ASSOCIATION OF ZOOS & AQUARIUMS

EULEMUR
(*Eulemur* spp.)
CARE MANUAL

CREATED BY
AZA PROSIMIAN TAXON ADVISORY GROUP
IN ASSOCIATION WITH
AZA ANIMAL WELFARE COMMITTEE

Eulemur Care Manual

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Authors and Significant Contributors:

Gina M. Ferrie, Disney's Animal Kingdom, AZA Mongoose Lemur SSP Coordinator, Eulemur Point of Contact
Tammie Bettinger PhD, Disney's Animal Kingdom, Former AZA Eulemur SSP Coordinator, Former Vice Chair AZA Prosimian TAG
Christopher Kuhar PhD, Cleveland Metroparks Zoo, Former AZA Eulemur Vice SSP Coordinator, Former AZA Prosimian TAG Vice Chair
Cheryl Lent, Indianapolis Zoo, Former AZA Mongoose Lemur SSP Vice Coordinator
Kris K. Becker, Disney's Animal Kingdom, AZA Brown Lemur Studbook Keeper
Cathy Williams DVM, Duke Lemur Center, Veterinary Advisor
Randy Junge DVM, Columbus Zoo, Veterinary Advisor
Megan Elder, St. Paul's Como Zoo, AZA Crowned Lemur Studbook Keeper
Monica Mogilewsky, Lemur Conservation Foundation, Former AZA Prosimian TAG Secretary
Andrea Katz, Duke Lemur Center, Husbandry Advisor, AZA Prosimian TAG Steering Committee Member
Julie Taylor, Duke Lemur Center, AZA Red-bellied Lemur Studbook Keeper, AZA Mongoose Lemur SSP Vice Chair
Jason Williams PhD, Indianapolis Zoo, Nutrition Advisor
Elizabeth Koutsos PhD, Mazuri, Nutrition Advisor
Tad Schoffner, Cleveland Metroparks Zoo, AZA Mongoose Lemur Studbook Keeper, AZA Prosimian TAG Steering Committee member
Jennifer J. Elston PhD, Disney's Animal Kingdom
Jenny L. Campbell PhD, Duke Lemur Center
Christina Dembiec, Jacksonville Zoo and Gardens
Ryan Sears, Omaha's Henry Doorly Zoo
Erin Ehmke PhD, Duke Lemur Center
Meg Dye, Duke Lemur Center
David Haring, Duke Lemur Center

Reviewers:

Stephanie Allard PhD, Detroit Zoo, AZA Prosimian TAG Steering Committee
Bobby Schopler DVM, Duke Lemur Center, Veterinary Advisor
Timothy Keith-Lucas PhD, Suwanee University
Gloria Fernández Lázaro, Instituto Franklin

AZA Staff Editors:

Maya Seaman, MS, Animal Care Manual Publication Specialist
Candice Dorsey, PhD, Director, Animal Programs & Science
Debborah Luke, PhD, Vice President, Conservation & Science
Felicia Spector, MA, ACM Intern

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

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Introduction

Preamble

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

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

Taxonomic Classification

Table 1. Taxonomic classification for *Eulemur* spp.

Classification	Taxonomy
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primata
Suborder	Strepsirrhini
Family	Lemuridae

Genus, Species, and Status

Table 2. Genus, species, and status information for *Eulemur* present in AZA zoos

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
Eulemur	*coronatus*	Crowned lemur	Endangered	VU/declining	Studbook
Eulemur	*mongoz*	Mongoose lemur	Endangered	VU/declining	SSP
Eulemur	*rubriventer*	Red-bellied lemur	Endangered	VU/declining	Studbook
Eulemur	*fulvus*	Brown lemur	Endangered	LR/NT	Studbook
Eulemur	*albifrons*	White-fronted lemur	Endangered	VU/declining	Studbook
Eulemur	*collaris*	Collared lemur	Endangered	VU/declining	Studbook
Eulemur	*sanfordi*	Sanford's lemur	Endangered	EN/declining	Studbook
Eulemur	*rufus (rufifrons*)	Red-fronted brown lemur	Endangered	LR/NT	Studbook
Eulemur	*macaco macaco*	Black lemur	Endangered	VU/declining	Studbook
Eulemur	*macao flavifrons*	Sclater's black lemur	Endangered	CR/declining	Studbook

General Information

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

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked

AZA Accreditation Standard

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

sidebar boxes. AZA-accredited institutions which care for *Eulemur* spp. must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

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

Eulemur is the genus for the medium sized lemurs, called "true lemurs," found on the island of Madagascar. A member of the family Lemuridae, *Eulemur* is found throughout Madagascar in different forested habitats. They are an arboreal, herbivorous species. They are seasonal breeders, giving birth just prior to the rainy season of Madagascar.

The head and body length of most *Eulemur* species is 300–450 mm (11.8–17.7 in.); the tail length is approximately 400–640 mm (15.7–25.2 in.). Weight is between 2–3 kg (4.4–6.6 lb) for *Eulemur fulvus* species, about 1.4–1.8 kg (3.1-–4.0 lb) for *Eulemur coronatus*, and 1.4–1.6 kg (3.1–3.5 lb) for *Eulemur mongoz*. The tail is slightly shorter than the head and body in some species, but longer in others. Their fur is soft and relatively long, and there is a pronounced ruff about the neck and ears. Coloration varies considerably across species and may include speckled reddish brown, gray, or reddish, brownish, or blackish throughout. The genus *Eulemur* is distinguished from *Lemur* by several dental characteristics including smaller third upper and lower molars, distinct protostyle development on the first and second molars, more developed anterior basin in the posterior lower premolars, and more continuous crests in the trigonids and talonids of the molars (Nowak, 1991).

Debate continues with regard to the taxonomy of *Eulemur*. Nomenclature used by the AZA *Eulemur* Species Survival Plan® (SSP) considers the former *E. fulvus* subspecies as a species, following Groves (2001; 2006) and Mittermeier et al. (2006). This nomenclature is consistent with how the current *Eulemur* population is managed, and is how they will be discussed in this document. With regards to the subspecies of *Eulemur macaco macaco* and *Eulemur macaco flavifrons*, Mittermeier's taxonomy elevated these two subspecies to species in 2010; however, the SSP still recognizes them as subspecies, although they are managed completely separately. Previously, *E. rufus* and *E. rufifrons* were considered interchangeable. However, genetic and morphological evidence now suggest that *E. rufifrons* (red-fronted brown lemur) is a distinct species (Pastorini et al., 2003; Groves, 2006). At this time there is no evidence to suggest which species is held in North America, so they will continue to be referred to as *E. rufus*, but with common name red-fronted brown lemur.

As of 2012, the AZA recognizes and exhibits the following 10 species in the genus *Eulemur*:

- Common brown lemur (*Eulemur fulvus*)
- Red-fronted brown lemur (*Eulemur rufus*)
- White-fronted brown lemur (*Eulemur albifrons*)
- Sanford's brown lemur (*Eulemur sanfordi*)
- Collared brown lemur (*Eulemur collaris*)
- Black lemur (*Eulemur macaco macaco*)
- Sclater's black lemur (*Eulemur macaco flavifrons*)
- Crowned lemur (*Eulemur coronatus*)
- Red-bellied lemur (*Eulemur rubriventer*)
- Mongoose lemur (*Eulemur mongoz*)

Eulemur species inhabit forested regions of Madagascar and the Comoros Islands. The IUCN Red List of Threatened Species (www.iucnredlist.org), using data from the 2012 assessment reported *E. macaco flavifrons* as "critically endangered," *E. sanfordi* as "endangered," *E. fulvus* and *E. rufus* (*rufifrons*), as "lower risks/near threatened," and the remaining species as "vulnerable." However, Conservation International (2006) suggests some species should be re-classified due to continued population declines. In 2006, *E. albocollaris* was listed as one of the world's 25 most endangered primates (Mittermeier et al., 2006). The primary threat to *Eulemur* species is loss of habitat.

All species of *Eulemur* were classified under Appendix 1 of CITES on July 1, 1975. CITES controls international trade by requiring licenses for all imports, exports, re-exports, and introductions of *Eulemur*. Appendix 1 species are those that are threatened with extinction, and trade of these is only permitted in exceptional circumstances. In addition, *Eulemur* species in zoos and aquariums in the United States are governed under the Captive Primate Safety Act (42 CFR 71.53), which prohibits the importation of

nonhuman primates except for scientific, educational, or exhibition purposes. Revisions to the Act (2009) require importers to register with CDC and to renew their registration every 2 years. Imported nonhuman primates are required to be held in quarantine for a minimum of 31 days following U.S. entry. This regulation also requires registered importers to maintain records on imported nonhuman primates and to immediately report illness suspected of being infectious to humans. Imported nonhuman primates and their offspring may not be maintained as pets.

Currently (2013), only the mongoose lemur (*E. mongoz*) is a Yellow SSP Program under AZA sustainability designations. All other *Eulemur* species are managed as Red Studbook Programs. The short-term goal of the AZA Prosimian TAG is to elevate crowned lemur (*E. coronatus*), collared lemur (*E. collaris*), and blue-eyed black lemurs (*E. m. flavifrons*) to Yellow SSP status. All *Eulemur* species are managed collectively even though there is only one SSP; however, there are some behavioral differences between the species and sub-species that should be considered when working within this taxon. For example, *E. mongoz* does not do well in mixed species settings, while other species can be safely housed with other taxa. Some species tolerate extended family groups while others, such as *E. mongoz*, do not. Thus, it is important to remember that not all *Eulemur* species will be managed in the same manner and that group management can even differ within the same species. The following chapters provide details on important aspects of *Eulemur* management and are intended for use as guidelines to provide optimal *ex situ* housing for *Eulemur* species.

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

> **AZA Accreditation Standard**
>
> **(1.5.7)** The animals must be protected from weather, and any adverse environmental conditions.

The animals must be protected from weather, and any adverse environmental conditions. (AZA Accreditation Standard 1.5.7). Animals not normally exposed to cold weather/water temperatures should be provided heated enclosures/pool water. Likewise, protection from excessive cold weather/water temperatures should be provided to those animals normally living in warmer climates/water temperatures.

Temperature: In northwestern Madagascar, there is little annual fluctuation in mean monthly temperature (Curtis et al., 1999). The average monthly low temperature for June through August is 25 °C (77 °F), with the lowest mean temperature of 17.8 °C (64 °F) recorded during July and August. The average monthly high temperature in November and December is 29 °C (84.2 °F), with the highest mean temperature of 35.5 °C (96 °F) recorded during November. Temperature can vary greatly throughout the course of a day. In northeastern Madagascar, the average maximum monthly temperature ranged from 22.5–31.6 °C (72.5–88.9 °F), and the average minimum monthly temperature ranged from 19–23.5 °C (66.2–74.3 °F) (Vasey, 2004).

Outdoor: *Eulemur* housed in outdoor exhibits or enclosures should be maintained in temperature ranges that are similar to those above. When temperatures fall below 18.3 °C (65 °F) heat sources (as described below) should be provided. When temperatures fall below 8.9 °C (48 °F), animals should be housed indoors only. This is typical for institutions; a survey by the AZA *Eulemur* SSP (unpublished data) found that institutions hold animals indoors when outdoor temperatures are below 8.9 °C (48 °F). Some institutions even provide animals with access to their holding areas when temperatures are in the 8.9–18.3 °C (46–65 °F) range. Some facilities consider certain *Eulemur* species, particularly *E. sanfordi*, *E. mongoz*, and *E. coronatus*, to be more cold sensitive and will provide indoor housing at 12.8 °C (55 °F). In Madagascar, these species encounter higher temperature ranges than do other *Eulemur* species (Mittermeier et al., 2006). In very few cases, *Eulemur* have been exposed to temperatures as low as 4.4 °C (40 °F), but only for short periods of time. Temperatures lower than this can lead to frostbite and loss of tips of tails and digits.

Daily weather patterns such as amount of sun, wind, and precipitation can make these temperature guidelines vary. Also, geographic location and exhibit setup can alter temperature guideline strategies. Effort should be made to monitor daily weather patterns and observe animals for signs of temperature stress.

Common artificial heat sources used in holding and on exhibit include brooders, heat lamps, ceramic lamps, heat mats (pig pads), and additional bedding. These items can be given to animals in a hide-box or other area of the enclosure. Morland (1993) pointed out that huddling behavior among lemurs may be one way of conserving energy during cold weather, since prosimians are not as efficient at thermoregulation compared to other primates. This behavior could be an indication that the animals may require an additional heat source. Multiple heat sources should be provided in enclosures with large groups or mixed species so that, regardless of rank, all animals can access a source of heat.

While temperatures can be quite high in Madagascar, animals managed in zoos and aquariums should have access to shade and additional ventilation when temperatures are 29.4 °C (85 °F) or higher. Fans, air conditioners, vents, or doors can be used for cooling on hot days. The recommendations described above meet the USDA requirements for non-human primates. In free-ranging exhibits with no attached indoor housing, shade areas that offer protection from the sun and heat should be provided during hot seasons.

Indoor: In Madagascar, average daily temperature ranges from 25–29 °C (77–84.2 °F); indoor temperature should approximate that range for *Eulemur* species (Curtis et al., 1999). USDA Animal Welfare Regulations state the ambient temperature should not fall below 7.2 °C (45 °F) (USDA, 2002). However, a survey by the AZA *Eulemur* SSP (unpublished data) of holding institutions found that the average temperature range at which inside holdings are maintained is 20.5–25.5 °C (69–78 °F). Heating systems reported to the AZA include forced air heat, gas heat, and heat shield electric heating elements.

These heating systems are sometimes supplemented with brooders or heat lamps to create specific areas of higher temperature within an enclosure. These additional heat sources should be safe and allow

for voluntary access by the animal. Heat lamps should be placed outside exhibit caging, and not within reach of the animal. If the animal can reach through the caging, the lamp should be placed at least a few inches further than the animals' reach. If that distance is too great to provide adequate heat, then small gauge wire can be placed over the lamp or over that area of caging, preventing the animals' ability to reach through and touch the bulb or lamp. Heat bulbs placed near metal caging should be kept at a distance to prevent the metal from overheating and possibly causing burns. Also, placement of bulbs near vinyl-coated wire should be far enough such that the vinyl/plastic coating does not get hot or melt.

Humidity: In Madagascar, humidity varies widely by location. For example Oldeman (1990) has reported annual humidity in the Ranomafana National Park area at 84%, while there are striking differences in humidity in the wet and dry seasons in the dry western forests (Curtis et al., 1999). Humidity is thought to be involved in cathemerality of lemurs, in which individuals become less active or become nocturnal during dry periods (Curtis, 2006; Donati & Borgognini-Tarli, 2006; Curtis et al., 1999). While there is little information on the impact of humidity on the welfare and breeding success of *Eulemur* species, Wrogemann & Zimmerman (2001) found humidity levels above 60% to facilitate breeding success in mouse lemurs (*Microcebus murinus*). This is consistent with work with other small-bodied primates (Beck et al., 1982; Savage, 1995).

A survey conducted by the AZA *Eulemur* SSP (unpublished data) found that most institutions do not actively monitor humidity. However, those that do, report an average humidity reading between 50–81%. These values fit within the USDA's recommendations for indoor humidity ranges for nonhuman primates. Most modern HVAC systems provide data on temperature and humidity for monitoring purposes. When levels are too low, misters can be used to raise humidity levels within acceptable ranges. No additional climate control or facilities are necessary, provided that exhibits and holding areas, both inside and outside, are maintained at the suggested temperature ranges.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available, while all mechanical equipment should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1).

AZA Accreditation Standard

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

Both heating and cooling systems in buildings should be separated into specific independent zones in buildings, exhibits, and holding such that they can be operated and adjusted by specific climate area.

All institutions housing *Eulemur* species in facilities that rely on climate control should have critical life-support systems and emergency back-up systems in place. Back-up systems should include emergency generators that can help operate the system in the event of a power outage. The mechanical equipment in these systems should be part of a preventative maintenance program. Equipment should be regularly serviced by a maintenance agreement or maintained by trained staff. Regular maintenance should be documented and records kept for review.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums.

In contrast to other primate species, little research has been conducted on the light intensity requirements of *Eulemur* species. Some *Eulemur* holding institutions report the use of UVB light bulbs or vita-lights to supplement exhibit lighting, particularly in the case of animals housed without access to natural lighting. More research is needed in this area.

In northwest Madagascar, the closed canopy forest limits light availability during the day, and day length typically does not vary dramatically (Curtis et al., 1999). The longest days occur in December and January (13 hours) and the shortest days occur in June (11 hours).

E. mongoz are active throughout the day and night; this is called "cathemerality" (Curtis et al., 1999). However, they exhibit more diurnal activity during the wet season and are more nocturnal during the dry

season. Curtis et al. (1999) concluded that the cathemeral habits of the mongoose lemur corresponded with sunrise, sunset, and day length, and that shifts to diurnal activity resulted from lower light intensity in the forest during the wet season. For red-fronted brown lemurs, cathemeral activity appeared to be related to moonset and sunrise, and additionally, nocturnal locomotion was associated with moon luminosity (i.e., greater distances were traveled during full moon nights) (Donati et al., 2001). Therefore, different species of *Eulemur* will exhibit different activity patterns according to their level of cathemerality. Also, without a change in photoperiod, some lemur species may not enter breeding season.

According to a survey of *Eulemur* holding institutions, most animals have access to natural light cycles by inhabiting outdoor exhibits and holding spaces, or in the case of some with only indoor exhibits, skylights. Some institutions choose to vary artificial light cycles to correspond to seasonal changes. Typically, animals exposed to natural light in the Northern Hemisphere will experience a shift in their breeding season that is opposite their breeding months in Madagascar. Since photoperiod influences breeding seasonality, when exposed to Northern Hemisphere light cycle, breeding season is 6 months opposite of that in the Southern Hemisphere. The decreasing day length triggers progression into a reproductive state (e.g., increasing testicle size, estrous cycles). Without a change in photoperiod, most *Eulemur* species will not breed.

1.3 Water and Air Quality

AZA-accredited institutions must have a regular program of monitoring water quality for aquatic animals and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration and disinfection of the water supply available for the collection. Additionally, high quality water enhances animal health programs instituted for aquatic collections.

AZA Accreditation Standard

(1.5.9) The institution must have a regular program of monitoring water quality for fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

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

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

Water quality: The AZA Ape TAG (2008) recommends that drinking water and water features (e.g., pools and moats) be maintained so they remain free of contamination by feces, urine, food, and cleaning agents. These conditions also apply to *Eulemur* exhibits. Flushing and refilling alone is insufficient to maintain an adequate level of sanitation. It is recommended to power and/or steam clean moats and pools. The use of algaecides in water features should be investigated for safety. Furthermore, veterinary staff should approve any chemicals used to disinfect pools and moats. Associated Material Safety Data Sheets (MSDS) should be maintained on grounds.

