Management and Husbandry of Duikers at the Los Angeles Zoo

Robert Barnes, Kelley Greene, Jeff Holland,* and Marnie Lamm

Los Angeles Zoo, Los Angeles, California

The Los Angeles Zoo has maintained and managed six different species of forest duikers since 1975. Over the years we have achieved relative success with the majority of these species. The maintenance and breeding of duikers has proved to be difficult at best. The major problems that we have experienced concern diet, stress-related medical conditions, neonatal mortality, and postanesthetic pneumonia. As concentrate selectors, duikers have a diet relatively low in fiber, a well-developed ability to forage selectively, a rumen bypass that is functionally important, a rapid passage and high fermentation rate for starch, and frequently encountered toxins. From an examination of the captive diet of duikers it is evident that the domestic fruits fed to duikers in captivity are not well suited for them. Duikers are highly susceptible to the slightest amount of stress. The group size in which duikers are managed has proved to be critical in the successful management of these species. In our earlier years of duiker management we often kept five or more animals together in a single exhibit. This would at times result in stress-related jaw abscesses. Our group size has since been reduced to no more than three animals in any one exhibit. Since 1977, the Los Angeles Zoo has had 92 duiker births. The survival rate past 6 months of age has been 61%. Of the 36 neonatal deaths, 42% were stillborn or died within a few hours of birth. Hypothermia and maternal neglect have been linked to infant mortality. Duikers are also easily prone to capture myopathy and regurgitation during anesthesia or capture, which can often lead to aspiration pneumonia. If at all possible, the capture and restraint of a duiker should be avoided. However, there are times when the capture or restraint (chemically or manually) of a duiker is required.

Zoo Biol 21:107–121, 2002. © 2002 Wiley-Liss, Inc.

Key words: group size; concentrate selector; stress; hand rearing

Duikers can be found everywhere in Africa, south of the Sahara desert. Of the 17 species of duikers, 16 are considered forest duikers and are found in the forested areas. These 16 species fall under the single genus Cephalophus, which refers to the

*Correspondence to: Jeff Holland, Curator of Mammals, Los Angeles Zoo, 5333 Zoo Drive, Los Angeles, CA 90027. E-mail: jholland@zoo.lacity.org

Received for publication May 15, 2001; Accepted November 29, 2001.
DOI 10.1002/zoo.10020
Published online in Wiley InterScience (www.interscience.wiley.com).

© 2002 Wiley-Liss, Inc.
crest of long hair between the horns commonly found among the forested species. The other species, the common duiker, is classified under the genus Sylvicapra and is typically found in savannas and open areas [Kranz and Ralls, 1984].

Duikers (an Afrikaans word meaning “divers”) are named for their habit of diving into thick cover when threatened or disturbed, which is why so little is known about the natural history of these species in the wild. The impenetrability of their habitat coupled with their secretive nature has made it very difficult to gather basic information [Kranz and Ralls, 1984].

Native people hunt duikers for food, and most species live in areas undergoing rapid human population growth. Therefore, the species are subject to intensive hunting and habitat destruction. The majority of the species have a limited distribution, although they are still common, while some have been almost entirely wiped out in West Africa [Nowak, 1999].

The IUCN has classified *C. adersi* and *C. rubidus* as endangered, and *C. spadix*, *C. jentinki*, and *C. zebra* as vulnerable. In addition, *C. jentinki* is listed as endangered by the USDI and is in Appendix I of CITES. All five species have very limited ranges [Nowak, 1999].

The IUCN has also designated *C. natalensis*, *C. harveyi*, and *C. rufilatus* as conservation-dependent, and all other *Cephalophus*, except *C. monticola*, as threatened. Those species listed in Appendix II of CITES include *C. monticola*, *C. ogilbyi*, *C. sylvicultor*, *C. dorsalis*, and *C. zebra* [Nowak, 1999].

**Duiker Population of the Los Angeles Zoo**

The Los Angeles Zoo has maintained and managed six different species of forest duikers since 1975. They include the zebra duiker (*Cephalophus zebra*), red-flanked duiker (*C. rufilatus*), black duiker (*C. niger*), bay duiker (*C. dorsalis*), Jentink’s duiker (*C. jentinki*), and yellow-backed duiker (*C. sylvicultor*). Over the years we have had relative success with the majority of these species. The black and bay duikers have done exceptionally well, while the remainder have either held their own or, in the case of the Jentink’s, have done poorly.

Maintaining and breeding duikers has proved to be difficult at best. The major problems that we have experienced concern diet, stress-related medical conditions, neonatal mortality, and postanesthetic pneumonia and mortality.

**Temperature**

Duikers are not a cold-tolerant animal and should not be kept outdoors when the ambient temperature falls below 55°F (7°C) for extended periods. When the animals are kept outdoors below 55°F a heated barn or shelter is required for the animals. Duikers can tolerate temperatures of 110°F (43°C). However, misters should be provided for the comfort of the animals during extended periods of high temperatures (85°F or above).

