
   d. Genetic Analysis:
   - Chromosome Analysis (Karyotyping)
     Whole Blood in Sodium Heparin (4.0-5.0 ml), ship overnight packed to avoid freezing or overheating to: Genetics, Brookfield Zoo, 3300 Golf Road, Brookfield, IL 60513, call before shipping.
   - DNA Analysis (SSP DNA Bank)
     Whole Blood in EDTA (2.0 ml)(preferred) or Heparin (2.0 ml), can also use blood clots and blood left over from other testing, ship overnight packed to avoid overheating to: Genetics, Brookfield Zoo, 3300 Golf Road, Brookfield, IL 60513, call before shipping.
   - If sending tissue biopsy (skin, etc.), samples should be placed in sterile saline with 0.1 ml of Pen/Strep a (10,000 u and 10mg/ml). Ship overnight packed not to freeze or overheat to same address Genetics, Brookfield Zoo.
   e. In-House Serum Bank

3. Treat Umbilicus (i.e., betadine)

4. Administer Vitamin E (6–11 IU/Kg)

5.Administer Selenium (0.05 mg/Kg), only if deficiencies have been seen

Failure of Passive Transfer of Maternal Immunoglobulins (FPT): Calves with evidence of FPT (based on neonatal blood work) should be observed closely for evidence of illness during the first month of life. These "at-risk" calves should be considered for plasma transfusion to boost serum immunoglobulin levels. Institutions breeding okapi should consider maintaining a frozen plasma bank for such occasions. Calves with FPT will need anywhere from 50 to 200 ml plasma/Kg body weight to raise immunoglobulins to acceptable ranges. The success of plasma transfer in raising serum globulins can be evaluated by measuring serum globulins and performing serum electrophoresis before and after transfusion.

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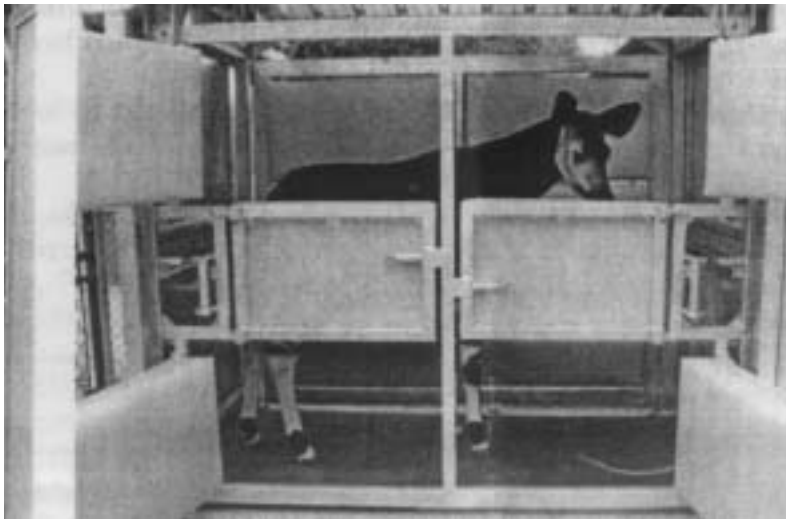
Right: *calf resting outside at Brookfield.*

Quarantine for okapis should be accomplished in a large animal quarantine facility if such a facility exists. Alternatively, the animal could be isolated from other ruminants and cared for by separate staff for the duration of the quarantine period. Pre-shipment tests should be carried out prior to transfer of the animal and repeated during the quarantine period to look for any travel-induced medical concerns.

Routine testing for parasites is recommended followed by treatment as needed. Annual vaccinations in some situations may be advisable depending on institutional and individual history. Acquiring blood samples opportunistically is recommended for baseline data.

To perform medical procedures, several methods have been used successfully. If the procedure is relatively non-invasive (TB test or read, blood draw) and the individual has an approachable temperament, a standing immobilization can be undertaken. Previous training to acclimate the individual to tactile contact is necessary in these circumstances. If the animal is not approachable or not acclimated to direct contact, or the procedure is more involved, a full immobilization is warranted. As with many ruminants, the risk of regurgitation, possibly resulting in inhalation pneumonia, is a serious concern. Individuals should be fasted from food and water for a specified amount of time as directed by the veterinarian. The procedure room should provide good footing and smooth walls to minimize possible injury to the animal. Animal care staff should be prepared to help position the animal as needed to facilitate the procedure and to minimize risk to the animal.