Drinking water for *Eulemur* species should conform to human quality standards. There should always be a source of drinking water that is separate from the exhibit water features to allow for proper sanitation. Multiple locations in an exhibit and in each holding stall should be planned to ensure access for lower ranking group members and limit need for competition in the group. Piping should be kept out of animal reach.

Fresh water should be available at all times. Lixit® animal water bottles are appropriate, provided that all animals in a group can and will use them. Large rubber bowls or dishes, and hamster/rabbit water bottles are also appropriate. Water should be changed daily, and containers should be disinfected regularly. Water and food bowls should also be weighted when infants are present in order to avoid trapping small animals if they become inverted.

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquariums.

More research is needed as to the effects that different levels of sound have on *Eulemur*. However, as in many other species, high noise levels and vibrations may cause distress in some individuals. Potential sources of sound or vibration problems are back-up generators, nearby water filtration systems, and cleaning machines such as power washers or high-pressure hoses. These cleaning machines are best used when animals are in another space, such as cleaning the outdoor exhibit when *Eulemur* are in the inside enclosure or vice versa.

Construction equipment in the animal's environment may also cause undue anxiety. It is best to leave exhibit construction for times when animals are not present in the exhibit (possibly winter in some areas). *Eulemur* can also be very sensitive when giving birth. Efforts should be made to reduce noise and vibrations when parturition is near.

More research to define parameters of hearing sensitivity would be beneficial in determining appropriate sound guidelines for *Eulemur* exhibits. Also, further research on music or sound used as enrichment would be useful.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

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

AZA Accreditation Standard

(1.5.1) Animals should be presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' functional welfare requirements with aesthetic and educational considerations.

AZA Accreditation Standard

(1.5.2) All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single specimens should be avoided unless biologically correct for the species involved.

Very little literature exists on the impact of enclosure size on behavior or welfare of *Eulemur* species. Given the lack of information, the AZA *Eulemur* SSP recommends that exhibit size be based on: (1) the size of the group; (2) the complexity of the enclosure; (3) the behavioral needs of the individuals; and (4) the number of non-conspecific individuals that share the enclosure. In designing and evaluating exhibit space and complexity, it is important to remember that *Eulemur* species tend to be highly arboreal, and they will make use of all trees and high, vertical space in exhibits.

Federal regulations stipulate that each individual *Eulemur* be provided with a minimum of 0.28 m^2 (3 ft^2) space per individual (USDA, 2002). However, the AZA *Eulemur* SSP considers this amount of space too small and encourages institutions to hold animals in larger spaces. Currently, enclosure space varies significantly among institutions. See Table 3 for published sizes.

Table 3. Examples of exhibit sizes and species held in various institutions

Species	Sizes	Additional Information	Reference
All *Eulemur*	Ranges from: 1.4 m x 2 m x 3.4 m–5.8 m x 3.5 m x 5.8 m (4.7 ft x 6.7 ft x 11.1 ft–19 ft x 11.6 ft x 19 ft)	Small enclosures hold individuals, geriatric animals, and non-breeding pairs. Breeding pairs are held in larger enclosures.	
E. mongoz	4–7.5 m^3 (140.6–265.8 ft^3)	Housed and reproduced	Hearn et al., 1996
E. macaco	25 x 18 m (82 x 59.1 ft)	Island exhibit with *L. catta*	Meyer, 1982
Eulemur	0.81–10.1 hectares (2–25 acres)	Large outdoor enclosures	Terranova, 1996
E. fulvus	6 m x 4 m x 2.6 m–8 m x 2.9 m x 2.6 m (19.7 ft x 13.1 ft x 8.5 ft–26.2 ft x 9.5 ft x 8.5 ft)	Inside/outside enclosures	Roeder et al., 2002
E. macaco	1 hectare (2.5 acres)	Wooded enclosure	Roeder et al., 2002
E. mongoz	7.5–22.5 m^3 (265.8–791.5 ft^3)	Pairs or small family units, outside runs	Perry et al., 1992
E. mongoz	36 m^3 (1270 ft^3)	Pairs or small family units, rooms that were inside	Perry et al., 1992
E. rufus	3.05 m x 4.3 m x 4.6 m (10 ft x 14 ft x 15 ft)	-	Demes et al., 2005
Eulemur	0.49 hectares and 3.54 hectares (1.2 acres and 8.75 acres)	Two large, forested enclosures with *L. catta*, surrounded by a 1.8 m (6 ft) chain link fence with electric wire along the top and bottom.	Alford-Madden, 1986

Please see Appendix H to view a complete list of exhibit dimensions and species composition of these exhibits for institutions currently holding *Eulemur* species.

The five outdoor runs at one zoological institution, called Natural Habitat Enclosures (NHE), are made of chain link fence topped with a 0.61–0.91 m (2–3 ft) high section of electronet. Enclosures contain several native species of trees that provide arboreal complexity. Clearings are made on both sides of fences to prevent escape. The NHEs range from 0.59 hectare (1.47 acres) to 7 hectares (17.3 acres) in area. All enclosures are equipped with a variety of natural tree/vines as well as an assortment of swings, trampolines, and other enrichment/play devices.

Exhibit design and complexity: Across institutions that house *Eulemur* species, a variety of climbing structures and interlocking branches have been used to create environmental complexity (e.g., Hearn et al., 1993). Common types of furniture include horizontal platforms, horizontal bars, tree branches, hanging tires, plastic chains, and nest boxes. All enclosures should include multiple off-exhibit holding areas or stalls to allow for olfactory and visual contact during separations. All housing should be escape proof. *Eulemur* species, especially young infants and juveniles who are beginning to venture away from their mothers, are very good at squeezing through small spaces. All housing should be inspected daily for all potential escape routes, such as gaps in fencing or between gates, and repaired as necessary. While *Eulemur* species in general do not dig, individuals will take advantage of holes created by other species, either on exhibit or by native wildlife outside the exhibit. Care should be taken to secure the perimeter of housing so that holes cannot provide escape routes.

Water features can include flowing streams, pools, and waterfalls. These add dimension to the animals' environment and can lessen ambient noises that could be disturbing, such as visitor traffic. Owing to the fact that *Eulemur* species typically do not swim, water or wet moats are sometimes used as a method of containment on island exhibits. Water depth should be deep enough to discourage animal entry, but also allow safe entry by animal care staff when necessary. Some animals can and will leap across at certain times. There are also instances of animals swimming or entering the water under stress; however, there are no records of distance swum or time spent in the water. Thus, an escape protocol should be provided under these housing conditions.

Materials commonly used in *Eulemur* exhibits include rocks or gunite, vines, logs, and ropes. In addition, the following materials are safe to use in *Eulemur* exhibits or holding areas: artificial grapevine, plastic benches, plastic, PVC, live trees (including *Ficus* spp., fig), artificial plants, nylon cargo nets, platforms/shelves, fire hose, wooden pole climbing structures, chains, branches, stools, crates, concrete trees. Outdoor exhibit substrates at most AZA institutions are usually natural materials such as dirt, soil, grass, mulch, gravel, and bark. Indoor exhibits and holding areas are generally constructed of concrete for ease of cleaning. Other substrates, including straw/hay, wood chips and wood wool, and shredded paper can be used as bedding material or for enrichment.

Behavioral repertoire: There are 12 species recognized in the genus *Eulemur*. Generally, behaviors are similar with only minor variation; however, there are some exceptions, which are discussed below. Regardless, all *Eulemur* are highly arboreal and their enclosures should provide opportunities to utilize the vertical space in the areas provided. This includes the ability to move from one tree to another, as well as the opportunity to sit, feed, sleep, and groom other lemurs in these elevated areas.

A hide or nesting box can also be provided to *Eulemur* species. One zoological institution has provided nest boxes constructed of wood frames with plexi-glass fronts measuring 1 m x 1 m x 2 m (3.28 ft x 3.28 ft x 6.56 ft) with electric heaters inside (Vick & Conley, 1976). While these species do not nest with their young, they can use the hide box as a visual barrier in the exhibit both from other individuals and guests, or as a secure, quiet spot to rest. They may also use the top as a perching site.

At one zoological institution, *Eulemur* have used similar nest boxes for giving birth. They are often seen using the top as a platform on which to sit. The presentation of arboreal structures may also facilitate copulation attempts and reproduction (Perry et al., 1992).

Enclosures that house complex or mixed species groups should provide ample opportunity for escape, shelter, and undisturbed feeding by all group members (Villers & Lent, 1993). There is little information on the minimum inter-individual distances preferred by *Eulemur*. However *Eulemur* frequently engage in huddling behavior. Roeder et al. (2002) found that for both brown lemurs and black lemurs housed in zoos and aquariums, agonistic interactions occurred mainly in resting areas, and resulted from individuals joining, leaving, or disturbing the resting individuals; multiple resting sites may lessen the potential for this type of agonistic interaction. A variety of perching or resting options at various heights in the environment are essential to allow for full use of the environment, with numerous methods of moving between resting sites. Also, if exhibits house more than one species of lemur, creation of clearly defined spaces and levels in the environment will allow for separation.

Inter-individual distances should be carefully considered during feeding as aggression is often reported in *Eulemur* species during this time. Feeding locations should be adequately spaced, and institutions may want to consider separation of species or specific individuals during feeding.

The best way to promote natural behaviors in *Eulemur* is to ensure a variety of exhibit furnishings that create a complex spatial environment. A survey by the AZA *Eulemur* SSP found that institutions made

use of many different materials as exhibit furnishings to create this complex environment. Many institutions also believe that while size of the environment is important, the most important aspect of managing *Eulemur* is to provide this complex three-dimensional space (see above in section on spacing complexity for more information).

A survey by the AZA *Eulemur* SSP (unpublished data) found that perching height should be as varied as possible, with average range of heights from 1.22–5.79 m (4–19 ft). Many of the same furnishings used in the exhibit can serve as perching sites. Using multiple trees and branches with limbs at various angles is an appropriate way to give complex perching. Vick & Conley (1976) reported perching platforms that were simply constructed of rectangles of wood raised about 2 m (6.5 ft) above the ground. The following materials are used regularly as effective perching materials on exhibit and in holding areas: logs, bread trays, wood, PVC, plastic, natural and artificial trees, branches, exhibit pipe structures, rope, ladders, wooden shelves, milk crates, rocks, vines, and fire hose.

Studies on the leaping behavior of *Eulemur* spp. suggest some variation in landing style (i.e., some species land hind limbs first, others forelimbs first, and still others land on all four limbs) (Terranova, 1996; Demes, 2005). Structures (e.g., artificial and natural limbs, platforms, etc.) that are situated in both horizontal and sloping positions should be used to accommodate leaping in *Eulemur* species. Perry (1991) states that the preference for natural, arboreal substrata during copulation of *E. mongoz* suggests that enclosure furnishing may influence copulatory behavior.

Eulemur males will scent mark using the anogenital region, head, and hands, while females will use the anogenital region and urine (Mittermeier et al., 2006). Scent marking is an extremely common behavior in *Eulemur* and may occur in a number of contexts. For example, black lemurs introduced to a new enclosure inhabited by ring-tailed lemurs were observed engaging in scent marking behavior (Meyer, 1982). Additionally, male red-fronted lemurs have been observed scent marking in areas previously marked by their female partners (Pereira & McGlynn, 1997).

Enclosure cleaning: All fecal matter and other waste should be removed daily from holding areas and enclosures. Institutions reported that holding areas were cleaned with water at least 5, and up to 7 days a week, while disinfecting was done an average of 4 days a week. Common disinfectants include dilute bleach, Nolvasan®, and Mediquat®. In order to maintain some of the scent marks in the *Eulemur* environment, scrubbing and cleaning branches and perching should be done on a rotational schedule or by spot cleaning the exhibit regularly, accompanied by monthly complete cleanings. If additional deep cleaning is necessary, a power-washer or degreaser can occasionally be used. Cleaning should be used to maintain a sanitary environment, which minimizes the possible spread of disease. However, because scent marking is an important behavior to these animals, maintaining the marks should be considered in the husbandry practices.

AZA Accreditation Standard

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

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

AZA Accreditation Standard

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

Change and variation: Whenever possible, perching, branches, and other furniture in the enclosure should be changed in order to create variation in the environment. Staggering the replacement of exhibit furnishings will provide the animals an extended opportunity to investigate and scent mark the newly added items. Using enrichment, novel food items, and varied food presentation can also add variation to the environment. A group of white-fronted lemurs housed on an indoor "island" exhibit increased natural behaviors including overall increased activity levels, location changes, and time spent in trees when provided with self-operated food boxes in trees (Sommerfeld et al., 2006). Various species of *Eulemur* have participated in cognitive research projects as well (e.g., Brannon et al., 2008; Mahajan et

al., 2008; Ruiz et al., 2008). Initiatives to vary the environment will be beneficial to *Eulemur* as it provides them novel experiences in a static enclosure.

To encourage species-appropriate behaviors, off-exhibit enclosures should have the same variations in height of perching and furniture that are present on exhibit. Platforms and perching for sleeping are also important in off-exhibit areas. Multiple enclosures or stalls are also very useful in off-exhibit areas for separating individuals or species in mixed-species settings whenever necessary.

2.2 Safety and Containment

Animals housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3).

AZA Accreditation Standard

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

Animals can be effectively secured in an open environment by using the containment measures described below, including moats, barriers, and electronet lined fences. All vegetation should be well maintained in an open environment to ensure that branches and other foliage do not come near the edges of the fence or moat. Additional risks that may affect animals held in an open environment include ingestion of garbage or other materials thrown into the exhibit by guests. Having a barrier and additional distance of a few feet between guests and an island exhibit will minimize the occurrence of unwanted or foreign objects in the exhibit. However, most barriers between island exhibits are low—approximately .9–2 m (3–4 ft)—so there is always a risk that objects will end up in the exhibit side of the barrier or fence. Procedures should be established such that animal husbandry staff is notified if garbage or other materials are seen in the waterways of island-exhibit enclosures.

Containment methods for all exhibit types (both enclosed and open to the environment) should be monitored daily. This includes checking that no holes or breaks in fencing have occurred, that electronet does not have any tears and that the electrical current is in working order, and that no foliage has fallen or leaned on the containment barrier. It is also essential that electricity be pulsed from electronet fences so that an animal can get away from the current. Even low voltage can be fatal if there is not adequate pulsing. Also, moats should be checked for breaches and that the water remains at appropriate levels. If there is a breach of exhibit containment, the necessary departments should be contacted, such as maintenance. Fence, moat, or electronet repairs should be made, and downed foliage removed, before animals are allowed back on exhibit.

When exhibiting *Eulemur* in open-environment enclosures, there are risks of exposure to other species. For example, predators such as birds of prey or carnivores may pose a threat to *Eulemur*, or disease transmission from native species such as raccoons may be a problem. Checking containment barriers to ensure outside species cannot enter and examining free ranging exhibits for signs (e.g., scat) of native species can help mitigate these risks.

In most cases, *Eulemur* are not housed in walk-through exhibits in North America. Because of zoonotic potential, steps should be taken to minimize contact with public. Professional staff need to continuously monitor any situations that bring *Eulemur* spp. within proximity to visitors (e.g., education programs, walk-through exhibits, etc.). Their job is to observe animal behavior and welfare, as well as human behavior, and to ensure both are maintaining appropriate distance from the other.

AZA Accreditation Standard

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

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). Pest control methods must be administered so there is no threat to the animals, staff, and public (AZA Accreditation Standard 2.8.1). Exhibit design must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

AZA Accreditation Standard

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

Various materials and designs have been used for containment of *Eulemur* spp. within the exhibit. A survey

conducted by the AZA *Eulemur* SSP found about an equal number of exhibits make use of wire, mesh, and wet moats as methods of exhibit containment. Institutions using a wet moat with an open top to the exhibit found that it was necessary to keep trees trimmed away from the edges to ensure containment on the islands, as *Eulemur* spp. will occasionally leap from exhibit trees to those outside of enclosures. While *Eulemur* generally do not swim, cases have been reported of individuals attempting to swim when under stress, or jumping into or across moats when being chased; drowning and swimming in a wet moat is a concern that should be considered.

Some institutions also report using electronet and chain-link fencing topped with electric wire as a method of containment. One zoological institution reported that when a naïve animal was released into an enclosure it would eventually approach and touch the electronet, receiving a very small shock. This is usually enough for them to learn aversion from the fencing. For indoor exhibits, concrete walls and glass or Plexiglas® is often used. *Eulemur* are prolific jumpers and it is recommended that trees be cut back at least 4.5 m (15 ft) from enclosure fences, moat ledges, or other barriers. Additionally, native species may dig holes in exhibits and under fences. Exhibits should be monitored for these breaches, as *Eulemur* species may be capable of escaping through these holes.

Various sizes of wire and mesh have been used in *Eulemur* enclosures. Both 5.08 cm x 5.08 cm (2 in. x 2 in.) and 7.62 cm x 7.62 cm (3 in. x 3 in.) are most likely too big, as adult *Eulemur* species have been known to push their entire heads through mesh this size. While they have not been known to escape, getting stuck or hung in the wire becomes a major concern. Exhibits that may have infants should avoid 7.62 cm x 7.62 cm (3 in. x 3 in.) and 5.08 cm x 5.08 cm (2 in. x 2 in.) mesh completely, as infants can easily escape through this size wire. In general, 2.54 cm x 5.08 cm (1 in. x 2 in.) and 2.54 cm x 2.54 cm (1 in. x 1 in.) mesh sizes are more acceptable for exhibits containing adult *Eulemurs* only; if infants will be present, 2.54 cm x 2.54 cm (1 in. x 1 in.) is the most acceptable.

While most *Eulemur* do not have 24-hour access to exhibits, in some cases, particularly in the summer months, animals may be left with access to their exhibit, or may reside in a free-ranging enclosure. When animals have 24-hour access to an exhibit or enclosure, security staff should be present on the grounds to monitor for inclement weather, breaches in the exhibit (e.g., fallen trees), and any other emergency situation or animal escapes. In the case of any abnormal conditions or concerns, security should follow the proper procedures to notify animal supervisory staff.

Exhibits in which the visiting public is not intended to have contact with animals must have a guardrail/barrier that separates the two (AZA Accreditation Standard 11.3.6).

AZA Accreditation Standard

(11.3.6) In areas where the public is not intended to have contact with animals, some means of deterring public contact with animals (e.g., guardrails/barriers) must be in place.