**Enclosure Barriers**

Exhibit barriers can be constructed of chain link, wood fencing, 1inch wire mesh, and/or block or formed wall. When a block or formed wall is used as part of the exhibit it is recommended that the sides of the walls be smooth in order to prevent any scrapes or abrasions that the animals might obtain when running in the exhibit. Duikers will often run blindly when frightened or being pursued, and therefore a
Management and Husbandry of Duikers

visual barrier along the chain link or mesh should be provided. Reed fencing or shade cloth works well for this purpose. The barriers should be at least 6 feet high.

The Los Angeles Zoo uses glass fronts to enable viewing. When an animal is introduced into a glass-fronted exhibit, the glass should be covered with soap or strips of white tape so that the duiker is aware that a barrier exists. After a few days the animals should be well adjusted and the soap or tape can be removed. However, we have found that even after many years in a glass-fronted exhibit an animal that is spooked or trying to avoid capture will try to run through the glass. Consequently, we no longer keep duikers behind glass and do not recommend its use in a duiker enclosure.

Outdoor Enclosures

The enclosure should be on level ground with no drastic change in landscape, such as a sharp incline or drop-off. Since forest duikers are a rainforest-dwelling species, the enclosures should be provided with an ample amount of cover, particularly for those duikers that are viewed by the public. Several types of low- to medium-growing plants that are not browse favorites can provide plenty of cover for the animals to hide in. The addition of crates or dog igloos in the enclosure also provides an area in which the animals can feel more secure. The use of a crate has the added advantage that the animals can become accustomed to entering a crate, thereby reducing their stress level when it comes time to crate the animals for shipment or a medical procedure.

The enclosure size for the black, red-flanked, zebra, and bay duikers is a minimum of 8' x 26'. Enclosure sizes larger than these have successfully been used with black duikers. The minimum enclosure size for Jentink’s and yellow-backed duikers is 40’ x 100’. Our yellow-backed duikers were kept in a 181’ x 56’ enclosure, in a mixed display with bongos. Figure 1 shows the layout and size of the yards and stalls utilized at our current off-exhibit duiker facility. This facility has housed black, red-flanked, and zebra duikers.

If the shrubs and trees do not provide ample shade within the exhibit, additional shade is recommended. In most cases the use of shade cloth over at least half of the enclosure will suffice.

Indoor Enclosures

The use of a temperature-controlled barn in which the duikers can be secured at night, and to which they are provided access during inclement weather, is recommended. In the past, hypothermia and maternal neglect were very much associated with infant mortality among those animals without a barn.

The minimum size for a stall housing black, red-flanked, zebra, or bay duikers is 8’ x 8’ (see Fig. 1). The maximum stall size we have used for these duikers is 12’ x 12’. For the Jentink’s and yellow-backed duikers the stalls are a minimum of 12’ x 12’.

At least two stalls with sliding doors (4’ x 8’) between them should be used for each pair of animals in order to allow for separation and/or movement of the animals if necessary.

Each stall is provided with forced-air heat, radiant heaters, or heat lamps hung from the ceiling. The heaters and lamps are secured 3 feet above the floor in order to provide adequate heating for the smaller duikers, and no more than 5 feet above the floor for the larger duikers.
Plenty of ventilation is provided throughout the stalls. A series of 18” × 24” sliding windows line the top of our off-exhibit stalls, as well as a single 18” × 24” ventilation window (covered with 1/4 inch hardware cloth) approximately 3 feet from the floor in each stall.

The stall surface is either roughened cement or dirt substrate that is heavily bedded with shavings. A dirt substrate provides better traction for the animal; however, it creates a lot of dust and needs to be replaced on a regular basis since areas become saturated with urine.

**Mixed-Species Displays**

Over the years we have displayed our duiker species with a number of bird and mammalian species, with varying degrees of success. We currently house a pair of black duikers with harnessed bushbuck (*Tragelaphus scriptus scriptus*), with few problems. Both species are housed in separate stalls at night, and the duikers have access to a small outdoor holding yard. We have also had success in displaying yel-
low-backed duikers with bongo (*Tragelaphus eurycerus isaaci*) and bat-eared foxes (*Otocyon megalotis*). Each species was secured in separate stalls at night, except for the bat-eared foxes, which remained on exhibit. The yellow-backed duikers were confined to a small holding yard with access to a small barn, while the bongos were housed in individual stalls.

We have also displayed red-flanked, zebra, and black duikers with crowned lemurs (*Eulemur coronatus*) and greater galagos (*Otolemur crassicaudatus*) with no problems. In the past we have tried red-flanked duikers with moustached guenons (*Cercopithecus cephus*), and zebra duikers with talapoin monkeys (*Miopithecus talapoin*). The guenons had a tendency to jump on and ride the backs of the duikers, but as the guenons matured they did not hassle the duikers as much. The talapoin monkeys caused the duikers to be very nervous, and the exhibit did not provide enough space for the duikers to get away.