Some individuals have been acclimated to allow minor yet repeated hoof trims without the use of immobilizing drugs or a restraint chute. This acclimation process usually begins when the animal is young and continues into adulthood. It is possible that by utilizing a protective barrier, which allows access to the animal, more procedures could be undertaken with minimal or no tranquilization. This type of acclimation is in development in a few of the managing institutions. Both San Diego Zoo and the Wild Animal Park utilize a restraint box for procedures which is working well for them. Animals walk through the box on a daily basis and are desensitized to touch and confinement as part of their normal routine. Drop chutes have not been utilized for okapis to date. **Geriatric animals** generally suffer from ailments similar to bovids. Arthritis is relatively common. Medication offering pain relief may be warranted. Solid flooring with good traction is important. Rubber flooring or thick bedding may also be warranted.



Photos:
Above: *access windows inside of chute at Dallas.*
Right: *restraint box used at San Diego.*

BEHAVIORAL MANAGEMENT

Behavior management is essential for successful maintenance of the species. It is an integral part of a management program and should be incorporated into daily operations. It must be considered when designing a facility—both on and off exhibit, inside and outside. Enrichment and training should not be programs separate from regular operations, but should be incorporated into the various aspects of the facility design, husbandry program and daily operations.

Training of Animals: Most okapis acclimate to keepers working around them fairly closely to accommodate routine cleaning of outside areas and shifting for interior stall cleaning. Desensitizing an animal to touch can be very helpful to monitor general health. It is possible to acclimate animals to allow a number of relatively non-invasive procedures, which give the animal care staff valuable health information and allow preventative care without the use of immobilizing drugs.

As mentioned above in the medical procedure section, the use of "working panels" or restraint boxes has helped facilitate the training process.

Behaviors or procedures which have been trained at a number of institutions include:

- Target training
- Manipulating feet for inspection and minor hoof trims
- Rectal temperatures
- Standing on a scale to gain routine weights
- Allowing growth measurements to be taken
- Trans-abdominal ultrasounds
- Collecting milk samples
- Acceptance of a crate or transport trailer
- Mouth exam
- Halter training
- Voluntary blood draw

Photos:
Top: *target training at St. Louis.*
Top middle: *a mouth exam at San Antonio.*
Middle bottom: *volunteer hoof trim at San Antonio.*
Bottom: *maintaining acceptance of a halter at San Antonio.*

Technical skills and competencies needed by animal care staff include:

• An understanding of the natural history, physiology, behavior and social structure of the okapi, both in the wild and in the zoo setting.

• An understanding of the basic principles of operant conditioning and training, and the need to integrate these into routine operations.

• Familiarity with, and an understanding of, the basic facility design and its operation.

• Ability to develop a rapport with the individuals in their care.

Photos:
Top: *applying hoof cream at San Antonio.*
Middle: *training for volunteer blood collection at San Antonio.*
Bottom: *a standing immobilization at San Antonio.*

ENRICHMENT

It is important that we strive to maximize opportunities to encourage the okapi's natural repertoire of behaviors in their environment. These activities help engage animals both mentally and physically, and help minimize, or eliminate, negative or unwanted behaviors. Some examples of enrichment are: spending time with their keeper, offering choice browse or smaller portions of their diet throughout the day, or novel items that catch their attention. Depending on the animals involved, allowing social opportunities or providing new areas to explore all contribute to a healthy and well-adjusted animal.

Food items are often the choice for enrichment by allowing for unlimited opportunities of browsing throughout the day. It should be noted that enrichment food items should not exceed the normal diet amounts. Food enrichment provides for needed oral stimulation that might otherwise become negative obsessive behavior. There is a number of approved browse species utilized at each institution and a variety of ways it can be offered. Daily cuttings of branches and leaves can be located at a variety of heights. Alfalfa can be offered in different types of containers and hung to encourage natural foraging overhead. Safe, novel objects like balls that have rough or smooth surfaces, or traffic cones, or even food puzzles, also encourage exploration. A survey completed in 1999 by 11 holding institutions provides information on how various plantings are utilized in outdoor enclosures. While some vegetation is occasionally browsed, most offer other aspects of enrichment for the animals such as, shade, security or cover, or for urine marking by the males.

Non-food items are also used for enrichment. Okapis will rub their necks on edges of objects. Natural-fiber floor mats have been attached to walls or posts for additional rubbing locations. Tips of branches are utilized to scratch the inside of their ears. Groupings of branches hung from above provide cover to hide behind when startled. Solid partitions ~4 feet tall and 6-8 feet long offer cover and at the same time, allow the animal to observe activity from behind by only exposing its head at one end to observe.

Photos: *typical enrichment activities at Brookfield.*

More detailed information on enrichment can be found in the references listed below:

Alison, M.: Okapi Enrichment at Brookfield Zoo. The Shape of Enrichment, Vol. 3, No. 2, 1994.
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