Exhibits with no wire or mesh enclosure should have guardrails or fences to keep zoo visitors from being able to enter exhibit or moated area. These guardrails or fences should not be relied upon as the sole mechanism for enclosing animals, as *Eulemur* spp. can easily scale or climb fences. In some enclosures in which *Eulemur* free-range, double entry and exit doors with locking mechanisms based on counterweight systems have become problematic, resulting in injury to the animals. While animals cannot open these doors, on occasion *Eulemurs* were found trapped or caught between the two doors. It is best to avoid this type of containment door system, and use traditional handles and locks instead.

AZA Accreditation Standard

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

All emergency safety procedures must be clearly written, provided to appropriate staff and volunteers, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.4). All institutions should have appropriate fire and weather (e.g., hurricane, flood, etc.) emergency response protocols and drills should be done regularly with consideration of *Eulemur* safety.

AZA Accreditation Standard

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

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

Procedures for evacuating animals in case of fire or flood should be in writing as well as detailed parameters for when such an evacuation is necessary. Similarly, for institutions holding animals in regions that experience hurricanes, tornadoes, and other severe weather, shelter rated to withstand such natural disasters should be available for housing animals during the period of risk. Written procedures must be maintained and made available to staff for how to transfer animals to a safe facility, when it is appropriate to do so, and who is authorized to make those decisions. In many emergency situations, previous crate training can provide a safe, efficient, and low-stress way to transfer animals to safe housing, but staff should have alternative ways of capturing and transferring the animals should crate training fail to yield the desired results.

Emergency drills should be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills should be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6).

As in other animal emergencies, in situations that arise regarding *Eulemur* species, such as escapes, pending births, and other health concerns, people such as animal care managers, curators, or senior keepers should be notified for proper procedures to be followed. No specific protocols exist for *Eulemur* specifically. Follow institutions protocols when dealing with policy and other emergency agencies.

AZA-accredited institutions must also ensure that written protocols define how and when local police or other emergency agencies are contacted and specify response times to emergencies (AZA Accreditation Standard 11.2.7)

No specific protocols exist for *Eulemur* specifically. Follow institutions protocols when dealing with policy and other emergency agencies.

AZA-accredited institutions that care for potentially dangerous animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals (AZA Accreditation Standard 11.5.3; AZA Accreditation Standard 11.5.2). *Eulemur* do not generally pose danger to humans. However, they do have very sharp teeth and may bite when distressed. This may occur during restraint, or when adults are defending infants or their mate. While many institutions do work in the enclosures with *Eulemur*, necessary precautions should be taken when working in close proximity to *Eulemur* (see Chapter 8.3).

Animal attack emergency response procedures must be defined and personnel must be trained for these protocols (AZA Accreditation Standard 11.5.3).

AZA Accreditation Standard

(11.2.5) Live-action emergency drills must be conducted at least once annually for each of the four basic types of emergency (fire; weather/environment appropriate to the region; injury to staff or a visitor; animal escape). Four separate drills are required. These drills must be recorded and evaluated to determine that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures documented whenever such are identified.

AZA Accreditation Standard

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

AZA Accreditation Standard

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

AZA Accreditation Standard

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

In the case of a bite or attack by a *Eulemur*, the bite victim and/or the animals should be removed from the immediate area as safely and quickly as possible. All areas holding primates should have a primate bite kit, which allows for rinse and disinfecting of wound area immediately. All appropriate staff members should be notified (managers, curators, human resources, veterinary team) of the situation. If

necessary, appropriate staff, security, animal keepers, or emergency medical technicians should be called to assist. The person who is bitten should visit the work place clinic or emergency room to be assessed by medical personnel. An accident report should be filed as per institution policy as soon as possible.

Animal attack emergency drills should be conducted at least once annually to ensure that the institution's staff know their duties and responsibilities and know how to handle emergencies properly when they occur. All drills need to be recorded and evaluated to ensure that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation Standard 11.5.3; AZA Accreditation Standard 11.5.2).

If an animal attack occurs and injuries result from the incident, a written account outlining the cause of the incident, how the injury was handled, and a description of any resulting changes to either the safety procedures or the physical facility must be prepared and maintained for five years from the date of the incident (AZA Accreditation Standard 11.5.3). Antivenin must be readily available and all staff members working in areas containing venomous animals should know the antivenin's location (AZA Accreditation Standard 11.5.1).

For animals such as *Eulemur*—that are considered non-dangerous—protocols should be developed in case of attack, escape, or guests/visitors in animal areas. One example of a protocol for non-dangerous animal escapes/situation follows:

1. Make radio call stating name, location, species, and situation
2. Take no unnecessary risks and keep visual watch on situation (e.g., escaped animal)
3. Tasks will be assigned by the Department Head or Lead
4. Animal enclosure should be secured and a perimeter around the situation should be established
5. Emergency capture equipment should be collected by identified staff
6. Radio silence should be in place unless directly related to emergency situation
7. Senior management staff or situation lead continues to provide direction until situation is resolved

These emergency protocols should be developed and disseminated to all animal care staff, and should also be maintained through regular drills and practices.

AZA Accreditation Standard

(11.5.2) All areas housing venomous animals, or animals which pose a serious threat of catastrophic injury and/or death (e.g., large carnivores, large reptiles, medium to large primates, large hoofstock, killer whales, sharks, venomous animals, and others, etc.) must be equipped with appropriate alarm systems, and/or have protocols and procedures in place which will notify staff in the event of a bite injury, attack, or escape from the enclosure. These systems and/or protocols and procedures must be routinely checked to insure proper functionality, and periodic drills must be conducted to insure that appropriate staff members are notified.

AZA Accreditation Standard

(11.5.1) Institutions maintaining venomous animals must have appropriate antivenin readily available, and its location must be known by all staff members working in those areas. An individual must be responsible for inventory, disposal/replacement, and storage of antivenin.

Chapter 3. Transport

3.1 Preparations

Animal transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). All temporary, seasonal, and traveling live animal exhibits must meet the same accreditation standards as the institution's permanent resident animals (AZA Accreditation Standard 1.5.10). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order.

AZA Accreditation Standard

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to. Planning and coordination for animal transport requires good communication among all involved parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

AZA Accreditation Standard

(1.5.10) Temporary, seasonal and traveling live animal exhibits (regardless of ownership or contractual arrangements) must meet the same accreditation standards as the institution's permanent resident animals.

All possible relevant regulatory agencies should be checked for shipping, health, and permit requirements before transporting animals (e.g., USDA, state regulations, CITES, CDC, Endangered Species Act, etc.). The International Air Transport Association (IATA) publishes specific guidelines for transport containers used for animal shipments during air transport. The guidelines are available in print or CD ROM format, and can be ordered from sales@iata.org, through their website:

www.iataonline.com/Store/default.htm

Or by contacting:
Publications Assistant, IATA
2000 Peel Street
Montreal, Quebec, Canada H3A 2R4

IATA regulations change occasionally, and the most recent publication or website should be consulted. Additionally, specific USDA regulations exist for crate design, transport vehicle, temperature during transit, food and water, and general care of the animal (Code of Federal Regulations 9, section 3.86 through 3.91).

Pre-shipment exams: All *Eulemur* spp. should receive a thorough pre-shipment physical examination. Ideally, a copy of the pre-shipment exam and laboratory work should be sent to the veterinarian and registrar and/or curator at the receiving institution before the animal is transferred. If an individual has a pre-existing medical condition, the case should be discussed between the veterinarians and curators at the shipping and receiving institutions before the animal is moved. All animal shipments should be accompanied by a hard copy of the medical records, as well as a health certificate and the USDA acquisition, disposition, or transport form. Institutions using MedARKS should provide the receiving institution with electronic copies of the medical records.

Transport container: Transport of *Eulemur* spp. is regulated by the United States Department of Agriculture (USDA); Convention on International Trade of Endangered Species (CITES); Endangered Species Act (ESA); Centers for Disease Control (CDC); and (for air transport) the International Air Transport Association (IATA). Specific USDA regulations exist for crate design, transport vehicle, temperature during transit, food and water, and general care of the animal (Code of Federal Regulations 9, section 3.86 through 3.91).

Always consult the IATA guidelines for specific requirements concerning shipping containers. It is important to adhere closely to these requirements, as airlines may refuse to fly animals in containers that do not conform to the guidelines. Container Requirement 31 of the IATA guidelines describes shipping containers appropriate for *Eulemur* spp. All shipping crates should allow for adequate ventilation. Ventilation holes should be small enough to prevent the escape of the animal and to prevent the animal from getting any part of its body through the opening. The base of the container should be solid and leak proof. A plastic pet container such as a Vari-Kennel® is suitable, provided a few modifications are made. These changes are described later in this section, and in detail in the IATA guidelines.

It is also advisable to affix small plastic mesh over any areas where openings are large enough to get a hand out of the crate. This can reduce the chances of the animal being injured, but can also discourage non-animal personnel from reaching into the crate. Doors of the transport container should be secured

from the outside to prevent accidental opening. Plastic zip ties or releasable cable ties can be used to secure the corners of the door after appropriate screening.

Crates should be large enough to allow the animal to stand up, turn around, and lie down in a natural manner. However, the crate should not be overly large that the animal risks injury from excessive movement. A branch-like structure should be installed in crates for *Eulemur*. It should be attached firmly within the container so the animal can perch and rest safely. This permits the animal to get up off the bottom of the crate if desired. Animals should be habituated to transport containers prior to transport and if possible, trained to enter the transport container on cue. If that is not possible, restraint methods detailed in Chapter 6.6 are appropriate.

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

The equipment should provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s). Very few supplies are required when transporting *Eulemur*. Besides the crate, food, and water, proper travel documents and records should accompany the animal in its travels. Copies of all documents should also be sent to the receiving institution prior to receiving the animal.

Safe transport also requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger (AZA Accreditation Standard 1.5.11).

Typically, personnel are not necessary to transport *Eulemur* spp. the entire duration of a trip if the animals are being transported by airplane. However, a minimum of two people should deliver the *Eulemur* to the airport and pick them up at their final destination. Two people should also be used if transporting animals by van or truck. In order to participate in transporting animals, staff should have experience in general husbandry and health status for *Eulemur* spp., as well as in capture and restraint of the animals. Staff involved in transport should be comfortable driving the transport vehicle, as well as moving and handling a crate with the animal inside of it. If transporting an animal by land, these staff should also be responsible for maintaining appropriate travel temperatures in the vehicle, and monitoring the food and water availability of the animal in the crate. While not necessary, staff can bring a thermometer to monitor vehicle internal temperatures to make sure they remain within the IATA suggested range of 7.2–29.4 °C (45–85 °F). If an animal is being transported by air, food and water should be checked by animal staff just prior to handing off to the airline staff, and as soon as the animal is picked up.

3.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. In brief, an animal should be trained to enter a crate voluntarily on cue, or if this is not possible, should be restrained as detailed in Chapter 6.6.

Food and water: The crate should allow for feeding and watering of the animal if necessary. Separate food and water containers should be provided, and should be either revolving or fixed. If fixed inside the container, they should be placed at a height that does not allow the animal to sit upon it, and there should be outside access for filling and emptying that does not allow the animal any chance of escape. Water containers should only be filled to demand, and should be emptied after each use so animals do not splash themselves, becoming wet and chilled. These containers should have rounded edges and be made of non-toxic material suitable for the species. Animals familiar with water bottles may be provided 8 oz. standard water bottles affixed to the crate door or other wire mesh. This allows a constant water supply.

Feeding and watering instructions should accompany the animals' transfer documents. Any feed or water given should be recorded on the container instructions with the date and time of supply. The shipper should provide food; if transport is international, the food provision should follow all regulations of the country of importation. IATA regulations state that animals do not normally require additional feeding or watering during 24 hours following the time of dispatch. If feeding is required due to an unforeseen delay or excessively long travel periods (i.e., greater than 12 hours), foods that resemble the current diet of the individual, including raw vegetables, greens, and appropriate high fiber primate biscuits, would be

suitable as food for transport. Soft fruit and vegetables should be fed sparingly since, if taken in excess, they can cause the animal stomach or digestive discomfort. Arrangements for feeding in these situations should be made in advance of shipping (AZA Ape TAG, 2008).

Substrate and bedding: Wood shavings can be used to cover the floor of the container or kennel to ensure comfort and safety during travel. The substrate will also help absorb waste and keep the container dry. If a grill or slatted floor is not suitable for the crate, there should be sufficient absorbent bedding material on the floor to absorb waste. Edges should be high enough to ensure containment of bedding material within the crate. Due to the restrictions regarding some importation of plant materials in certain foreign countries, using straw or hay during transport should be avoided during international travel.

Temperature: Primates are affected by temperature changes and temperature extremes. Care should be taken to ensure that they are not subjected to drafts or abrupt changes in temperature. Most species can withstand reasonable variations in temperature; however, consideration should be given not only to temperature changes, but to the wind chill factors involved as well. Primates should not be exposed to direct heat, including placing them in sunlight or near other external heat sources. Primates unavoidably subjected to extreme heat should be cooled so as to prevent dehydration or heat prostration.

During prolonged transit stops, when the ramp temperature exceeds approximately 20 °C (68 °F), the aircraft compartment doors should be opened and, in extreme temperatures, ground equipment should be used to ventilate the compartments. The different climatic factors during travel should always be considered when arranging the routing and carriage of live primates. For example, if crates are stranded on runways, parking areas, etc., they should be moved into the shade as soon as possible to avoid overheating the individuals in the crates (AZA Ape TAG, 2008; IATA 2007).

Light and sound: During shipping, the animal can experience stress or excitement caused by changes in the environment. Noise should be kept to a minimum (including sudden loud noises, constant high-pitched noises, or anything considered uncomfortable to people), and the animal kept in low light conditions. A material such as muslin may cover all ventilation openings of the container. This will help maintain low light levels.

Group size: The United States IATA guidelines require that no more than one primate be transported in a container; however, there are exceptions in cases where more than one individual is being shipped at the same time. A mother and her nursing young, an established male-female pair, a family group, a pair of juvenile animals, or other pairs of animals that have been habitually housed together may be shipped in the same container. In general, transport of females with suckling young is not recommended due to possible changes in behavior of the mother due to stress that could harm the young (IATA, 2007). Furthermore, stress caused by transportation can result in aggression between individuals, even in well-established pairs and family groups. The potential for injury caused by aggression should be weighed against the potential stress relief of companionship during transportation.

Monitoring during transport: United States transport requirements state that all wild mammals be inspected at least every 4 hours, whenever the cargo hold is accessible. IATA regulations should be consulted for specifications of other countries and airlines.

In general, the handler or vet should not need to access the animal during transport, and the transport crate should be designed so that food and water can be given without having to access the animal directly. Instructions on what should be done in the case of an emergency that necessitates animal treatment should accompany all animal shipments. If access to an animal is required due to illness or extended shipment delays, the shipping/receiving institutions should be notified, and the crate should be transferred to the nearest zoo or veterinary clinic prepared to handle the animal.

Most transport can be accomplished within 24 hours. If delays occur, it is not always possible to move an animal to a temporary holding facility. Shifting an animal out of a shipping container and then having to get it back in may be more stressful than leaving it in the shipping crate and providing for its basic needs. If a known delay or layover of more than 72 hours is planned, and there is a convenient facility with appropriate veterinary and care staff available, then it may be beneficial to allow the animal access to temporary housing (AZA Ape TAG, 2008).

Post-transport release: After arrival at the holding institution or quarantine facility, the shipping crate should be placed inside the quarantine holding area as soon as possible, the door opened, leaving the animal to exit at will. All quarantine or temporary holding areas should be provided with food, water,

alternate hiding places, perching, and enrichment items. The quarantine area should be kept quiet with minimal staff activities until animals have had time to adjust to the new enclosure.

If a pair of animals is shipped in separate containers, the status of these animals as compatible is not guaranteed. The reunion of these animals upon reaching the destination should be monitored closely to evaluate for signs of aggression.

Chapter 4. Social Environment

4.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors.

Group structure and size: The social structure and group size of *Eulemur* species in the wild show marked variation. For example, while *E. mongoz* and *E. rubriventer* have been found as monogamous pairs with dependent offspring, other species have been found as multi-male/multi-female groups (*E. fulvus*: Tarnaud, 2006b; *E. macaco*: Bayart & Simmen, 2005; *E. rufus*: Pereira & McGlynn, 1997; and *E. coronatus*: Mittermeier et al., 2006). In the wild, *E. rufus* groups may consist of one dominant male and several subordinate males, and dominance is clearly established (i.e., dominant males more often instigate conflict and are aggressive toward other group members and prevail over subordinate males during conflict) (Ostner et al., 2002). Ostner et al. (2002) also found that dominant males engage in more reproductive activity than subordinate males.

Despite the differences found in the wild, managed *Eulemur* species are traditionally housed as pairs with dependent offspring. Individuals less than one year of age are considered infants and should be maintained in their natal group. Roeder et al. (2002) referred to animals less than 2 years as juveniles and animals older than 2 years as adults; however, it should be noted that both sexes of many species could be reproductively mature at 18 months. Some pairs are tolerant of offspring remaining in the group for extended periods of time (years and multiple generations), while others may try to evict offspring within a year or so of birth. This variation in parental behavior has even been reported within the same species.

The practice of housing *Eulemur* as pairs occurs for several reasons ranging from aggression among group members to enhancing reproductive success. Exhibit size is likely a major contributor to aggression among individuals in larger groups. For example, *E. fulvus* may form large groups in the wild; however, they can also occupy extremely large home ranges (15–100 ha [37.07–247.11 ac]), thus allowing for greater spacing of individuals within the group (Mittermeier et al., 2006).

In general, most *Eulemur* species are housed as male-female pairs with dependent offspring and it is the goal of the AZA *Eulemur* SSP to prevent solitary housing of *Eulemur* whenever possible (Perry et al., 1992). In addition to pair housing, different group compositions have been established with varying degrees of success. In most *Eulemur* species, male-male pairs have been established and some have been successful for very long periods of time. A few trios of males have been established, but most fail within a few years when the males fully enter reproductive maturity, or during breeding season. In general, female *Eulemur* are not tolerant of one another, however a few female-female pairs have been established. In a few of the species (*E. mongoz*, *E. m. flavifrons*), two females have been housed with a single male and/or castrated males.

Larger groups—usually formed by retaining multiple generations of offspring in the group—are also possible, but should be undertaken with caution and it is recommended that the enclosure offer the ability to separate individuals if necessary. Care should be taken to ensure enough space and environmental complexity is available to manage the more complex groupings. Flexibility in housing and additional space—should individuals be evicted from the group—ought to be considered before undertaking large, complex groupings. Additionally, species that show a monogamous social structure in the wild (e.g., *E. mongoz*) are probably less appropriate for larger social groups.