Currently we display a pair of red-flanked duikers with a pair of white-crested touracos (*Tauraco leucolophus*), which has been successful. The male duiker adjusted well to the birds; however, the female duiker at first was often spooked by the touracos flying overhead and/or “dive bombing” her. It took her about 3 weeks to adjust to the birds’ presence.

**Group Size**

Duikers are highly susceptible to the slightest amount of stress. Careful attention must be given to reducing the amount of stress these animals experience. The group size in which they are managed has proved to be critical in the successful management of these species.

In our earlier years of duiker management we often kept five or more animals together in a single exhibit. This overcrowding usually resulted in stress-related jaw abscesses. We have since reduced our group size to single animals, pairs, or at the most, trios. Trios have consisted of a single male and two females, three females, or a pair and their offspring. Pairs are typically a single male and single female, or, occasionally, two females. We have kept two male red-flanked duikers together, as well as two male zebra duikers. In both cases the animals were hand raised together, and once they reached sexual maturity (at the age of 2) they had to be separated because of fighting.

We have observed no negative effects from housing animals singly, and they seem to do quite well under those conditions. In some instances a highly stressed animal can benefit from being paired with an animal that is much calmer, and will settle down to a more manageable condition. However, this pairing can also have the opposite effect: the calm animal becomes stressed because of the excitable animal.

**Breeding and Parturition**

Upon the initial introduction of a male to a female, the male may become aggressive with the female by continuously chasing her. Adequate keeper staff needs to be on hand during these initial introductions to intervene if necessary. These initial periods of chasing should not last more than a few hours. If the male becomes overly aggressive, the pair should be separated. Once introduced the pair should settle down. The female’s first estrus should be non-eventful, with the exception of some chasing by the male if the female is not quite receptive.

Observations of duikers in captivity suggest that estrus occurs about once a month throughout the year [Nowak, 1999]. Estrus will usually last 2–3 days. A fe-
male can give birth to two single offspring within a 12-month period. Nowak [1999] suggested that the gestation period is 126 days for *C. niger* and as long as 245 days for *C. rufilatus*. Observations at the Los Angeles Zoo have been limited, and an actual breeding date has never been recorded in order to determine an accurate gestation. However, the birth interval is on average 6.5 months for *C. rufilatus* and 7.5 months for *C. niger*.

Throughout the gestation period the male can remain with the female. The female will become noticeably larger over the months leading up to parturition, and her food consumption will increase.

**Hand Rearing**

Since 1977, the Los Angeles Zoo has had 92 duiker births: 49 neonates (52%) were male, 42 (47%) were female, and one was classified as undetermined. The survival rate past 6 months of age has been 61%. Of 36 neonatal deaths, 15 (42%) were stillborn or died within a few hours of birth.

Since 1980, 35 neonates have successfully been raised to weaning age. The decision to pull neonates from their dams has been based on the condition of the calf, maternal behavior of the dam, and conditions relating to husbandry, such as available heat, hiding places, potential for disturbance by the public, and number of duikers in an enclosure. Presently all duiker calves are pulled for hand rearing in order to keep the animals in a relatively calm state, thus making management of these species much safer and less difficult. There is one exception in which we do not pull a calf for hand rearing, and that is when both the sire and dam are very tractable and calm. In this instance we have found that the calf will also become tractable and calm.

Of the 39 births of red-flanked duikers at the Los Angeles Zoo, 15 were parent reared and 24 were hand reared. Of the 15 parent-reared animals, the longest life span was 5 years 7 months; the hand-reared animals include seven animals that are still alive, with ages between 6 and 11 years. The vast majority (14 of 17) of our black duikers have been hand reared. We have five animals that are still alive, and are between 5 and 11 years of age. The neonatal mortality has been reduced over the years, thus enabling the growth of the population of black and red-flanked duikers. However, because of the high degree of inbreeding among both the red-flanked duikers and the black duikers we have experienced deleterious inbreeding effects, including hermaphroditism, lack of bile duct, and extra dew claws. These inbreeding effects have been the recent causes of our neonatal mortalities.

When feasible, neonates are left with their dams for 24 hr to ensure adequate intake of colostrum. If they are allowed to remain with their dams for longer periods of time, it is often difficult to establish them on a bottle.

Neonates are kept in a stall that is heavily bedded with wood shavings. They are placed on towels to prevent ingestion of shavings and to facilitate monitoring of fecal and urine output. Stalls are heavily bedded to provide good footing and prevent leg splaying. Ambient nursery temperature is maintained at about 70°F, and spot heat in the form of heat lights is provided.

Duiker calves are fed six times a day at 3-hr intervals as follows: 9 AM, noon, 3 PM, 6 PM, 9 PM, and midnight. Amounts fed are determined by birth weight (Table 1). Starting volumes of formula taken range from 15 to 150 ml/day on days 0 and 1. The first feeding consists of tepid, previously boiled distilled water, one-half the amount of formula that would be offered. This initial feeding allows the keeper
to evaluate the feeding response, and potential aspiration of formula is avoided. For the first 72 hr, neonates are fed bovine colostrum. Raw colostrum is purchased from a dairy that is certified Johne’s free. Colostrum is pasteurized by placement in a 55°C water bath shaker for 45 min and cultured before use.

Plastic Evenflow® baby bottles (Evenflow Company, Ravenna, OH) with human “preemie” nipples are used. The nipple hole is enlarged slightly with a hot needle. All feeding equipment is washed in hot water and dish soap, then soaked in a chlorine bath of 1 cup of bleach to 3 gallons of water between feedings, and rinsed thoroughly before use.

At 72 hr the formula is changed to 50% cow’s colostrum and 50% evaporated (not condensed) goat’s milk that has been diluted with equal parts distilled water. This formula is fed for another 72 hr. At 6 days, the colostrum makes up 10% of each bottle of reconstituted goat’s milk as follows: 10 ml colostrum + 90 ml of evaporated goat’s milk diluted 1:1 (45 ml:45 ml) with distilled water. This formula is fed until the calf is 21 days old, and thereafter only evaporated goat’s milk diluted 1:1 with distilled water is fed until weaning. When the calf is 7 days old, the formula is supplemented with ¼ teaspoon of Vitamin E acetate powder (500 iu/gm) once daily, and Hi-Vite drops (EVSCO Pharmaceuticals, affiliate of IGI Inc., Buena, NJ) at the rate of one drop per 50 ml of formula in each bottle.

Formula increases are made at 72 and 144 hr, and then weekly for about 45 days. Increases are usually in increments of 20%. Weaning begins at day 60 by eliminating one feeding per day each week and is completed at 93–100 days (Table 2). A bottle of warm water is offered once daily after weaning, as long as it is accepted, in order to keep the calf tractable and as a way to administer oral medications if necessary.

Alfalfa hay and acacia browse are offered from birth, and ADF-16 herbivore pellets (5/32” size) and Mazuri browser maintenance pellets are offered at 30 days. Animals housed with older hoofstock companions tend to start eating solid foods earlier than those housed alone. Rumination is usually first noted by 3–4 weeks.

Hand-reared duikers must be stimulated to manually defecate and urinate until 1–2 weeks of age. Meconium is passed in the first 24–48 hr, followed by yellow- to orange-colored pasty stools. Normal pelleted or log-shaped feces are passed starting at approximately day 20–30 once solid food is being eaten regularly.

The average birth weight of black, red-flanked, and zebra duikers is shown in Table 3. The weighing of hand-reared duikers is easily accomplished up until the age
of about 25 days. At this point the calves become less intolerant of being handled and are not as willing to stand on a scale long enough to be weighed. Therefore, the weights recorded after 25 days do not include all the animals included in the average weights for birth to 10 days of age. See Appendixes I and II for individual birth weights and weight progression.

**Socialization**

Neonates raised alone tend not to thrive and are nervous and flighty. Neonates are kept alone in a small (5’ x 5’) stall until they are reliably taking bottle-feeding, and then they are placed with other neonatal/juvenile hoofstock within a few days. Duikers at the Los Angeles Zoo have been housed with infant gerenuk, axis deer, pudu, bushbuck, Arabian oryx, warthog, and pronghorn.

Hand-raised duikers have been easily introduced to other parent-reared duikers. No efforts are made by nursery staff to prevent imprinting on humans. For the most part, hand-reared neonates tend to behave normally socially and reproductively, and are calmer and less stress-prone than mother-reared duikers.

**Postnatal Processing**

Within the first 48 hr of birth, and often during transfer to the nursery, neonates are given full physical exams, sexed, weighed, given a vitamin E injection, ear-notched

| Species    | Sex  | Birth | 8–10 days | 25–30 days | 40–45 days |
|------------|------|-------|-----------|------------|------------|
| Black      | Male | 1.42–2.18 | 1.65–3.20 | 3.85–4.00 | 5.9        |
|            | Female | 1.45–2.05 | 1.80–2.75 | 2.75–3.65 | 3.85–3.95  |
| Red flanked| Male | 0.82–1.70 | 1.20–1.67 | 1.75–2.64 | 2.50–3.36  |
|            | Female | 0.81–1.10 | 1.45–2.62 | 2.10–2.25 | 2.50–3.15  |
| Zebra      | Male | 1.30–1.75 | 1.71–2.10 | 2.95–3.60 | 4.45       |
|            | Female | 1.27–1.55 | 2.2 | 2.85–3.15 | 3.62–4.62  |
and transpondered, and the umbilicus is cleaned and dipped in iodine. Blood is collected for a complete blood count and serum chemistry panel. Immediate in-house blood work includes total protein, packed cell volume, glucose, and glutaraldehyde tests. The glutaraldehyde test is the testing of proteins for passive transfer. The situation and condition of the neonate often dictate whether these procedures are done all at once or at intervals. The umbilicus is checked and cleaned with Betadine solution on initial examination and one to two times daily until the stump dries and falls off, which usually takes a week.