Single-sexed groups: Groups are not traditionally formed from cohorts, but there are several examples of pairs or trios of males (i.e., half siblings, siblings, twins, or fathers and sons) that were removed from their natal group and continue to be housed together. Successful male-male groups have been formed with *E. collaris, E. m. macaco* and *flavifrons*, and *E. coronatus*. The success of this formation is probably facilitated by having no conspecific females in the area or by housing castrated males. However, the effectiveness of castration is variable and not effective for all male-male pairs. Given the genetic importance of all animals in these populations, the AZA *Eulemur* SSP Coordinator should be consulted before castration is performed. Various drug therapies have been tried to reduce aggression in males, but their effectiveness has not been consistent (Ferrie et al., 2011). In some cases, males have assumed female color patterns. Male-male pairs are more common than female-female pairs, but sisters have been

removed from their natal group and housed together. Also, mother-daughter pairs may be compatible until the daughter becomes sexually mature.

Males—and to a lesser extent, females—that are housed in same sex groups may coexist peacefully during the majority of the year, but then become aggressive during the breeding season (November–March). Institutions housing multiple males should monitor the groups for aggression and be prepared to separate individuals if necessary. Aggressive situations can arise overnight or from one day to the next, with few or no behavioral changes or cues.

4.2 Influence of Others and Conspecifics

Animals cared for by AZA-accredited institutions are often found residing with conspecifics, but may also be found residing with animals of other species.

There is little evidence that adjacent conspecific groups have a negative impact. In fact, it is hypothesized that reproduction in *E. macaco* and *E. mongoz* has been enhanced by the presence of conspecifics (Hearn et al., 1996). However, more recent pairings have shown that at least in *E. mongoz*, breeding also occurs without conspecifics nearby (see *E. mongoz* studbook data). If a group member is temporarily separated from the core group, care should be taken to maintain visual contact with the rest of the group. In some cases, even brief separations have resulted in an inability to reintroduce the individual back into the group.

Visual, acoustic, and olfactory barriers: Visual barriers are used in both exhibit settings and in holding areas. On exhibit, foliage or rockwork may provide adequate visual barriers for animals to use as hiding areas. In holding areas, it may be necessary to use visual barriers to separate individuals, particularly during breeding season and times of heightened aggression. These barriers may be necessary when bringing animals on and off exhibit so that subordinate animals will not be displaced during shifting. Visual barriers can also be used during introduction periods, in order to minimize exposure between animals if necessary or when housing groups close together. In addition to reducing agonism, these barriers can prevent physical contact such as bites to fingers and hands that are stuck through the mesh.

There are no data to suggest a need for acoustic or olfactory barriers within the space, as these factors have not been found to cause concern in management of *Eulemur* species.

Mixed-species exhibits: Given that *Eulemur* species are quite small and are often housed in relatively large outdoor areas, including islands, it is becoming increasingly popular to house them in mixed-species groups. Any attempt to create a mixed-species group should follow introduction procedures similar to those described in Chapter 4.3.

Care should be taken to provide numerous areas for varying behaviors in mixed-species and large groups. In a mixed-species exhibit of *E. collaris* and *L. catta*, the two species occupied and made use of separate cave, feeding, and sleeping areas (Villers & Lent, 1993). In general, inter-individual distance is important in managing mixed-species exhibits. Each species will need to find areas that they are comfortable inhabiting. The decision to exhibit mixed species will influence the size of exhibit needed. Besides size of exhibit, creating areas of the exhibit for each species to occupy and feel comfortable using is important. As mentioned above, additional perching and sleeping areas as well as visual barriers in the exhibit are important. Further information on successful mixed-species exhibits is necessary, and the AZA *Eulemur* SSP is dedicated to examining this issue.

There are several cautions that should be taken when housing mixed-species groups with *Eulemur*. If the grouping contains multiple species of *Eulemur*, the females should be placed on contraception to prevent breeding. The different species and subspecies can interbreed, resulting in hybrids that cannot be part of any of the managed breeding programs. There have been natural hybrids reported from the wild, including:

- *E. mongoz* x *E. fulvus* (Zaramody & Pastorini, 2001)
- *E. macaco* x *E. fulvus* at Manongarivo (Goodman & Schütz, 2000)
- *E. macaco* x *E. flavifrons* (Meyers et al., 1989; Rabarivola et al., 1991)
- *E. fulvus* x *E. rufus* (Lehman & Wright, 2000)

Johnson & Wyner (2000), Johnson (2002) and Wyner et al. (2002) also reported a zone of hybridation between *E. albocollaris* (now called *E. cinereiceps*) and *E. rufus*. *Eulemur* species most commonly held together in AZA institutions include *E. m. macaco, E. coronatus*, and *E. rufus.*

The space survey conducted for the 2008 Prosimian Regional Collection Plan revealed that a number of species, including many non-primate species, have been exhibited with *Eulemur*. Although small in size and primarily vegetarian, *Eulemur* will capture and consume smaller animals. Small birds and their eggs, as well as small reptiles, can become targets of *Eulemur* attention and are likely to be consumed (Ichino, 2011). Some *Eulemur* pairs can be quite assertive (e.g., *E. m. flavifrons*) and displace other larger species such as ruffed lemurs, while some are very timid and will be easily displaced and/or injured by larger species (e.g., *E. mongoz*).

Table 4. Non-primate species reported as mixed species exhibit partners with *Eulemur* spp. during the 2008 Prosimian Regional Collection Plan Space Survey*

Common Name	Scientific Name
Chestnut teal	*Anas castania*
Coscoroba swans	*Coscoroba coscoroba*
Deer	
Elk	*Cervus canadensis*
Greater flamingos	*Phoenicopterus roseus*
Hippopotamus	*Hippopotamus amphibius*
Hottentot teal	*Anas punctata*
Leopard tortoise	*Geochelone pardalis*
Lesser flamingos	*Phoenicopterus minor*
Malagasy giant jumping rat	*Hypogeomys antimena*
Marbled teal	*Marmaronetta angustirostris*
Pelicans	*Pelecanus* spp.
Silver teal	*Anas versicolor*
Sulcata tortoise	*Geochelone sulcata*
White-faced Tree Duck	*Dendrocygna viduata*

**Eulemur* will eat birds and eggs.

Eulemur species are often held with other non-*Eulemur* prosimians as well. Ring-tailed lemurs (*Lemur catta*) were the most frequently noted mixed-species partners, but *Eulemur* species were also noted as being housed with ruffed lemurs (*Varecia* spp.), sifaka (*Propithecus* spp.), and bamboo lemurs (*Hapalemur grisues*) (see also Alford-Madden, 1986; Meyer, 1982; Dee & Emerson, 1973). Despite their prevalence as mixed species animals, only one breeding group of *Otolemur garnettii* has been reported in mixed species exhibits with *Eulemur*.

As with the formation of any large social group, care should be taken to provide all species with sufficient space and refuge within the exhibit. Interspecific inter-animal distances will vary widely and will be influenced by both the species and the individuals. Ideally, species with different spatial preferences can be chosen so as to partition the space in the exhibit and prevent aggression related to desired sleeping or feeding sites (Villers & Lent, 1993). When planning a mixed-species exhibit, it is important to exposure to species that have the potential to transmit diseases to *Eulemur*.

Reproduction: It should be noted that while successful reproduction and rearing of offspring has occurred in mixed-species groupings with *Eulemur*, it is more often unsuccessful. Where reproduction has occurred in mixed-species groups, the presence of offspring may change the dynamics of the group, resulting in sudden, increased aggression and death of the infants. Black lemurs, mongoose lemurs, brown lemurs, and red-bellied lemurs have all been suspected of infanticide toward other lemurs (Coffman, 1996). One zoological institution has also witnessed an *E. mongoz* infant killed by a group of *E. m. macaco* (J. Campbell, personal communication, 2008). In general, reproduction may not be successful in mixed-species groups, and reproduction in single species groups is encouraged whenever possible.

4.3 Introductions and Reintroductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

Most introductions between new individuals begin using a visual introduction (e.g., howdy cage, separate stalls with no tactile contact). Release into the group should be based on the behavior of the existing group toward the new individual. Positive behaviors include minimal interest in the new animal and lack of aggression. Introductions between males and females are typically less eventful than

introductions between males or mixed-species groupings. It has also been noted that introducing two females or adding a new female to an existing pair is more difficult. When planning introductions, it is also important to consider the time of year. Introducing two males during the breeding season could be potentially difficult; however, male-female introductions during this time should be relatively successful. Also, some species of *Eulemur* may be easier to introduce into a mixed-species setting. There have been more successful introductions to other species with *E. coronatus* and *E. collaris* than with *E. m. macaco* and *E. m. flavifrons.*

Introducing a group of black lemurs to a group of ring-tailed lemurs was successful after several attempts at one zoological institution (Meyer, 1982). Ring-tailed lemurs were kept on an island exhibit with two dens present. One pair of black lemurs was kept in a holding cage inside one of the dens on the island, giving both lemur species the opportunity to familiarize themselves with one another. When the black lemurs were released, there was immediate aggression toward them by an adult male ringtail lemur. The two black lemurs made no attempt to defend themselves, and therefore were placed back in the holding cage. After 2 weeks, the male ringtail lemur was placed in a holding cage and the black lemur pair was released without further problems from the other ringtails. Later, additional black lemurs were released on the island with little agonistic incidence. After a short time they were residing peacefully together. Ten weeks after the ringtail male had been transferred to the holding cage, he was released back to the island without further aggression.

Another example is from a research institute that houses lemurs in two mixed-species enclosures. Introductions were made through housing new animals in smaller enclosures within the area before release into the group (Alford-Madden, 1986).

Two other zoological institutions reported experiences with introductions between *E. collaris* and *L. catta*, *E. coronatus* and *L. catta*, and *E. m. flavifrons* and *Varecia rubra* (Mogilewsky & Lent, personal communication, 2008). The introductions began by placing the animals in adjoining cages, arranged side-by-side, for a few days. This time period proved long enough for the animals to be exposed to each other, but short enough so that agonistic interactions did not become repetitive or rehearsed. In situations where these behaviors were observed, a pen was placed between the cages to reduce aggression. This process began with the dominant animals from the established group. Animals were then added or subtracted based on aggression levels. Aggressive animals were removed, and less aggressive animals added. This process was continued until the entire troop was united. Once the decision was made to leave the group together overnight, every attempt was made to avoid separating individuals from that point onward. Generally, the introduction period may take as little as a day or as long as several months.

Eulemur species have a fairly strict reproductive season. Females come into estrous beginning around October and ending by late March. Estrous cycles occur roughly every 30 days. Likewise, males experience increased levels of testosterone and aggressive behavior during the same time period. Aggression between males and between females may increase during the breeding season, as well as between males and non-cycling females, and male-male pairs. Introductions between males and females may be easier during breeding season, but overall aggression levels tend to be higher at this period. Females on contraceptives have been reported to receive increased aggression from the male during breeding season in some pairs. Females not on contraception may also receive increased aggression from the male. Also, contracepted females in female-dominant species such as mongoose lemurs may become aggressive to males attempting sexual solicitation.

Introduction facilities and management practices: Multiple shift pens, visual barriers, howdy pens, gates, or side-by-side pens with multiple visual and tactile blocks are all useful during introduction of new individuals. Flexibility is a key component of any introduction. One zoological institution has suggested that introductions begin with periods of side-by-side visual/olfactory and limited tactile contact. Timing is critical in that these initial periods should be long enough to allow familiarity to develop and short enough so that negative behavior patterns are not established or rehearsed. When no sustained aggression is observed in side-by-side housing, and when animals rest as close to each other as possible, introductions may proceed to short duration, full contact introductions.

Another zoological institution has found that providing olfactory exchange prior to introducing individuals or groups can ease aggression during introductions. These olfactory exchanges can be done by having animal keepers move scent-marked objects between individuals and groups to be introduced or by allowing individuals/groups to “switch” enclosures, allowing each individual or group to explore and scent mark the space of the individual or groups that will eventually be introduced.

It may be helpful to release subordinate animals into the new housing first for a period of several hours before introducing dominant animals. Aggression may be permitted during introductions, as long as the aggression is not targeted and there is not group aggression against a particular individual. Short duration introductions are conducted daily, and the length of the daily introduction is based on the behavior of the animals.

Periods of access continue to increase in length as long as aggression does not occur. Once individuals are showing relaxed behavior (e.g., feeding, sleeping, sunning, huddling), direct supervision can give way to frequent checks on individuals. Eventually this proceeds to leaving animals together overnight. Even after individuals have been successfully introduced, staff should watch for aggression, because aggression in *Eulemur* may occur later after an initial "sizing up" period.

When conducting introductions of complete troops, the troops are introduced to each other in smaller groups. For introductions of *Eulemur* to each other, typically a subordinate will be introduced to another subordinate first. This should be the protocol for any introduction, including those of same sex pairs, or of introducing dams with infants back into the family group or if family groups are temporarily split and re-introductions are attempted. For *Eulemur* introductions to other species, the dominance of each species and individuals should be evaluated before choosing which individuals to put together.

Operant conditioning is helpful to allow for routine husbandry to occur, as well as allowing for feeding stations, feeding tolerance, and inspection for wounds. Multiple pens allow for separation of individuals during introduction to prevent an entire troop from ganging up on a new animal. Whenever possible, during introductions, "dead ends" should be blocked off or eliminated, ensuring animals are not cornered or blocked from having an alternative if being pursued by another individual. When possible, having a circular space, such as connecting stalls and exhibits, is useful.

In the experience of the one zoological institution, introductions between single males and females in *Eulemur* have been fairly uneventful (C. Lent, personal communication, 2008). Introductions or reintroductions with multiple animals is difficult and may not be successful. Introductions between mixed species can also be very difficult. However, level of success of all introductions will depend on individual animals and space. The AZA *Eulemur* SSP is continuing to examine this issue, particularly regarding the success of *Eulemur* in mixed-species groups. Please reference the AZA Prosimian TAG Mixed Species Manual for guidance and factors to consider regarding mixed-species exhibits and mixed-species introductions.

Chapter 5. Nutrition

5.1 Nutritional Requirements

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

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all *Eulemur* (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Scientific Advisory Group (NAG) feeding guidelines: (http://www.nagonline.net/Feeding%20Guidelines/feeding_guidelines.htm), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

In general, *Eulemur* species select diets rich in leaves and fruit; although seasonal, environmental and species-specific differences exist. Across all species, it is clear that no species restricts intake to a single food type; folivorous lemurs often consume some fruit, and frugivorous lemurs often consume some leaves. Additional food items such as fungi, small invertebrates and vertebrates, eggs, and nectar have been reported to be consumed in the wild (Godfrey et al., 2004; Vasey, 2000; Curtis, 2004; Vasey, 2004).

Fruit consumed by *Eulemur* are moderately high in fiber. For example, 26% crude fiber in the fruit consumed by mongoose lemurs, 9% crude fiber in fruits consumed by black lemurs, and not excessively high in sugars (<20% total glucose, fructose, and sucrose in fruit consumed by mongoose lemurs) (Curtis, 2004). Leaves consumed by *Eulemur* are generally higher in essential amino acids and total protein, although most wild-type food items are limiting in methionine and cysteine (Curtis, 2004; Simmen et al., 2007). The composition of the wild-type diet varies dramatically from that of domesticated fruits that are often provided to animals in zoos (Willis, 2008). Also of note, the consumption of fruit by many *Eulemur* spp. plays an ecological role in addition to a nutritional role; for example, *E. macaco* consume a number of fruits for which seeds are not digested but are excreted intact and subsequently germinate (Birkinshaw, 2001).

Fruits and leaves consumed by *Eulemur* are generally low in phenolics, tannins, and alkaloids (Simmen et al., 1999; Simmen et al., 2007), and lemurs in zoos avoided alkaloids in preference trials (Glander & Rabin, 1983). However, tannin-rich foods may be consumed in the wild including *Tamarindus indica*, *Terminalia*, *Haronga madagascariense* (Spelman et al., 1989). The consumption of tannin-rich food items is a subject of discussion relative to the concern about hemosiderosis (iron-storage disorder) in lemurs.

Table 5. Wild-type dietary items consumed by Eulemur spp.

Species	Reported food items consumed by free-ranging animals	Source
Eulemur fulvus albifrons (White fronted brown lemur)	Primarily fruit, some leaves, occasionally insects	(Vasey, 2000; 2004)
Eulemur rubriventer (Red bellied lemur)	≥ 50% fruits, some flowers, some insects and millipedes in winter (12% of diet at peak)	(Overdorff, 1993)
Eulemur macaco (Black lemur)	>65% fruit, some flowers and leaves, small amounts of bark, gum, and earth (all data from dry season)	(Simmen et al., 2007)
Eulemur mongoz (Mongoose lemur)	Primarily fruit (~50–60%; mature and immature), leaves (~8–21%; mature and immature), seeds (9% in wet season); flowers (3–6%), nectar (24% in wet season), ants (13% in dry season); occasional bird-nest predation	(Curtis, 2004)
Eulemur coronatus (Crowned lemur)	Primarily fruit, some flowers and leaves	Reviewed by (Godfrey et al., 2004)
Eulemur fulvus (Brown lemur)	>70% fruit (ripe and unripe) in all seasons; <30% leaves (mature and immature) in all seasons; some reported animal matter	(Simmen et al., 2003)
Eulemur collaris (Collared lemur)	>75% fruit (predominantly ripe), flowers, leaves, invertebrates	(Donati, Bollen et al. 2007)

The gastrointestinal tract of lemurs (Figures 1–5) consists of a simple stomach and an expanded cecum and/or colon (with or without sacculation or haustration), which would be the primary site of microbial fermentation (Godfrey et al., 2004). *E. rubriventer* and *E. m. flavifrons* are reported to have similar GI anatomy to *E. fulvus* and *E. coronatus* (Gomis et al., 2009). This type of GI anatomy indicates ability for some alloenzymatic fiber digestion, although this capacity in *Eulemur* spp. is generally lower than other prosimian species; digestibility of fiber by *E. fulvus* was lower than that of *Propithecus* sp. or *H. griseus* fed similar diets.

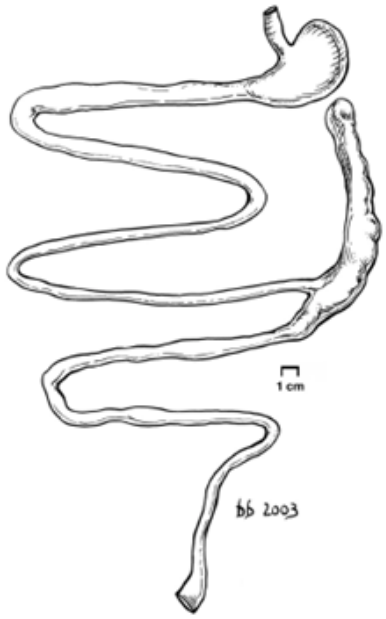

Figure 1. Drawing, to scale, of the gastrointestinal tract of a brown lemur (*Eulemur fulvus*). From Campbell, 2003.

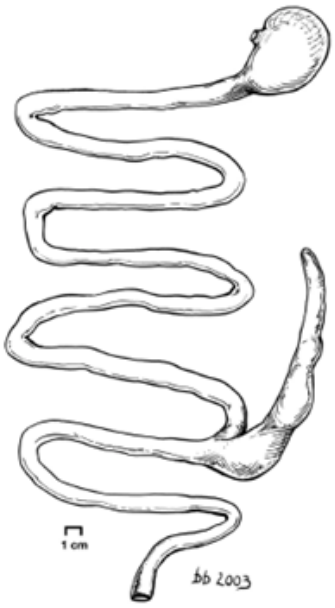

Figure 2. Drawing, to scale, of the gastrointestinal tract of a crowned lemur (*Eulemur coronatus*). From Campbell, 2003.

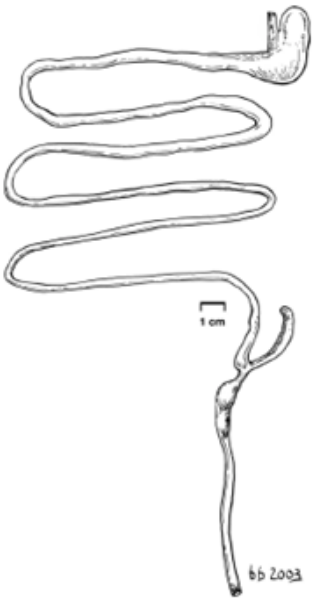

Figure 3. Drawing, to scale, of the gastrointestinal tract of a dwarf lemur (*Cheirogaleus medius*). From Campbell, 2003.

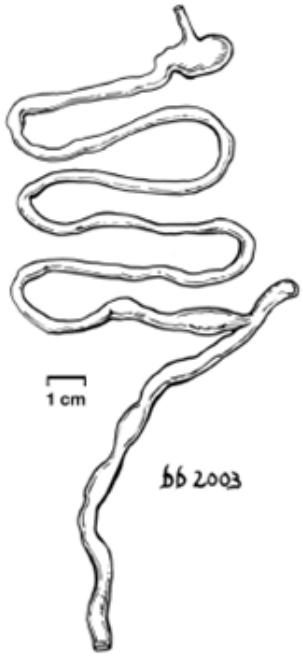

Figure 4. Drawing, to scale, of the gastrointestinal tract of a mouse lemur (*Microcebus murinus*). From Campbell, 2003.

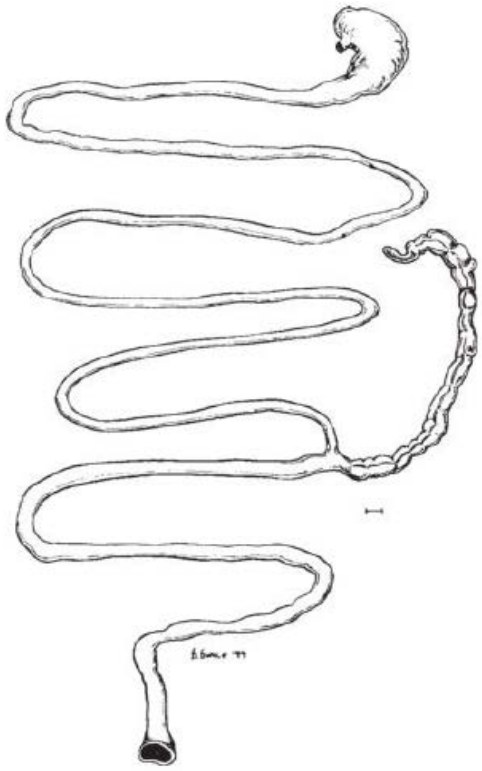

Figure 5. Drawing, to scale, of a red ruffed lemur (*Varecia rubra*).
Scale equals 1cm. From Campbell et al., 2000)

Transit time through the stomach of *E. fulvus* was 1–8 hours (longer for larger particles), while transit through the intestine was ~1 hour regardless of particle size (Campbell et al., 2004). Mean retention time in this species was 7.9–10.4 hours (Campbell et al., 2004). Again, this indicates some capacity for alloenzymatic digestion, but the retention of food in the GI tract is shorter than for more folivorous prosimians such as Propithecus and Hapalemur (Campbell et al., 2004).

Food-related behaviors including regurgitation and coprophogy have been noted in *Eulemur* spp. For example, *E. fulvus rufus* were observed in the wild regurgitating and re-swallowing their food during resting bouts after feeding on unripe fruit and occasionally mature leaves (Overdorff, 1993). Similarly, *E. fulvus rufus* and *E. rubriventer* were observed practicing coprophagy in the wild (Overdorff, 1993). Owing to their dietary flexibility, *Eulemur* species have been successfully housed in zoos and aquariums for centuries. Thus their nutritional management can be straightforward, provided that a few key issues are carefully addressed. The main issues are: (1) provision of a palatable and nutritionally complete diet; and (2) prevention of obesity.

Without exception, all managed *Eulemur* species have been successfully maintained on a diet consisting of a nutritionally complete, commercially available biscuit designed for feeding omnivorous primates, in combination with a mixture of locally available produce. Most commercially available produce is safe to feed; however, the quantities offered should not affect the adequate consumption of the nutritionally complete biscuit provided. The U.S. Food and Drug Administration recommends washing fresh produce thoroughly with tap water before eating. When appropriate, produce should be scrubbed with a brush to remove microorganisms that might be present. The surfaces of firm fruits and vegetables, such as apples, melons, and cucumbers, can withstand scrubbing with a brush. However, fragile produce, such as berries and lettuce, cannot be scrubbed and should be rinsed thoroughly with clean tap water before eating. It is important to remember that the Food and Drug Administration does not recommend using anything other than clean tap water to wash fresh produce (FDA, 2010).

More recently, locally available browse species have been used as a dietary enrichment item (Campbell et al., 2001). While all browse species offered should be documented as safe for consumption, browse can provide animals with a novel and challenging food item and can be good for maintaining dental health. Recommended nutrient intake is provided in Table 6, based on minimum estimated nutrient requirements as published in the NRC Nutrient Requirements of Nonhuman Primates, 2nd edition (NRC, 2003).

Table 6. Recommended nutrient intake of *Eulemur* spp.*

Nutrient		Recommended nutrient level*	Species based on (from NRC)
Protein	%	8; 14 growth	Macaque; growth=chimp
Fat	%	n/a	
Crude Fiber	%	n/a	
NDF	%	20	Lemur
ADF	%	10	Lemur
Calcium	%	0.55	Macaque
Phosphorus	%	0.33	Macaque
Sodium	%	0.25	Baboon
Magnesium	%	0.04	Macaque
Potassium	%	0.24	Baboon
Omega-3 fatty acids	%	0.5	Macaque, squirrel monkey, *Cebus* spp., chimp
Omega-6 fatty acids	%	2	Macaque, squirrel monkey, *Cebus* spp., chimp
Chloride	%	0.27	Baboon
Chromium	ppm	>0.09	Squirrel monkey
Copper	ppm	15	Macaque
Iodine	ppm	0.65	Marmoset, tamarin
Iron	ppm	100	Macaque
Manganese	ppm	44	Macaque
Selenium	ppm	0.11	Macaque, squirrel monkey
Zinc	ppm	13; mtnc 20; growth	Macaque
Ascorbic Acid	ppm	110	Macaque
Biotin	ppm	2–4	*Cebus* spp.
Choline	ppm	1,000	Overall species
Folic acid	ppm	1.5; growth 3.3; repro	Squirrel monkey, *Cebus* spp.
Niacin	ppm	16	Macaque
Pantothenate	ppm	20	Macaque, *Cebus* spp.
Pyridoxine	ppm	3.1	Baboon
Riboflavin	ppm	1.7	Macaque, *Cebus* spp.
Thiamin	ppm	1.1	Macaque
Vitamin A	IU/kg	12,000	Squirrel monkey
Vitamin D3	IU/kg	1,000	Macaque, *Cebus* spp.
Vitamin E	IU/lb	68	Macaque
Vitamin B12	mcg/kg	11	Macaque
Vitamin K	ppm	>0.06–3	Macaque

Based on Nutrient Requirements of Nonhuman Primates, 2nd edition (NRC, 2003).

Commercial diets commonly offered, and which provide minimum estimated requirements when fed at recommended dietary inclusion level provided by the manufacturer include:

- Purina Monkey Diet (5038): www.purina-mills.com
- Marion Leaf Eater Diet: www.marionzoological.com
- Mazuri Leaf Eater Diet (5M02): www.mazuri.com
- Mazuri High Fiber Sticks (5MA3): www.mazuri.com
- Mazuri Primate Maintenance (5MA2): www.mazuri.com
- Mazuri High Fiber Geriatric Gel (5S2R): www.mazuri.com
- Mazuri Primate L/S Biscuit (5M1G): www.mazuri.com

Additionally, a recent survey examined the diets of black & white ruffed lemurs (*V. variegata*) at 33 US Zoological institutions found that majority of institutions fed either Marion Leaf Eater Diet (10 institutions), Mazuri Leaf Eater Diet (14 institutions), or Mazuri Primate Browse Biscuit (10 institutions). In addition to commercial diets, apples, bananas and browse were offered (although 33% of institutions reported little to no consumption of browse offered (Donadeo, 2013). The estimated chemical composition (dry matter basis) of the diets showed a median crude protein content of 17%, median crude fat content of 4.7%, and median energy density of 3.2 kcal ME/g. In comparison to nutrient composition of plant parts from Madagascar (Schmidt et al., 2010; Donadeo, 2013), zoo diets were estimated to contain higher crude protein and digestible carbohydrates and lower fat and fiber levels. Compared to plant parts from

Madagascar, managed diets were estimated to have higher CP and NFE, and lower fat and fiber concentrations. Reducing the amount of fruit included in diets for black-and-white ruffed lemurs would decrease digestible carbohydrate content and increase fiber content of these diets, which could reduce the prevalence of obesity and diabetes in *V. variegata*.

For successful dietary management, the produce portion of the diet should not be considered a significant contributor to the animals' nutritional needs. In fact, overconsumption of produce that is particularly high in sugar and starch can contribute to diarrheal episodes, obesity, dental decay, and diabetes. However, produce possessing a low glycemic load (i.e., less than or equal to 10) can be viewed as a key enrichment item, providing daily variety in the dietary protocol. Glycemic load (GL) is a grading system designed to describe the relationship between the carbohydrate content of a particular food and its effect on blood sugar and insulin response (Ludwig, 2002). In human subjects, research has demonstrated that sustained elevations in blood sugar and the associated spikes in insulin level may lead to an increased risk of diabetes and insulin resistance (Ludwig, 2002). Low glycemic load commercial produce that is commonly included in *Eulemur* diets:

- Leafy greens: no limit
- Cucumbers, carrots, celery: no limit
- Cruciferous vegetables (broccoli, cauliflower, kale, cabbage): limit amounts daily
- Starchy vegetables (sweet potatoes, corn): limit amounts daily
- Fruits (apples, blueberries, plums, cherries, pears, raspberries, blackberries, cantaloupe, honeydew melon, bananas): limit amounts daily

Food intake of wild *Eulemur* spp. is ~16–34% of body weight (BW) on an as-fed basis, varying due to species. *E. mongoz* consumed 19% of BW (3.2% DMB) (Curtis, 2004). *E. fulvus* consumed 16% of BW as is basis, and *E. macaco* consumed 28–34% of BW as is basis (6–7.5% DMB) (Simmen et al., 2003; Simmen et al., 2007). However, in zoo-managed animals, food intake is generally lower. Managed adult lemurs at maintenance typically consume around 2–2.5% of their bodyweight in dry matter daily. This corresponds to 20–25 g of dry matter per kilogram of body weight. Diets should be formulated so that 80–90% of total dry matter (DM) intake is composed of commercially available complete feed and 10–20% of the remaining diet is produce. At this level, all minimum estimated requirements would be met by the intake of biscuit, while produce levels will be high enough to provide dietary variety.

The rate of passage of ingesta may be far more rapid in *Eulemur* than in other lemur species. As mentioned previously, transit time through the stomach of *E. fulvus* was 1–8 hours (longer for larger particles), while transit through the intestine was ~1 hour regardless of particle size (Campbell et al., 2004). Mean retention time in this species was 7.9–10.4 hours (Campbell et al., 2004). Again, this indicates some capacity for alloenzymatic digestion, but the retention of food in the GI tract is shorter than for more folivorous prosimians such as *Propithecus* spp. and *Hapalemur* spp. (Campbell et al., 2004). Although the number of animals included in the research is not high enough to constitute statistical significance, it does suggest the potential importance of considering nutrient passage rate when formulating diets for *E. fulvus*. Measures should be taken to avoid feeding an inappropriate diet in this species and all *Eulemur* species.

While concern about hemosiderosis has been discussed with respect to managed lemurs, its actual prevalence and clinical significance is unclear. Recent studies suggest that different lemur species have varying propensities for accumulating excess iron in tissues and that the incidence of the condition is likely much lower than previously thought (Williams et al., 2006; Glenn et al., 2006). While some authors have recommended adding tea, beans, or tannins to managed lemur diets in an effort to reduce dietary iron absorption there is currently insufficient evidence to support these recommendations (Wood et al., 2003). Thus, with the exception of avoiding giving iron-containing supplements to lemurs, diet modifications to decrease iron absorption are not currently recommended (Hemosiderosis statement, AZA).

Body size and energy requirements: In general, *Eulemur* spp. have a relatively low basal metabolic rate (BMR) compared to haplorrhine primates and other mammals (Daniels, 1984). Actual BMR has been calculated at 28–70% of that predicted by Kleiber's equation (BMR (ml O_2/h) = 3.42 x BW^0.75) (Genoud, 2002; Harcourt, 2008). This low BMR coupled with relatively lower activity level in the zoo environment likely predisposes these animals to obesity; care should be taken to monitor body condition and caloric intake to maintain healthy body weights. Smaller species typically exhibit higher BMR and lowered energy costs of locomotion (Warren & Crompton, 1998). Smaller body mass also tends to be accompanied by

selection for more nutrient dense dietary items (Pough, 1973). However, folivory, which is common to many lemur species, is often linked with slower basal metabolic rates possibly due to the low bioavailability of leaf biomass (McNab, 1978; Ganzhorn, 1992). When formulating diets for the more folivorous prosimian species, it may be prudent to consider a slower rate of metabolism in addition to body size. Calculated energy intake of black lemurs in the wild (using Atwater factors) was 230–260 kcal/day (~92–104 kcal/kg BW*d) (Simmen et al., 2007). A mixed *Eulemur* group (brown x collared) was reported to have total energy expenditure of 314–349 kJ/kg BW*day (~75–83 kcal/kg BW*d) (Simmen et al., 2010).

Age and activity: For brown lemurs, young are generally weaned at approximately 4–5 months of age, but females may reduce nursing when young are 3–5 months, encouraging the young to consume solid foods at this time (Tarnaud, 2006b). Managed infants at one zoological institution have been observed sampling food items at as early as 4–6 weeks of age. The institution typically begins including food rations for the juvenile at 50% of an adult portion, at approximately 3 months of age. Further diet increases are implemented based on changes in body weight and hunger. In general, animals are offered a full adult portion by 1 year of age. As infants are weaned they tend to consume more solid foods with high sugar content (fruit) than protein content (e.g., flowers, young leaves), while lactating females consume more protein-rich foods (e.g., flowers) (Tarnaud, 2006b). Adult male white-fronted brown lemurs will also consume more insect material (Vasey, 2004).

Older animals' diets are not dramatically altered unless a medical condition necessitates a diet change; however, animals with severely worn molars may require biscuits be softened by spritzing with water or dilute fruit juice in an effort to encourage consumption. Terranova & Coffman (1997) compared the body weights of wild and managed lemurs and found that overall, the animals were heavier in zoos. Additionally, they found that crowned lemurs (*E. coronatus*) and Sclater's black lemurs (*E. m. macaco*) in zoos and aquariums weighed significantly more than their wild counterparts and proposed that the high occurrence of obesity in managed Sclater's black lemurs may be problematic for this species. Activity levels are typically lower for *ex situ* lemurs relative to free ranging animals.

They further suggest that obesity in managed lemurs may be a function of the elements of a managed environment, such as physical limitations, a steady and highly palatable food supply, and dominance hierarchies which may lead to overconsumption of food by some individuals. Given that they are prone to obesity, body weights and dietary intakes should be monitored on a regular basis. Increasing activity when possible, using multiple feeding sites in group-housed animals, and avoiding overfeeding are all helpful measures that can help reduce obesity in managed *Eulemur* species. If a change in diet is necessary, changes should be implemented slowly, be carefully documented, and body weights monitored frequently. Recommended healthy weight ranges for *Eulemur* housed at one zoological institution are:

- *Eulemur collaris, E. fulvus, E. rufus, E. macaco, E. rubriventer*: 2–2.4 kg
- *Eulemur mongoz, E. coronatus*: 1.4–1.7 kg

Unlike most other primates, all *Eulemur* species have been reported to exhibit some level of both nocturnal and diurnal activity (i.e., cathemerality), including feeding behavior (Tattersal, 1987; Overdorff 1998; Overdorff & Rasmussen, 1995; Wright, 1999). There are species differences in the time spent feeding (in addition to seasonal differences), but most species spent reasonable time during day and night on feeding activities (Andrews & Birkinshaw, 1998). The total time spent feeding and foraging in the wild is reported to be 12–20% of the time budgets of *E. mongoz*, *E. fulvus*, *E. rubriventer*, and *E. fulvus rufus* (Overdorff, 1993; Curtis, 2004; Tarnaud, 2006a and 2006b). Research performed by Sussman and Tattersal first documented nocturnal feeding behavior of the normally diurnal *Eulemur mongoz* in 1976 (Wright, 1999). Research conducted by Overdorff (1998), reported an average of 6 hours of nocturnal activity that was balanced by 6 hours of sleep during midday for *Eulemur rubriventer*. It has been suggested that adaptations towards energy conservation and a high level of metabolic efficiency have developed in order to maximize the utilization of scarce resources (Wright, 1999).