**Glutaraldehyde Test Protocol**

1. Make 10% glutaraldehyde solution by mixing 4 ml of 25% glutaraldehyde and 6 ml distilled water.
2. Mix 1 part reagent (50 μl) + 10 parts serum.
3. Observe coagulation time by tilting tube. Should coagulate in <1 hr.

**Vaccination Protocol**

| Time            | Vaccine                                                                 |
|-----------------|-------------------------------------------------------------------------|
| Day 0:          | *E. coli* (Genecol) orally if no nursing observed.                      |
| 2 months:       | Tetanus toxoid                                                          |
| 3 months:       | Tetanus toxoid                                                          |
| Weaning or 5 months: | IBR/BVD, PI3, Lepto, Pomona, hardjo, grippotyphosa, canicola, icterohemmagica (Triangle 8), Clostridium bacterin (which includes *C. tetani* and *C. chauvoei*, septicum, novyi, perfringens C&D, haemolytica (Covexin 8)), Rabies |
| 1 month later:  | Triangle 8, Covexin 8                                                  |
| Annually:       | Triangle 8, Covexin 8, Rabies                                           |

When feasible, animals known to be pregnant are boostered prior to parturition with a killed vaccine combination of rotavirus, coronavirus, *E. coli*, Clostridium perfringens (ScourGuard, Pfizer Animal Health, Exton, PA), and tetanus (Covexin, Schering-Plough Animal Health Corp., Omaha, NE). They are given two doses 2 weeks apart, with the last dose ideally at 2–3 weeks prior to parturition.

**Diet**

Duikers are considered concentrate selectors in ruminant feeding ecology. Concentrate selectors are grouped into two categories: browsers (those that eat leaves and herbs) and frugivores (those that eat fruits). Duikers fall into the frugivore category. The implications of being concentrate selectors are that they have a diet relatively low in fiber, a well-developed ability to forage selectively, a rumen bypass that is functionally important, a rapid passage and high fermentation rate for starch, and frequently encounter toxins [Dierenfeld, 2000].

From examination of the diets of captive duikers compared to diets in the wild, it is evident that the domestic fruits fed to duikers in captivity are not well suited for them. Domestic fruits contain 80–90% sugar and 1–4% fiber, whereas the wild fruits eaten by duikers contain less than 50% sugar and are 14–62% fiber. The wild fruits, such as Rheedia, Licania, and Clusia, contain chemicals and tannins not found in the domestic fruits [Dierenfeld, 2000].
The diet for the duiker species at the Los Angeles Zoo has gone through an extensive evolutionary process. Our original diet (for two duikers) consisted of the following: a handful of alfalfa hay; 6 cups of monkey chow; 15 carrots (diced); 6 apples (diced); one bunch of broccoli or one head of lettuce; half-pound of grapes; 2 cooked yams; quarter-pound of raw meat.

We have since found that the duikers do exceptionally better with the elimination of monkey chow, cooked yams, grapes, and raw meat. In addition we decreased the overall amount of apples and carrots while increasing the herbivore pellets and browse intake. Our current duiker diets follow.

Red-flanked duiker diet for 1.1 animals: free choice of alfalfa hay; 2 quarts of Mazuri browser maintenance pellets; browse (Table 4); one bunch of broccoli or spinach (alternated every other day); quarter-pound of squash (butternut or acorn); quarter-pound of carrots Black duiker diet for 1.1 animals: free choice of alfalfa hay; 3 quarts of Mazuri browser maintenance pellets; browse (Table 4); one bunch of spinach or broccoli (alternated every other day); half-pound of squash (butternut or acorn); three-quarters-pound of carrots.

Over the years we have observed that the amount of browse offered to the duikers has a direct effect on their overall health. The more browse the duikers consume, the better their overall health.

Browse Species Fed to Duikers

Initial information concerning native food composition, and experimental data from captive duikers suggest that domesticated fruits raised for human consumption are poor nutritional (chemically or physically) substitutes for the foods eaten by duikers. Browse leaves and/or domestic vegetables (with rinds) appear to provide more appropriate dietary substitutes, and are being investigated in more detail. In addition, no commercially available pelleted product has been shown to be clearly optimal for maintaining the health of captive duikers. Clearly, research is needed to find the optimum diet for the forest duiker species [Dierenfeld, 2000].