Reproductive factors: There are nutritional considerations for reproductive *Eulemur* females. Food consumption by wild female brown lemurs increases during lactation and is also greater during the early lactation period compared to the subsequent weaning period (Tarnaud, 2006b). Managed females that are lactating may receive an increased daily ration; however, care should be taken not to overfeed. Increases (or decreases) in the diet should be implemented in no more than 10% increments, and intake

and weight should be carefully monitored. Diets should return to baseline when the female is no longer lactating. Female white-fronted brown lemurs will consume more low-fiber protein than males during gestation and lactation (Vasey, 2000b).

Seasonal variation: Managed *Eulemur* do not experience large seasonal changes in dietary intake. At most, animals consume somewhat less food during hot or inclement weather. The decrease is typically not enough to necessitate a decrease in amounts offered. At this time there is no recommendation to implement dietary increases or decreases based on season. Thus, dietary requirements do not vary greatly with seasonal changes. Seasonal changes in body condition have not been noted in *Eulemur* species.

Health status: One indicator of a change in health status is a change in stool consistency. Most zoo diets are lower in both the amount and variety of fiber types than are wild diets. As a result, stool consistency in managed lemurs tends to be looser than in wild lemurs. If loose stool is a problem in managed lemurs and pathogens have been ruled out as a cause, it is possible that diet modifications are warranted. Changes to the diet that may improve stool consistency include limiting fruits and starchy vegetables, increasing the amount of fiber in the diet, and feeding fresh browse if available.

5.2 Diets

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

Sample diets: Feeding practices can contrast greatly between institutions. Care should be taken when utilizing domestically harvested fruit products in *Eulemur* diets. Domesticated fruits are cultivated to contain high levels of soluble and low levels of structural carbohydrate and thus carry the potential to contribute to obesity and diabetes (Schwitzer et. al., 2008). The nutritional profile of wild fruits native to Madagascar more closely resembles that of domestically grown vegetables than fruits (Schwitzer et al., 2008). The utilization of low glycemic load produce should also be considered. The feeding of browse has been suggested as a means of increasing structural carbohydrate (fiber) levels in the diet. However, prior to incorporating browse into a feeding program, both a nutrient analysis and an assessment of secondary metabolites should be conducted (Campbell et al., 2001). The feeding of browse can contribute significantly to the total nutrients supplied in the diet, and secondary plant compounds can potentially affect palatability as well as impose additional energetic costs for detoxification (Campbell et al., 2001; Ganzhorn, 1992; McNab, 1978).

Example 1

Species: *E. coronatus*
Age: Adult male
Health status: Clinically healthy
Diet/Ration provided daily:

- Mazuri Primate L/S Biscuit (5M1G) (30% AF)
- Carrots (20% AF)
- Blackberries (30% AF)
- Dandelion greens (20% AF)

Selected nutrient analysis:

- ME (3.2 kcal/g DM)
- Protein (18.1% DM)
- Fat (5.3% DM)
- NDF (27.9% DM)
- ADF (13.7% DM)
- Calcium (0.8% DM)
- Phosphorus (0.4% DM)
- Iron (153 ppm DM)
- Ascorbic acid (410 ppm DM)

Example 2

Species: *E. collaris*
Age: Geriatric female
Health status: Hyperglycemic/Insulin resistant
Diet/Ration provided daily:

- Fresh cherries (30% AF)
- Greens (20% AF)
- Mazuri High Fiber Sticks (5MA3) (30% AF)
- Soluble fiber supplement (*Amorphophallus konjac*) (20% AF)

Selected nutrient analysis:

- ME (2.9 kcal/g DM)
- Protein (17.6% DM)
- Fat (4.5% DM), NDF (27.4% DM)
- ADF (14.9% DM), Calcium (1.0% DM)
- Phosphorus (0.5% DM), Iron (216 ppm DM)
- Ascorbic acid (495 ppm DM)

Abbreviation key:
ME = Metabolizable Energy
NDF = Neutral Detergent Fiber
ADF = Acid Detergent Fiber
AF = As Fed
DM = Dry Matter

Food variety and presentation: *Eulemur* should be provided a variety of foods including produce; approved browse and a protein source (see Table 6 for more detailed dietary requirements). In the wild, brown lemurs naturally spend 13–20% of their time searching for and consuming their diet (Tarnaud, 2006b). They forage opportunistically on both ripe and unripe fruits, flowers, and young and mature leaves; females tend to prefer fruit to leaves (Tarnaud, 2006b). Food should be provided at least twice daily, and more often as necessary for specific individuals' requirements. More complex foraging opportunities, including browse, puzzle feeders, multiple feedings, and scatter feedings allow for increased foraging activity.

Feeding: Food should be provided early in the day in multiple locations within the enclosure to promote foraging. USDA regulations require that appropriate feeding containers be present in all holding areas. Care should be taken to ensure that each individual has access to their appropriate diet, and that one individual does not monopolize resources. When possible, the scattering of food may help to reduce or prevent dominant animals from monopolizing a particular feeding position. Multiple bowls/feeding stations should be spaced as far apart as possible. Individuals may be separated during feedings if necessary to prevent food aggression.

Eulemur species may also prefer arboreal feeding stations. This is extremely important for lemurs that are candidates for reintroduction. In most cases, animals will relocate to the ground to feed if necessary. Food should be spaced throughout an exhibit or holding area to avoid social conflict through food competition as well as prevent a dominant animal from monopolizing a food source. Steps should be taken to increase foraging time through the use of enrichment devices when possible.

Various mechanisms can be used to present *Eulemur* species with opportunities to work for food. Enrichment items, browse, and food chopped into different sizes are all techniques used to present food items. For example, Sommerfield et al. (2006) utilized self-operated feeder boxes to increase locomotion and overall activity in *E. albifrons* to levels that approximated activity levels in the wild. Other examples include giving foods whole, cut very small, or leaving in husk/rind/shell. Food can also be hung, skewered, or mixed with substrate to increase foraging time. Commonly utilized commercial laboratories that routinely perform analysis on animal feeds include: Dairy One Forage Lab, Ithaca, NY; Michigan State Diagnostic Center for Population and Animal Health, Lansing, MI; BASF Corporation: Animal Nutrition Technical Services Laboratory, Wyandotte, MI; Eurofins Scientific, Inc. Des Moines, IA; Central Analytical Laboratories, Metairie, LA; Midwest Laboratories, Inc. Omaha, NE; and Barrow-Agee Laboratories, Memphis, TN. It is recommended that zoo professionals not familiar with the interpretation

of nutritional analysis request assistance from SSP nutrition advisors and or the AZA Nutrition Advisory Group (NAG) prior to incorporating dietary changes based on analytical data.

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

AZA Accreditation Standard

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

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

AZA Accreditation Standard

(2.6.3) The institution should assign at least one person to oversee appropriate browse material for the animals.

Nutritional analysis of browse species can be difficult to locate and interpret. Nijboer & Dierenfeld (1996) list analyses of browse species common to the diets of managed nonhuman primates. Although browse is a valuable enrichment tool, fatalities have been reported in certain species of primates as a direct result of browse consumption (Ensley et al., 1982; Janssen, 1994; Robinson et al., 1982). Some species of browse found safe for hoof stock have caused illness and death in some species of primates (Ensley et. al., 1982). It is critical for any institution that utilizes browse in their dietary protocols to have qualified staff officially designated to the identification of primate specific edible browse. Individuals are encouraged to contact the AZA *Eulemur* SSPs, the AZA Prosimian Taxon Advisory Group nutrition advisor, or the AZA Nutrition Advisory Group as reference prior to initiating a browse-feeding program (Toddes et al., 1997). Commonly utilized browse species include, but are not limited to *Cornus* sp. (Dogwood), *Salix* sp. (Willow), *Morus* sp. (Mulberry), *Phyllostachys* sp. (Bamboo), and *Cercis* sp. (Redbud). If husbandry staff are not familiar with a particular browse species and subsequently how that feed source may react with their animals they should seek advice from qualified individuals.

5.3 Nutritional Evaluations

Nutrition related health concerns with the potential to affect *Eulemur* species include obesity, diabetes, and both vitamin and mineral imbalances. Obesity can be significant for *Eulemur* species of all ages, and should be monitored closely. Although hemosiderosis has classically been considered an associated condition with *ex situ Eulemur* populations, research suggests that this disorder is not as pervasive as has been previously reported (Williams et al., 2006; Glenn et al., 2006). However, if iron storage pathologies are present and hemochromatosis is suspected, the levels of dietary iron and ascorbic acid (vitamin C) should be considered.

Assessments of nutritional status should be routinely administered as a direct function of preventative animal health care. Evaluations commonly utilized for this purpose include: body condition scoring by properly trained nutrition veterinary and or husbandry staff; fecal scoring based upon current established literature; and blood vitamin and mineral panels analyzed via commercial laboratories (Nijboer et al., 2001; 2006). If zoo professionals are unfamiliar with the interpretation of hematologic nutritional analyses they should seek advice from appropriate SSP Nutrition and Veterinary Advisors or the AZA Nutrition Advisory Group. Physical evaluation, through both visual and routine body weights and morphometric measurements, can be a valuable tool in addressing animal health. Although a sanctioned body condition scoring system does not currently exist for *Eulemur*, basic parameters can be utilized to implement a visual and or palpation based scoring system.

Developing an index of body condition requires a visual assessment of mass (i.e., fat to lean tissue that can be correlated with species specific skeletal reference points including spinous, rib cage, abdomen, etc.). To be effective, the establishment of these reference points should be undertaken by staff with an excellent working knowledge of the structural parameters of the species in question. Typical body condition scoring systems rely upon either a 1–5 or 1–9 point numeric scale. A score of 1

designates an emaciated individual with severe depletion of total body energy reserves and is often accompanied by extreme angularity due to skeletal protrusions and a lack of subcutaneous fat. Depending on the scale used, a score of 5 or 9 will designate an obese individual with extreme fat deposition and greatly reduced structural angularity due to excess subcutaneous fat stores. It is often helpful to utilize photography when establishing a scoring system as this allows for reference to be made specific to score, health status and age of individuals. These practices when combined with routine body weight determinations can play an important role within preventative health care programs.

Chapter 6. Veterinary Care

6.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian is recommended, however, in cases where this is not practical, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and to any emergencies (AZA Accreditation Standard 2.1.1). In some instances, because of their size or nature, exceptions may be made to the twice-monthly inspection requirement for certain institutions (e.g., insects only, etc.). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). The AZA Accreditation Standards recommend that AZA-accredited institutions adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV) that were updated in 2009 (http://aazv.affiniscape.com/associations/6442/files/veterinary_standards_2009_final.docx).

AZA Accreditation Standard

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

AZA Accreditation Standard

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

Routine health monitoring should be performed on all *Eulemur* species on a regular basis. For most institutions, routine health inspections occur annually; however, a rotational system that examines each animal on a 2–3 year cycle is acceptable as long as no significant health issues are identified in the collection. Email information for the current AZA SSP/TAG veterinary advisor for prosimians, particularly *Eulemur* is:

Cathy Williams, DVM
Duke Lemur Center
Cathy.Williams@duke.edu

Basic information on prosimian medicine is available in the current scientific literature, specifically Zoo and Wild Animal Medicine (Junge, 1999a; 1999b). Additional veterinary references can be found in the reference section of this document. There are no lemur-specific training programs in veterinary medicine currently available.

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

AZA Accreditation Standard

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

Appropriate anesthetic drugs for *Eulemur* species are listed in Chapter 6.6 regarding immobilization.

The following drugs and dosages have been used in *Eulemur* without obvious ill effect; however, studies ensuring safety and efficacy are not available. All medications should be used under the direction of a licensed veterinarian.

Anesthetic drugs:

- Diazepam (0.25–0.5 mg/kg PO, IV)
- Midazolam (0.1–0.3 mg/kg IM)
- Ketamine (5–10 mg/kg IM; see details below)
- Tiletamine/zolazepam (3–6 mg/kg IM)
- Dexmedetomidine (0.02 mg/kg IM)
- Butorphanol (0.1–0.4 mg/kg IM).

The inhalant anesthetics isoflurane and sevoflurane are generally safe for use in *Eulemur* spp.

Antibiotics:

- Amoxicillin (10–15 mg/kg q12h PO)
- Ampicillin (10–30 mg/kg SQ, IM, IV q8h)
- Ceftazolin (8–16 mg/kg IM q8h)
- Cephalexin (20 mg/kg PO q12h)
- Cetiofur (1.1–2.2 mg/kg IM q24h)
- Trimethoprim/sulfa (30 mg/kg PO, IM q 24h)
- Enrofloxacin (5 mg/kg PO, IM q24h)
- Azithromycin 5–10 mg/kg PIO q 24hrs.

Anthelmintics:

- Ivermectin (0.2 mg/kg IM, PO)
- Mebendazole (10–20 mg/kg PO)
- Thiabendazole (50 mg/kg PO)
- Pyrantel pamoate (5–10 mg/kg PO)
- Albendazole 10 mg/kg PO)
- Metronidazole (25 mg/kg PO)

Therapeutic agents should be stored in a secure location that is temperature controlled. The law states that only a licensed veterinarian can prescribe medications for animal care.. Medications should be administered only at the direction and supervision of a licensed veterinarian. Diazepam, midazolam, ketamine, butorphanol, and Telazol® are controlled substances and have to be stored in accordance with state and federal regulations. Clinicians using these substances may only do so under the direction of a veterinarian holding an active license from the Drug Enforcement Agency of the United States.

All drugs have the potential for idiosyncratic or hypersensitivity reactions and therefore should be used only under the direct supervision of a licensed veterinarian. Hypotension is a common occurrence in *Eulemur* that have been anesthetized with the inhalant anesthetics isoflurane and sevoflurane; blood pressure should be monitored when these agents are used. Ketamine is not appropriate for use in *Eulemur* as a **single** agent for immobilization due to inconsistent results, long recovery times, the tendency for *Eulemur* to vomit on induction and recovery, and to develop seizures. Combining ketamine with either midazolam or midazolam and dexmedetomidine is safer and provides better results. Telazol®, a combination of tiletamine and zolazepam, is frequently used in lemurs for field immobilization. Benefits of using Telazol® include a wide margin of safety, good muscle relaxation, and smooth recoveries; however, recovery times are long, in the range of 4–6 hours, and the drug has a short shelf life once reconstituted. Nausea and vomiting are also associated with this drug. Ideally, antibiotics should be prescribed based on results of culture and sensitivity testing. The duration of treatment should be the minimum amount of time needed to control the infection. Antibiotic treatment can adversely impact normal intestinal microflora populations resulting in diarrhea and overgrowth of pathogenic bacteria.

AZA Accreditation Standard

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

AZA Accreditation Standard

(1.4.7) Animal records must be kept current, and data must be logged daily.

Animal recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining an animal record keeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be retained in a fireproof container within the institution (AZA Accreditation Standard 1.4.5) as well as be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4).

AZA Accreditation Standard

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

Some suggestions for effective record keeping and management are listed in Chapter 11. Any veterinary treatment and procedure, as well as medications administered, should be kept in each

individual animal's records. Any behavior or sign that is abnormal for this species should be recorded in the animal's daily records and also communicated to an appropriate staff member for consideration of follow up monitoring, action, or intervention.

AZA Accreditation Standard

(1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

Records should include descriptions of any clinical symptoms related to illness or injury, medical care provided, anesthetic events, therapeutic agents used including the dose used and duration of treatment, and test results. Records should also include observations such as appetite, changes in urination or defecation, and gait abnormalities etc. Weight should be monitored regularly and be included in the medical records.

Keeper observations should be entered daily. Veterinary records should be entered at the time of an event or procedure. Records should ideally be computerized and backed up on regular intervals to prevent against loss. There are no known health related record-keeping laws and regulations specific for *Eulemur*.

Records should include descriptions of clinical symptoms, abnormal behavior, response to therapy, summaries of exam findings, treatments, anesthetic events, weight, and test results. Records should also include observations related to changes in appetite, urination, defecation, gait, and mental awareness. Keeper observations should be entered daily. Veterinary records should be entered at the time an event or procedure takes place.

Every state has different requirements in permits required to exhibit or maintain lemurs. Please check with state regulations to determine laws and policies in your state. In general, since all lemurs are listed as CITES Appendix I species, a Fish and Wildlife Service issued Captive Bred Wildlife Permit (CBW)—which are valid for 5 years from date of issue—should be held by both institutions engaged in any transaction that involves any commercial exchange of lemurs across state lines. Some individual states allow lemurs to be owned without a CBW, as long as they were purchased in state. A zoo can hold lemurs without a CBW permit, but the animals have to have been donated or loaned to them, and without the permit, zoos cannot sell animals across state lines, only donate or loan them.

All institutions holding *Eulemur* should also have USDA exhibitors Class C license. The Class C license states:

> "Persons holding Class C licenses may exhibit their animals to the public. All exhibitors, whether municipal owned zoos, or privately owned zoos, circuses, or professional educators that bring animals off-site to the places of business of their customers, must adhere to the same USDA guidelines and standards. USDA Class C facilities may breed and sell offspring (non-endangered), they may broker offspring bred by others, and they may exhibit animals, though the major activity of a Class C licensee must be the exhibiting of the animals."

All original CITES import permits that allowed for original collection of animals from the wild or from import from another country should be maintained indefinitely. Any additional paperwork related to donations or loan agreements should also be maintained.

6.2 Identification Methods

Ensuring that *Eulemur* are identifiable through various means increases the ability to care for individuals more effectively. Animals must be identifiable and have corresponding ID numbers whenever practical, or a means for accurately maintaining animal records must be identified if individual identifications are not practical (AZA Accreditation Standard 1.4.3).

AZA Accreditation Standard

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

Eulemur spp. can be differentiated by their individual coloration and features. However, additional methods are often used to identify individuals including microchips, collars for individuals kept in free-ranging exhibits, and skin tattoos on the inner thigh. Ear tags can be used for *Eulemur*, but are not recommended as they may easily be pulled out. Identification marking should be done before the animal becomes independent. Subcutaneous transponder chips may be placed at an early age (i.e., 1 month) without harm to most species.

AZA member institutions must inventory their *Eulemur* population at least annually and document all *Eulemur* acquisitions and dispositions (AZA Accreditation Standard 1.4.1). Transaction forms help

document that potential recipients or providers of the animals should adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy (see Appendix B), and all relevant AZA and member policies, procedures, and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities. All AZA-accredited institutions must abide by the AZA Acquisition and Disposition policy (Appendix B) and the long-term welfare of animals should be considered in all acquisition and disposition decisions. All species owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2).

AZA Accreditation Standard

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions at the institution.

AZA Accreditation Standard

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

If an animal is transferred between two institutions, both institutions should determine transaction details prior to transferring an animal. Appendix C provides a sample transaction agreement and Appendix D provides a sample loan agreement that may be used or adapted to meet your institution's needs.

6.3 Transfer Examination and Diagnostic Testing Recommendations

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

Recommended prosimian pre-shipment veterinary assessment guidelines are included below. The receiving institution should be immediately contacted with any abnormal results and treatments.

1. Signalment: Age, sex, origin, studbook number, ISIS number, local accession number
2. Anamnesis: Summary of health screens, medical problems, diagnostic test results, and treatment. A hard copy and disc of the complete medical record should be sent to the receiving institution in a timely manner.
3. Complete physical examination: Including a review of all systems. Examination should be performed within 30 days of shipment unless otherwise agreed on by receiving institution.
4. Identification: Animals should be permanently identified. Placement of transponder microchips between scapulae is recommended.
5. Body weight
6. Blood collection: Complete blood count and serum chemistry panel. Bank serum (volume dependent on species). Samples may be retained by sending institution or may be shipped to the Prosimian Tissue Bank. Additionally, an optional serologic (ELISA) test for toxoplasmosis can be run. Test should be a non-species specific assay, such as a blocking antibody assay. This is available at the University of Tennessee. Due to the significance of Toxoplasmosis in some lemur species, receiving institutions may request this test.
7. Urinalysis (optional): Ideally, collect a urine sample by cystocentesis while animal is under anesthesia for a physical exam, but voided samples collected free catch or from a clean tabletop or cage bottom are acceptable. If protein is detected in a urine sample analyzed by a commercial laboratory (not by dipstick), consider running a urine protein/creatinine ratio.
8. Fecal analysis: Both direct and sedimentation parasite screens should be performed. Sedimentation techniques are preferred, as they concentrate small numbers of oocytes. An enteric pathogen screen should also be run, focusing on an aerobic culture of feces for pathogens, specifically for detection of *Salmonella, Shigella, Campylobacter*, and *Yersinia*. Detection of *Klebsiella* should be noted, as this organism may be pathogenic for some species under stressful conditions.

9. TB test: Intradermal skin test with mammalian old tuberculin (MOT) is recommended. This may be performed in the superior palpebra. Tuberculosis is extremely rare in prosimians but has been documented.
10. Vaccinations: Currently there are no specific recommendations for prosimians. Tetanus toxoid and rabies vaccinations are used by some institutions based on risk. Administration of these vaccinations is at the discretion of the sending and receiving institution.
11. Shipment: Industry standards for shipment of small primates are appropriate. Access to food and water should be provided, and water in the form of high water content food items is adequate for most trips. Crates should be secure to prevent escape or tampering. Temperature considerations should be observed. For most small primates a range of 7.2–29.4 °C (45–85 °F) is considered safe.

6.4 Quarantine

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

AZA Accreditation Standard

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/associations/6442/files/veterinary_standards_2009_final.docx.

AZA Accreditation Standard

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

AZA Accreditation Standard

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

Standard quarantine facilities and practices apply. Animals should be held in appropriate enclosures that are isolated from the remainder of the colony. Lemurs should undergo a minimum of 30 days of quarantine. During that period, they should have a physical examination and blood collection for a complete blood count and serum biochemical profile. They should also have 3 consecutive negative fecal examinations for endoparasites and a negative TB test before release.

If a separate dedicated quarantine facility is not available, lemurs may be quarantined in another animal building that does not house primates. Staff caring for the animals should wear full personal protective equipment (PPE) and not work with other primates the same day. Standard quarantine practices should be followed.

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

Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items should be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with resident animals. Common disinfectants used to clean materials include dilute bleach, Nolvasan®, and Mediquat®. Equipment and enrichment items used

in the quarantine area should be cleaned daily when removed from holding. During quarantine periods, staff working with non-human primates should use appropriate personal protective equipment including facemasks, disposable gloves, shoe covers, and gowns to prevent transmission of zoonotic diseases.

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

Quarantine should be a minimum of 30 days for domestic transfers, and 30–60 days for international transfers depending on the origin of the animal and CDC recommendations. If additional animals are added to the quarantine facility (sharing the same space and air), quarantine should start over for all taxonomically similar animals (i.e., all primates). Quarantine is complete 30 days after that last animal was added.

During the quarantine period, specific diagnostic tests should be conducted with each animal if possible or from a representative sample of a larger population (e.g., birds in an aviary or frogs in a terrarium) (see Appendix E). A complete physical, including a dental examination if applicable, should be performed. Animals should be evaluated for ectoparasites and treated accordingly. Blood should be collected, analyzed and the sera banked in either a -70 °C (-94 °F) freezer or a frost-free -20 °C (-4 °F) freezer for retrospective evaluation. Fecal samples should be collected and analyzed for gastrointestinal parasites and the animals should be treated accordingly. Vaccinations should be updated as appropriate, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations.

A tuberculin testing and surveillance program must be established for animal care staff as appropriate to protect both the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test to yearly repetitions of diagnostic tests as determined by the veterinarian. Animals should be permanently identified by their natural markings or, if necessary, marked when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Release from quarantine should be contingent upon normal results from diagnostic testing and two negative fecal tests that are spaced a minimum of two weeks apart. Medical records for each animal should be accurately maintained and easily available during the quarantine period.

AZA Accreditation Standard

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

Quarantine guidelines should follow those identified in the AZA Accreditation Standards. Briefly, they are as follows:

- All incoming prosimian primates should be quarantined for a minimum of 30 days.
- A complete physical examination should be performed, including confirmation of animal identification.
- Blood collection: CBC and serum chemistry profile, and serum for banking.
- Fecal analyses: Three fecal examinations (direct and sedimentation) at two-week intervals should be performed. Animals should be treated as appropriate. Three negative fecal examinations post treatment should occur before release from quarantine.
- Fecal culture for enteric pathogens may be performed during the quarantine period (optional).
- TB testing: Intradermal tuberculin skin test (TST) (0.1 ml MOT in upper palpebrum) should be administered during quarantine. Laboratory primate standards recommend three intradermal tuberculin tests at 2-week intervals. However, *Eulemur* spp. are considered extremely low risk for contracting TB. The practice of one negative TST pre-shipment and one negative TST during quarantine is acceptable, but individual institutions' quarantine requirements are at the discretion of the attending veterinarian. Animals with positive or suspect reactions should be extensively evaluated (cultures, PCR, and radiography) and remain in isolation until determined clear of TB by the attending veterinarian).

If a *Eulemur* should die in quarantine, a necropsy should be performed on it and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standard 2.5.1). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples form the body organs should be submitted for histopathological examination (see Chapter 6.7).

AZA Accreditation Standard

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

6.5 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize disease prevention (AZA Accreditation Standard 2.4.1). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals: (www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf).

AZA Accreditation Standard

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

Routine health monitoring should be performed on all prosimians on a regular basis. For many institutions, this is annually; however, a rotational system that examines each animal on a 2–3 year cycle is acceptable as long as no significant health issues are identified in the collection. Preventative health protocols should include:

- Regular physical examination, including intra-dermal tuberculin skin testing, and dental examination
- CBC, serum biochemical profile, and urinalysis if possible
- Fecal examination (direct and sedimentation)
- Optional: Fecal culture (if history of enteric bacterial infections exist)

Medical management of neonates: Average birth weight for *Eulemur* infants ranges between 55–105 g depending on the species or subspecies. Dams most commonly give birth to singletons; however, twinning may occur in some species. Time to weaning is approximately 3–5 months.

Eulemur infant mortality is highest in the first 72 hours after birth. Recognizing and correcting problems early in the neonatal period can often prevent the need for long-term intervention. Careful observations of an infant's behavior and accurate daily weights are the best measure of health status. If possible, obtain a weight the day of birth, then twice weekly until the infant is 1 month old, then weekly until weaned. A 1–2 day drop in weight is acceptable but longer plateaus or decreases in weight gain are reason for concern. If a question exists as to the status of an infant, removing it from the mother for a physical exam, including a temperature and weight, is necessary. Normal newborns vocalize loudly, eyes are open and alert, movements are vigorous, and the grip in hands and feet are strong. Droopy eyelids, infrequent or weak vocalizations, hypothermia (body temperature less than 35.5 °C [96 °F]), and weak grip are all signs of trouble (Williams, 2002).

A common problem in neonates is the failure to begin nursing after birth. Infants normally begin nursing within a few hours of birth and infants that do not nurse during the first 8–12 hours lose strength rapidly. They may cling in abnormal positions such as to the dam's leg, arm, or back. Once the infant's strength wanes, its head begins to drop and the grip becomes weak, until it finally falls off the mother. Infants may not nurse for several reasons, including:

- Neonatal weakness due to a premature or traumatic birth
- Inability to initiate nursing because of irregular maternal anatomy (e.g., maternal obesity, or inverted or small nipples)
- Inability to nurse often enough; agitated females move frequently thereby preventing infants from suckling for sufficient amounts of time
- Maternal neglect: maternal factors predisposing toward neglect include illness, first time birth, increased agitation, and hypothermia or generalized weakness of the infant

Hypothermia, hypoglycemia, and dehydration are commonly encountered problems in the early neonatal period. A hypothermic but otherwise healthy neonate can be warmed, given oral electrolytes and dextrose, and returned to a maternally competent dam. If a dam neglects her offspring but is not aggressive, isolating the mother and infant(s) for several days in a small confined space, such as an

airline kennel, may induce a reluctant dam to care for her young. Infants may need partial support in the form of oral or subcutaneous fluids, feeding, or warming until a dam begins showing interest in her offspring.

The longer mother and infant are separated, the greater the likelihood the mother will reject the infant when returned. Maternal rejection may occur after separation from newborns for 24 hours or less. Therefore, housing the mother in close proximity to the sick infant and maximizing visual, olfactory, and physical contact improves the chance the mother will accept the infant when it is returned.

Medical management of pregnant females: No specific medical issues related to pregnancy have been identified at this time. Abdominal palpation and/or ultrasound can be used to confirm pregnancies and verify the infant is alive if there is question about the due date of the dam.

Medical management of geriatrics: In managing geriatric animals, it is important to maintain them in an environment that provides a high quality of life and does not subject them to unnecessary distress. Individuals should be socialized in an appropriate group if available. Exhibit modifications should also be made to allow for appropriate movement around the exhibit. This includes adding or lowering perches, ensuring that food and water sources are available at different locations, and adjusting feeding schedules if necessary. Complete examination of geriatric animals should be done on a routine basis. These exams should include a complete physical examination, fecal parasite examination, and routine blood work (CBC and serum biochemical profile). In addition, procedures such as radiographs, ultrasound, and specific disease serology may be warranted, as determined by the attending veterinarian.

Normal physiological values for *Eulemur* species are available on ISIS, to ISIS members.

Standard veterinary equipment is required and appropriate for the management of *Eulemur*. Husbandry equipment should not be shared between enclosures housing different taxa.

Veterinary standards have not been developed for *Eulemur* specifically. Lemurs should be provided quality veterinary care similar to other primates. Animals should have regular medical examinations, lab work, and TB tests performed. Licensed veterinarians should properly attend to illnesses and injuries.

Eulemur species are social animals and housing an individual in isolation from other members of their species may adversely impact their well-being. It is preferable to house compatible group members together. If this is not possible, maintain visual, olfactory, and auditory contact with other compatible *Eulemur*. Single *Eulemur* can often be housed compatibly with lemurs of other species if an appropriate enclosure mate of the same species isn't available. The enclosure mate should be of the opposite sex to avoid fighting during the breeding season.

AZA Accreditation Standard

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

As stated in the Chapter 6.4, AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals. Keepers should be designated to care for only healthy resident animals, however if they need to care for both quarantined and resident animals of the same class, they should care for the resident animals before caring for the quarantined animals. Care should be taken to ensure that these keepers are "decontaminated" before caring for the healthy resident animals again. Equipment used to feed, care for, and enrich the healthy resident animals should only be used with those animals.

All equipment used to clean and maintain *Eulemur* exhibits and holding areas, as well as enrichment devices used in *Eulemur* exhibits should be disinfected on a regular basis (between 1–4 days a week). Whenever possible, equipment should be duplicated in different holding areas and quarantine areas to prevent the transfer of disease. Common disinfectants used to clean materials include dilute bleach, Nolvasan®, and Mediquat®.

Staff working with *Eulemur* species should recognize and be educated on the risks of zoonotic diseases. Potential zoonotic diseases from lemurs include enteric bacteria and protozoal parasites. Standard hygienic practices and personal protective equipment are adequate to prevent infection.

AZA Accreditation Standard

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

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

The AZA Prosimian TAG does not support the use of *Eulemur* species as program animals; therefore, animals should not be taken off zoo grounds for any purpose except medical emergencies. In instances where a lemur is transported to an external facility for medical evaluation or procedures it should be kept separate from humans and/or animals at that site to prevent potential disease transfer. All surfaces that the animal contacts should be disinfected prior to and after procedures are completed.

Also stated in Chapter 6.4, a tuberculin testing and surveillance program must be established for animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test, to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species.

AZA Accreditation Standard

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

All animal care staff should be tested for tuberculosis (TB) on an annual basis when working with *Eulemur.*

6.6 Capture, Restraint, and Immobilization

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

AZA Accreditation Standard

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

Manual restraint of *Eulemur* is relatively simple. Animals less than 1 kg (2.2 lb) are restrained by grasping over the back of the neck and around the mandible with a gloved hand to control the head, using a second hand to control the lower abdomen and back legs. For animals weighing between 1–4 kg (2.2–9.7 lb), the animal is first netted in its enclosure or manually removed from a transport kennel. It is beneficial to train the animals to enter a transport kennel voluntarily. When manually restraining larger lemurs, grasp the upper arms of the animal above the elbow and pull them toward its back, or restrain the lemur around the neck with a gloved hand then allow it to grasp the restrainer's arm.

AZA Accreditation Standard

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

It is recommended that the handler wear elbow length gloves or arm guards to protect against scratches when animals grasp the handler's forearm. If needed, a second handler is employed to support the hind limbs. If more control is needed, the second handler should restrain the hind limbs by grasping the thighs and extending the hind legs. It is important that the person restraining the hind legs grasp the thighs above the stifles to prevent injury to the knee joint.

Endotracheal intubation is relatively straightforward in most prosimians. A small blade laryngoscope is useful to aid visualization and move the epiglottis out of the way to expose the glottis. Ketamine is a widely used anesthetic agent in primates for chemical restraint. The effect of ketamine on prosimians, however, is variable. When used alone, ketamine provides unpredictable levels of immobilization, poor muscle relaxation, and frequent vomiting on recovery. Seizures are common in black lemurs even at doses of 5–10 mg/kg IM. Side effects of ketamine are diminished and the quality of anesthesia is improved when it is combined with either midazolam or dexmedetomidine; however, the duration of effective immobilization remains short at only 10–15 minutes.

Telazol®, a combination of tiletamine and zolazepam, is frequently used in lemurs. Benefits of using Telazol® include a wide margin of safety, good muscle relaxation, and smooth recoveries. The main disadvantages include prolonged recovery times in the range of 4–6 hours and a short shelf life of the reconstituted drug. Nausea and vomiting are also associated with this drug.

Combining dexmedetomidine with either ketamine and butorphanol, or midazolam and butorphanol, produces heavy sedation to complete immobilization lasting from 20–60 minutes. Both combinations can be used for induction prior to gas anesthesia or as complete injectable regimes. The combinations produce minimal cardiorespiratory effects and the level of analgesia is sufficient to perform minor surgical procedures.

Isoflurane works well and is safe for use on *Eulemur* species. All *Eulemur* species can be easily induced with gas anesthetics via facemask or induction chamber. Administering pre-medication improves

the quality of mask induction with isoflurane. Nausea and vomiting are possible complications associated with isoflurane. Care should be taken to prevent aspiration of saliva or regurgitated matter/fluids, particularly during the early part of the induction. Also, another potential risk is a dramatic drop in blood pressure, which should be monitored when using isoflurane. Sevoflurane has also been used in *Eulemur* and seems to cause less agitation and struggling during induction.

All anesthetic agents have the potential to adversely affect the major organ systems of the body. Body temperature, heart rate and rhythm, respiratory rate, and capillary refill time can be monitored in even the smallest lemur or loris. Reliable readings for oxygen-hemoglobin saturation (pulse oximetry), end-tidal CO_2 (capnography), and blood pressure (oscillotometry) can be accomplished in patients weighing more than 1.5 kg (3.3 lb). Lemurs are highly prone to developing hypothermia under anesthesia owing to their lean body confirmation and high surface area to body mass ratio therefore measures should be taken to minimize heat loss. Some options include placing animals on warm water circulating heating blankets, covering portions of the body below the neck not involved in surgical manipulations, and pre-warming skin preparations solutions.

The quality and speed of recovery depend on the agent used, the general health of the animal, and the success of maintaining physiological processes within optimal ranges through the use of monitoring and appropriate supportive care. Pre-medication with a variety of agents may prolong time to extubation. Reversible agents allow smooth and controlled recovery from anesthesia. Providing supplemental heat during recovery is beneficial for animals in which body temperatures drop during anesthetic procedures. Animals should be prevented from attempting to climb or jump until well coordinated. Allowing recovery to occur in a confined space, such as a pet carrier, is helpful and care should be taken when re-introducing a previously anesthetized animal back to its social group to ensure the animal is fully recovered.

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

AZA-accredited institutions should have an extensive veterinary program that manages animal diseases, disorders, or injuries and has the ability to isolate these animals in a hospital setting for treatment if necessary. *Eulemur* keepers should be trained for meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques, and recognizing behavioral indicators animals may display if their health becomes compromised (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department. *Eulemur* hospital facilities should have radiographic equipment or access to radiographic services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short and long term medical treatments and control for zoonotic disease transmission.

AZA Accreditation Standard

(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not diagnose illnesses nor prescribe treatment.

AZA Accreditation Standard

(2.3.2) Hospital facilities should have radiographic equipment or have access to radiographic services.

A variety of bacterial pathogens have been associated with enteritis and colitis in prosimians, including *Yersinia enterocolitica*, *Campylobacter fetus jejuni*, *Salmonella typhimurium*, enteropathogenic *E. coli*, *Listeria monocytogenes*, and *Klebsiella pneumoniae*. The results of fecal culture should be evaluated in light of the clinical presentation of the animal and medical intervention determined accordingly. Hemorrhagic enterocolitis has been documented in prosimians associated with *Clostridium difficile* overgrowth. The condition most frequently occurs secondary to antibiotic treatment, but may occur in stressed animals without previous antibiotic therapy. Diagnosis is by demonstration of *C. difficile* toxins in feces of affected animals.