Table 4. Browse species fed to duikers

| Common name                  | Scientific name             | Comments                                      |
|------------------------------|-----------------------------|-----------------------------------------------|
| Acacia                       | Acacia sp.                  | Well liked depending on species              |
| Cape plumbago                | Plumbago auriculata         | Well liked                                    |
| Mulberry                     | Morus sp.                   | Well liked, seasonal                          |
| Fruitless mulberry           | Morus alba                  | Well liked, seasonal                          |
| Cottonwood                   | Populus sp.                 | Well liked, seasonal                          |
| Chinese elm                  | Ulmus parvifolia            | Some individuals like                        |
| Natal plum                   | Carissa grandiflora         | Well liked, watch the thorns                 |
| Hibiscus (flowers & leaves)  | Hibiscus sp.                | Well liked                                    |
| Eugenia                      | Eugenia sp.                 | Some individuals like                        |
| Ficus                        | Ficus benjimina             | Some individuals like                        |
| Evergreen pear               | Pyrus kawakamii             | Well liked                                    |
| Rose flowers                 | Rosa rugosa                 | Well liked                                    |
| Loquat (leaves only)         | Eriobotra japonica          | Some individuals like                        |
| Mimosa or silk tree          | Albizia julibrissin         | Some individuals like                        |
| Kaffir plum                  | Harpephyllum caffrum        | Some individuals like                        |
| Flowering plum               | Prunus cerasifera           | Well liked                                    |
| Jacaranda                    | Jacaranda minosifolia       | Some individuals like                        |
Capture and Restraint

If at all possible the capture and restraint of a duiker should be avoided. Duikers are very “flighty,” high-strung animals. Even hand-reared animals will become flighty when captured or restrained. Duikers are easily prone to capture myopathy and regurgitation, which often leads to aspiration pneumonia. However, there are times where capturing and restraining the animal is unavoidable, such as for shipping or medical procedures.

The most desirable method of capture, particularly for transport, is to have the animal herded or lured into a crate or kennel to which the animal is accustomed. This can often be accomplished by feeding the animal inside the crate on a regular basis. This way the crate or kennel door can easily be closed behind the animal. If the crate or kennel serves as a safe haven for the animal when it is spooked, it will often take refuge inside when forced, and the door can be closed behind the duiker.

If the duiker needs to be anesthetized, it should be confined to a small stall that is void of any objects. If the duiker can be secured inside a crate or kennel, isoflurane gas can be used for induction. We have used a modified kennel that is completely enclosed, with an attachment to allow for the administering of isoflurane gas. If the anesthetizing of the duiker is planned ahead of time, the modified kennel is left in the duiker exhibit for several days and the animal is fed inside. This allows the duiker to become accustomed to the kennel. On the day of the procedure the duiker is lured into the kennel and closed inside. The animal is then transported to the health center, where it is anesthetized with isoflurane gas. If this method is unavailable, a dart is used to administer the immobilization drug.

A quick capture to administer a TB test or to lance a jaw abscess can be accomplished by the use of hand nets for the smaller forest duikers. The duiker is confined to a small stall and two keepers, each with a net, enter the stall and as quickly as possible net the animal and immediately restrain it. Speed is essential in capturing these animals because they can quickly become overheated. This is particularly true of the black duikers. One keeper controls the animal’s back legs and the other keeper holds the head and front legs. It is very important to avoid applying too much pressure and restraint to the duiker’s legs, to prevent their being broken. Close attention is paid to the animal’s breathing and swallowing reflex. At the slightest sign of regurgitation or irregular breathing the duiker is immediately turned loose. For medical procedures it is important that the veterinary staff be prepared to complete the procedure as quickly as possible. It is also important to remember not to apply pressure to the rumen area, and to move the animal as little as possible during any restraint to help prevent regurgitation. Although this method generally has been successful, a number of animals have died during capture or a few days later due to capture myopathy.

Shipping and Transport

For transport, a crate that meets or exceeds IATA regulations is utilized. Wooden crates measuring 32” L x 24” W x 28” H with slated floors for good footing, and plenty of ventilation holes, are used to transport black duikers. The crate size for the red-flanked duikers is 28” L x 17” W x 20” H. The floor of the crate is bedded with shavings and straw or alfalfa for comfort. Since duikers are easily frightened, the ventilation holes are covered with cut burlap bags to give the animals a sense of security. When transporting *C. sylvicultor* and *C. jentinki*, the top of the crate is
padded to prevent damage to the horns. Most of the duikers we have shipped have
gone by plane and have done well.

Acclimating an animal to the crate in advance is essential to alleviate any un-
necessary agitation during shipment. To animals that are very flighty we have ad-
ministered fluphenazine decanoate (Gensia Laboratories, Ltd., Irvine, CA) a few days
prior to shipment to calm the animal down. This drug is a long-acting neuroleptic
that is used to relieve anxiety, decrease motor activity, and moderate excitement. The
effects of fluphenazine decanoate occur within 24–72 hr and can last up to 21 days.
The use of neuroleptic drugs in ungulates has been shown to: 1) alter the mood or
attitude of the animal; 2) cause the animal to be indifferent to its surroundings; 3)
reduce the animal’s fear of humans and inability to tolerate them at close proximity;
4) reduce belligerent, dominant, and aggressive behavior; and 5) reduce self-inflicted
trauma. Prolixin is a compound that has a long history of use in human medicine;
however, it has been rarely used in veterinary medicine [Blumer, 1991]. For a single
adult male red-flanked duiker we administer 15 mg of Prolixin, which lasts 3 weeks.

CONCLUSIONS

1. A great deal of progress has been made over the years in the management
and husbandry of these unique and delicate animals. The increased life span for sev-
eral of the duiker species of less than 5 years to over 8 years, and in some cases over
10 years, appears to be associated with hand rearing, improved diet, and reduced
social groupings.

2. The need to find a diet more closely resembling the wild diet is still press-
ing, as is the need to reduce the number of deaths associated with anesthesia. Over-
all, great strides have been made in duiker management that have led to improved
husbandry and maintenance, as well as to the availability of these sensitive animals.
These improvements have led animal managers who once ignored these species due
to their lack of availability and difficult management to consider them for their col-
lection plans.

ACKNOWLEDGMENTS

We thank the staff of the Los Angeles Zoo for its long-term support and com-
mmitment to duiker management. In particular, we thank the animal-care staff—An-
gela Anderson, Robin Noll, Robin Parker, and Fran Woods—for their several years
of work in improving the management of the duiker species at the Los Angeles Zoo.
We also thank Cathleen Cox, Los Angeles Zoo Director of Research, and Michael
Dee, General Curator, for their valuable comments on the manuscript.

REFERENCES

Blumer E. 1991. A review of the use of selected
neuroleptic drugs in the management of non-
domestic hoofstock. Proceedings American As-
sociation of Zoo Veterinarians, Calgary. p 333–9.
Dierenfeld E. 2000. Duiker Workshop Minutes.
Husbandry, nutrition and health of captive duik-
ers. St. Catherines Wildlife Conservation Cen-
ter. March 24–27.
Kranz K, Ralls K. 1984. Duikers. In: MacDonald
D, editor. The encyclopedia of mammals. New
York: Facts on File. p 556–7.
Nowak R. 1999. Walker’s mammals of the world.
Baltimore and London: Johns Hopkins Univer-
sity Press. p 1164–5.
APPENDIX I. Duiker birth weights

| C. niger | C. rufilatus | C. zebra | C. dorsalis | C. sylvicultor |
|----------|-------------|---------|-------------|---------------|
| 1.85 kg (m) | 1.35 kg (f) | 1.62 kg (f) | 3.65 kg (m) |
| 1.80 kg (f) | 1.15 kg (m) | 1.30 kg (m) |
| 1.42 kg (f) | 1.15 kg (f) | 1.59 kg (m) |
| 1.45 kg (f) | 1.10 kg (m) | 1.50 kg (f) |
| 1.80 kg (f) | 1.17 kg (f) | 1.27 kg (f) |
| 1.70 kg (f) | 1.05 kg (m) | 1.55 kg (f) |
| 2.05 kg (m) | .82 kg (f) | 1.55 kg (m) |
| 1.65 kg (f) | 1.05 kg (f) | 1.75 kg (m) |
| 2.18 kg (m) | 1.05 kg (f) |
| 2.05 kg (f) | 1.00 kg (f) |
| 1.42 kg (m) | .90 kg (m) |
| 1.70 kg (m) | .90 kg (f) |
| 1.70 kg (f) | 1.15 kg (f) |
| 1.70 kg (f) | 1.00 kg (f) |

* Died at 3 days, ingested shavings.
* Died at 4 days, ruptured rumen.
* Died at 5 days, bloat.
* Euthanized at 26 days, no bile duct.
* Euthanized, no feeding response; extra dew claw.
* Died, no gall bladder.
* Euthanized, neurologic problem.
* Euthanized, hermaphrodite.
* Euthanized, urine in abdomen.

APPENDIX IIA. Weight progression of hand reared female duikers

| C. dorsalis |  |
|-------------|---|
| Day 4 | Day 42 | Day 55 |
| 1.62 kg | 3.65 kg | 4.60 kg |

| C. zebra |  |
|----------|---|
| Birth | Day 7 | Day 41 |
| 1.50 kg | 2.25 kg | 4.45 kg |
| Birth | Day 3 |
| 1.27 kg | 1.30 kg |
| Birth | Day 6 | Day 27 |
| 1.55 kg | 2.20 kg | 2.95 kg |

| C. niger |  |
|----------|---|
| Birth | Day 7 | Day 15 |
| 2.05 kg | 2.70 kg | 3.15 kg |
| Birth | Day 5 | Day 9 |
| 1.80 kg | 2.10 kg | 2.50 kg |
| Birth | Day 7 | Day 14 | Day 25 |
| 1.65 kg | 1.60 kg | 1.85 kg | 2.20 kg |
| Birth | Day 7 | Day 45 |
| 1.45 kg | 1.75 kg | 3.95 kg |
| Birth | Day 6 | Day 11 |
| 1.45 kg | 1.70 kg | 2.00 kg |

(continued)
APPENDIX IIA. Continued.

| Species         | Birth     | Day 8     | 5½ mo  | Day 15 | Day 23 | 6 mo   | Day 7   | Day 42 | Day 50 | 17.25 kg |
|-----------------|-----------|-----------|--------|--------|--------|--------|---------|--------|--------|----------|
| C. niger        | 1.70 kg   | 2.25 kg   | 15.40 kg | 1.80 kg | 2.95 kg | 3.65 kg | 1.70 kg | 2.15 kg | 4.55 kg | 5.20 kg  |

| Species     | Birth | Day 12 | 11 mo | Day 7 | Day 26 | 2.35 kg | Day 35 | 1.57 kg | 2.35 kg | 1.15 kg |
|-------------|-------|--------|-------|-------|--------|---------|--------|---------|---------|---------|
| C. rufilatus | 1.15 kg | 1.56 kg | 9.3 kg | 1.17 kg | 1.57 kg | 2.35 kg | 1.15 kg | 1.25 kg | 2.35 kg | 1.15 kg |

| Species       | Birth     | Day 12 | 11 mo | Day 7 | Day 27 | 2.35 kg | Day 35 | 1.57 kg | 9.7 kg  | 1.15 kg |
|---------------|-----------|--------|-------|-------|--------|---------|--------|---------|---------|---------|
| C. sylvicultor | 1.05 kg   | 1.55 kg | 2.35 kg | 0.90 kg | 1.35 kg | 2.85 kg | 1.00 kg | 1.40 kg | 2.50 kg | 1.15 kg |

APPENDIX IIB. Weight progression of hand reared male duikers

| Species         | Birth     | Day 7 | Day 30 | Day 7 | Day 30 | Day 7 | Day 37 | 5 mo   | Day 7 | Day 42 | Day 57 | Day 86 |
|-----------------|-----------|-------|--------|-------|--------|-------|--------|--------|-------|--------|--------|-------|
| C. sylvicultor  | 3.65 kg   | 4.10 kg | 6.60 kg | 1.05 kg | 1.35 kg | 3.35 kg | 1.59 kg | 1.83 kg | 4.40 kg | 1.15 kg |

| Species         | Birth     | Day 7 | Day 44 | Day 41 | Day 41 | Day 7 | Day 44 | 4 mo   | Day 7 | Day 42 | 4 mo   | Day 53 |
|-----------------|-----------|-------|--------|--------|--------|-------|--------|--------|-------|--------|--------|--------|
| C. zebra        | 1.30 kg   | 1.64 kg | 3.74 kg | 1.83 kg | 4.17 kg | 6.02 kg | 1.55 kg | 1.95 kg | 4.40 kg | 1.75 kg |

| Species         | Birth     | Day 7 | Day 42 | Day 42 | Day 42 | Day 7 | Day 44 | 5 mo   | Day 7 | Day 42 | Day 42 | Day 42 |
|-----------------|-----------|-------|--------|--------|--------|-------|--------|--------|-------|--------|--------|--------|
| C. niger        | 1.85 kg   | 2.60 kg | 5.45 kg | 1.85 kg | 2.60 kg | 5.45 kg | 1.85 kg | 2.60 kg | 5.45 kg | 1.85 kg |

(continued)
### APPENDIX IIIB. Continued.

| C. *niger*     | Birth   | Day 7 | Day 42 | Day 55 |
|----------------|---------|-------|--------|--------|
|                | 1.70 kg | 2.15 kg | 4.25 kg | 5.50 kg |

| C. *rufulatus*  | Birth   | Day 7 | Day 42 | Day 72 | Day 92 |
|----------------|---------|-------|--------|--------|--------|
|                | 1 lb. 11 oz. | 1 lb. 13.5 oz. | 2 lb. 9 oz. | 3 lb. 3 oz. | 3 lb. 8 oz. |
|                | 1.15 kg | 1.44 kg | 3.24 kg | 4.62 kg | 9.975 kg |

| Birth   | Day 7 | Day 42 | Day 56 |
|---------|-------|--------|--------|
| 1.10 kg | 1.55 kg | 2.90 kg |
| Birth   | Day 7 | Day 21 | 13 mo  |
| .90 kg  | 1.20 kg | 1.85 kg | 9.7 kg |
| Birth   | Day 5  |       |        |
| .85 kg  | .85 kg  |       |        |
| Birth   | Day 12 |       |        |
| .906 kg | 1.35 kg |       |        |
| Birth   | Day 7  | Day 42 |        |
| .85 kg  | 1.10 kg | 2.80 kg |
| Birth   | Day 7  | Day 30 |        |
| .95 kg  | 1.20 kg | 2.20 kg |