Bacterial pneumonia in lemurs is not common under good management conditions; however, it can occur in stressful conditions or when animals are acclimating to a new environment. Cases have been reported in newly managed animals exposed to environmental changes. Clinical signs include pyrexia, inappetence, and dyspnea. Incidences of *Klebsiella pneumoniae* pneumonia are often peracute and fulminant, resulting in rapid fatalities.

Viral encephalitis is rare in prosimians. The clinical signs associated with the disease included intermittent rear limb lameness progressing to seizures, coma, and death. Serological surveys of free-ranging lemurs in Madagascar have demonstrated titers to West Nile Fever virus and other alphaviruses

and flaviviruses in a small percentage of animals in some regions. However, actual viruses were never isolated from lemurs in any of these cases. Serological surveys of viral diseases in wild lemurs tested for adenovirus group-specific antibody, influenza A antibody, influenza B antibody, parainfluenza 1 antibody, rotavirus group-specific antibody, hepatitis A antibody, and hepatitis B surface antigen failed to detect serum antibody titers.

A non-specified herpesvirus was identified in pygmy and slow lorises with chronic health problems, including chronic dental disease and upper respiratory disease, and in lymphocytes of a slow loris with lymphoma.

Gastrointestinal parasitism may cause diarrhea in managed lemurs. Protozoal parasites are most commonly associated with clinical diarrhea, including *Entamoeba*, *Trichomonas*, *Giardia*, and *Balantidium*. Infection is identified by direct fecal examination. Most protozoal infections respond to treatment with metronidazole or paromomycin; potentiated sulfas and tetracylines have also been used. *Cryptosporidium* spp. have also been demonstrated in lemurs and this agent causes severe diarrhea in lemurs of the family Indriidae (sifakas). There is no reliable method of treatment, although paromomycin or azithromycin have been used to decrease shedding of cysts in feces. Supportive care is essential for preventing death due to dehydration and electrolyte imbalance.

Common nematode parasites include organisms in the genera *Strongylus*, *Strongyloides*, *Gongylonema*, *Physaloptera*, *Enterobius*, *Trichurus*, oxyurids, and ascarids. Infestation with *Pterygodermatides nycticebi* in lorises may produce significant anemia. Gastrointestinal nematodes are identified by fecal flotation, sedimentation, or centrifugation, and respond to a variety of anthelminthics. *Physaloptera* may present a challenge in diagnosis and treatment. The eggs of this gastric nematode are shed intermittently and may be difficult to find in fecal flotations. *Physaloptera* is more easily diagnosed using Sheather's solution with a specific gravity ≥1.26 (higher than sodium nitrate 1.22).

Some *Eulemur* species are quite sensitive to serious systemic disease associated with *Toxoplasma gondii* infection. Clinical toxoplasmosis is most common in ring-tailed lemurs, possibly because they are a more terrestrial species. Often, deaths are peracute; in some instances death may follow a 1–2 day course of nonspecific signs such as depression and inappetence. Clinical pathology may reflect the multi-systemic nature of the infection and include elevated liver and renal function indices. Diagnosis is conclusively made by histological examination of tissues in animals that die. Tachyzoites may be seen in many tissues and may initiate inflammatory reactions or necrosis. In animals that survive, determination of toxoplasmosis titers in paired serum samples confirms the diagnosis. No treatment is effective. The disease is transmitted via ingestion of oocysts from feces of infected cats (domestic or exotic); effective sanitation should prevent occurrence.

Aberrant tapeworm larvae (hydatid disease and cysticercosis) have occurred in lemurs and galagos. In these cases, the agents are the canid intestinal tapeworms *Echinococcus granulosus* and *Taenia crassiceps*. When infective eggs are consumed by an aberrant host—such as lemurs—larvae develop into cysts in body cavities. The significance of the disease depends on the extent and location of cysts.

Trichobezoars may occur in managed lemurs, especially ruffed lemurs (*Varecia*). Surgical intervention may be required to alleviate gastric obstruction in severe cases. Regular administration (i.e., weekly or biweekly) of laxatives or lubricants (such as oral mineral oil or cat laxatives) may decrease the occurrence. Trichobezoars have not been reported in wild lemurs, and it is likely that components in the natural diet prevent accumulation of hair in the stomach.

Hemosiderosis (increased iron storage in tissues) has historically been considered a common problem for lemurs in zoos and aquariums, although the clinical relevance to morbidity and mortality is unknown. The condition is suspected to be the result of the combination of excess dietary iron, easily absorbed forms of iron in the diet, and lack of tannins and/or other iron binding ingredients in the managed diet. Recognition of hemosiderosis has resulted in decreased levels of iron in primate chows; however, more information is needed to better understand the current prevalence and clinical significance of the condition.

Pleural effusions have been reported in ring-tailed lemurs. In these idiopathic cases, cytological examination and culture of aspirates has characterized the fluid as a sterile transudate. Effusions have been isolated to one hemithorax and conservative management with repeated thoracocentesis resulted in resolution.

A familial bone disease involving periarticular new bone formation coincident with progressive renal failure has been described in black lemurs. This disease, described as periarticular hyperostosis (PH), has occurred in animals ranging from 3–27 years of age. Proliferation of bone and degeneration of

kidneys continue throughout the course of illness resulting in death from end stage renal disease or euthanasia in 6–12 months. The etiology of PH in lemurs is not known.

Age-related renal degeneration is a common cause of mortality in aged prosimians. Glomerulonephritis, glomerulosclerosis, chronic interstitial nephritis, and polycystic renal disease are variably diagnosed at postmortem examination of aged individuals. Urethral obstructions also have occurred but are not common. Urethral obstructions due to coagulum plugs may occur after electroejaculation.

Seizures may occur in relation to a variety of generalized or systemic illnesses. Epilepsy (recurrent seizures of unknown etiology) may occur rarely. In cases where the incidence of seizures is high, anticonvulsant therapy with phenobarbital is effective. Spongiform encephalopathy has been reported in managed lemurs (*E. fulvus mayottensis*) after being fed a commercial food product containing meat compounds.

Cases of toxicosis are infrequently reported in lemurs, although it is uncertain if this is because of the difficulty in establishing a diagnosis or a low incidence of toxic exposures. Three ruffed lemurs were apparently poisoned by hairy nightshade (*Solanum sarrachoides*) when introduced into a new exhibit. Lead poisoning secondary to exposure to lead paints has also been documented.

A variety of neoplasias have been reported in prosimians. Hepatocellular carcinoma is one of the most common neoplasias of lemurs and occurs in a variety of species. Although it has been previously suggested that the high frequency of hepatocellular carcinoma in lemurs may be associated with an increased level of iron deposition in tissues, recent studies do not support this hypothesis (C. Williams, unpublished data). Adenocarcinoma of the colon, pancreas, and mammary gland has been documented in several species, as has liposarcoma, fibrosarcoma, and carcinoma of the thyroid, ovary, and bile duct. The possible association of lymphoma with herpesvirus infection in slow lorises has been suggested. Congenital defects include pectus excavatum, which appears to be inherited as an autosomal dominant gene, scoliosis, kinked tails, and skull abnormalities.

Eulemur species are social animals and housing an individual in isolation from other members of their species may adversely impact their well-being. Long-term isolation of single animals may result in animals being evicted from their social groups as well as the development of abnormal social behaviors. When possible, it is preferable to keep compatible group members together, or at a minimum, to maintain visual, olfactory, and auditory contact. For very short term, animals may be isolated in a rolling cage or in their home enclosure (taped/chained off as mentioned above). Longer-term isolation requires remaining their home enclosure or in a more isolated holding area. Whenever possible, animals are kept with their family group.

Eulemurs are social animals and therefore isolating a single animal presumably causes some degree of stress. Social hierarchies can be greatly disturbed when one or more group members are removed even for a short period of time. When an animal is separated short term from its group, especially in more unstable groups, other group members may be kenneled or separated from each other as well. Animals separated for even a short period of time can become the target of aggression when returned to his or her group. Separating all group members from each other can alleviate some of this aggression. If an animal is left alone while its enclosure mate is being treated and shows signs of anxiety (e.g., pacing, calling, etc.) they can be given extra enrichment items to help distract them. If an animal is not a health risk to its enclosure mate(s), every effort is made maintain social housing.

Outside of newly acquired animals in 30 day quarantine, individuals are typically only isolated if they are diagnosed with cryptosporidia (however this disease has only ever occurred in sifakas at this time), giardia, or an undiagnosed illness that could be contagious. When possible, animals are moved to a more isolated area; as this is not always feasible, the area surrounding their home enclosure should be marked with tape or chain to designate isolation. Staff personal protective equipment (PPE) and separate cleaning supplies (rakes, dustpans, hoses when possible) are required in that area. PPE includes waterproof disposable shoe covers, gloves, and facemask. When hosing/cleaning or at risk of having feces contact your body, disposable waterproof suits and face shields should be worn. Signage defining the need for PPE and isolation should be posted at all entrances and exits to the isolated area, and access is limited to essential personnel. Separate trashcans should be provided, and all trash double bagged before disposal.

AZA-accredited institutions must have a clear process for identifying and addressing *Eulemur* animal welfare concerns within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. This process should identify the protocols needed for animal care

staff members to communicate animal welfare questions or concerns to their supervisors, their Institutional Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues.

AZA Accreditation Standard

(1.5.8) The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution in a timely manner, and without retribution.

Animal keepers working with *Eulemur* species should be trained to recognize specific welfare problems—such as abnormal behaviors or health concern—by the vet, a senior manager, or a keeper with good working knowledge and experience with *Eulemur* behavior. Any abnormal behavior activity should be reported to the individual's manager or superior, as well as documented in a daily report. If the problem persists, it should be followed up by an inquiry with the vet, or if necessary, the reported to the institution's Animal Welfare Committee. All animal managers and keepers should also be trained regularly (at least annually) on the institution's process for reporting animal welfare concerns. Successful husbandry and training protocols have been developed to deal with welfare concerns such as food aggression between group members, reducing weight in obese animals, and adjusting housing conditions for geriatric animals, or those recovering from a health issue or illness. Animal welfare concerns should be brought to facility managers or to administrators that have the authority to investigate the concerns and implement changes to institutional policy and husbandry practices if indicated. The ideal system allows complaints to be delivered anonymously if desired. There should be no repercussions to the registering of animal welfare concern. An unbiased committee should evaluate complaints for merit in a timely manner. The committee's decision and plan for corrective action should be conveyed to the individual registering the complaint (if known) to ensure closure.

Knowledge gained from dealing with welfare issues (both successfully and unsuccessfully) should be completely document and shared with other *Eulemur* holding institutions, as well as any additional interested parties. Information can be shared in many ways, including established e-mail list-servers, semi-annual husbandry meetings, yearly AZA Prosimian TAG and AZA *Eulemur* SSP meetings, and other animal welfare related publications. In the future, it would be useful to compile this information into a database or reference list.

AZA-accredited zoos and aquariums provide superior daily care and husbandry routines, high quality diets, and regular veterinary care, to support *Eulemur* longevity. In the occurrence of death however, information obtained from necropsies is added to a database of information that assists researchers and veterinarians in zoos and aquariums to enhance the lives of *Eulemur* both in their care and in the wild.

As stated in Chapter 6.4, necropsies should be conducted on deceased *Eulemur* to determine their cause of death, and the subsequent disposal of the body must be done in accordance with local, state, or federal laws (AZA Accreditation Standard 2.5.1). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples form the body organs should be submitted for histopathological examination. Many institutions utilize private labs, partner with Universities or have their own in-house pathology department to analyze these samples. The AZA and American Association of Zoo Veterinarians (AAZV) website should be checked for any AZA *Eulemur* SSP Program approved active research requests that could be filled from a necropsy.

AZA Accreditation Standard

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

Necropsy protocol and procedures for all prosimian taxa are found in Chapter 11 of this document. Humane euthanasia should be done via intravascular injection of euthanasia solution or via exsanguination under anesthesia or administration of an injection of potassium chloride IV under deep anesthesia.

Comprehensive surveys of causes of mortality in *Eulemur* have not been performed. Common causes of death in geriatric *Eulemur* include renal failure and neoplasia. In younger animals, death can occur from a wide variety of pathologies including trauma, cardiac disease, and infection (parasitic, bacterial, fungal, and possibly viral).

Necropsies should be performed in accordance with the Necropsy Protocol for Prosimians included in this document (Chapter 11) and available on the AZA and AAZV website. Histologic samples should also

be collected and stored in accordance with the Necropsy Protocol for Prosimians included in this document (Chapter 11).

Eulemur are subject to a wide range of injuries and illnesses, which may vary by species, age, institution, and geographic location. There are not any particular syndromes that are overly represented in this taxa. Therefore, at this time, there are no normal or abnormal gross and histopathological results that are overly common in this taxa. Please address all concerns on this topic to the institution's veterinarian, or speak with the Prosimian TAG's vet advisors (listed in this manual).

Chapter 7. Reproduction

7.1 Reproductive Physiology and Behavior

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

In North America, the reproductive season for *Eulemur* typically begins in late fall, with births occurring between February and June. The gestational period is thought to be between 125–129 days for all *Eulemur* species (Perry et al., 1992; Bayart & Simmen, 2005). As such, most species produce ~75% of their offspring between March and May. However, births in some species may start as early as February (e.g., *E. rufus*), while others may produce offspring into June (e.g., *E. mongoz, E. rubriventer, E. fulvus, E. sanfordi*). Note that this pattern differs from Madagascar (Southern Hemisphere) where copulation occurs in the spring (May and June) and females give birth in the fall (September through November) (Mittermeier et al., 2006). Additionally, Perry et al. (1992) showed natural reproductive cycles when animals were housed indoors without windows under a lighting regime similar to that found in Madagascar.

The majority (~75–80%) of *Eulemur* species give birth to singletons: however twinning is slightly more common in *E. albifrons* and much less common in *E. flavifrons*, *E. mongoz*, *E. rubriventer*, and *E. rufus* (see Table 7).

Male reproduction: The average age for the first siring of an infant in most *Eulemur* species is approximately 3 years of age. However, offspring have been sired by males as young as 8 months of age and as old as 29 years (see Table 7). Housing and social behavior within the group can have an effect on male age at first reproduction.

Female reproduction: Females first reproduce at the age of approximately 3 years, and this is consistent with work from the field (Overdorff et al., 1999). As with males, the youngest reported dam was an eight-month-old female and the oldest reported dam was a 24-year-old.

Table 7. Reproductive data for *Eulemur* species from individual studbooks*

		Sire			Dam		
Species	**% Twins**	**Median**	**Min**	**Max**	**Median**	**Min**	**Max**
E. albifrons [1]	40%	2.8	1.6	16.3	2.9	1.9	21.0
E. collaris [1]	22%	4.3	2.4	22.5	3.0	2.0	23.3
E. coronatus [2]	26%	3.6	1.7	16.1	3.1	1.7	19.9
E. flavifrons [3]	4%	3.7	1.7	21.8	4.0	1.9	16.0
E. fulvus [1]	17%	3.7	1.3	29.0	3.1	1.7	23.2
E. macaco [4]	21%	3.9	0.7	29.6	3.1	0.7	21.5
E. mongoz [5]	5%	3.6	1.5	20.0	3.8	2.1	19.1
E. rubriventer [6]	4%	5.0	2.9	15.0	4.2	2.1	15.3
E. rufus [1]	9%	2.9	0.8	25.0	2.1	1.8	24.0
E. sanfordi [1]	17%	2.7	2.0	8.4	3.2	1.9	19.6

*Median=median age at first reproduction (years); Min=minimum recorded age of reproduction (years); Max=maximum recorded age at reproduction (years). All values are from individual studbooks.
[1] (Becker, 2007); [2] (Elder, 2007); [3] (Porton, 2007a); [4] (Porton, 2007b); [5] (Schoffner, 2007); [6] (Trull, 2007)

Social behavior and reproduction: Much attention has been given to the fact that *Eulemur* tend to be more aggressive and have higher testosterone levels during the mating and birthing seasons (Kappeler, 1989; Bayart & Simmen, 2005; Marolf et al., 2007; Ostner et al., 2002). Because aggression in lemurs tends to be focused around feeding opportunities, particular care should be given in the provision of food and enrichment during the mating and birthing seasons (Jolly, 1984). Marolf et al. (2007) suggested that individual weights, particularly those of males, should be monitored to ensure that overweight individuals do not assume unnatural positions in the dominance hierarchy due to their size. Care should also be taken to ensure that high levels of aggression in males do not result in infanticide or undue stress to the mother around parturition (see Chapter 3.4).

As both male and female *Eulemur* become increasingly aggressive during the breeding season, institutions should be prepared to conduct temporary separations if necessary. It has also been reported that for brown lemurs, black lemurs, and crowned lemurs, new mothers may react aggressively toward

other individuals (Roeder et al., 2002). As *Eulemur* species are traditionally housed as pairs, particularly in reproductively active groups, there is little precedent for nursery groups with these species.

Reproductive behaviors include increased scent marking by both sexes across all *Eulemur* taxa and increased incidence of aggression, as mentioned above. Groups that are stable outside of the breeding season may experience some instability during breeding season, including the dissolution of male-female and same sex dyads, and the formation of previously unfavorable dyads (both male-female and same sex). Males will increase investigation (sniffing) of female anogenital regions, while females (particularly when not yet in estrus) may respond aggressively with charging, cuffing, and chasing. Females on temporary contraception, which alter hormones, may be particularly aggressive in the presence of persistent male attention. Males will often attempt to dominate the time of females in estrus by charging, cuffing, or chasing competing males and even non-estrus females. Females may become more aggressive with each other, particularly in groups that lack strict female hierarchies, like *E. rufus* and *E. sanfordi*.

Typical mating behaviors include increased scent marking of habitat structure, increased scent marking of females by males, including occasionally urinating on females, increased grooming of conspecifics, mounting attempts by males of females, and copulation. While most normal behaviors are seen regardless of housing conditions, increased aggression in a small space may increase the likelihood of severe injuries during breeding season. In some cases, it may be necessary to temporarily separate a breeding pair from the larger group or from a mixed-species enclosure to minimize injury to other animals and increase the likelihood of successful copulation with intromission. However, as many facilities only house *Eulemur* in pairs, and those that house groups tend to have larger enclosures, separation is only necessary in case of extreme aggression or unusual circumstances.

Often with *Eulemur*, copulation takes place and offspring are produced without observation of mating behavior. Thus, the lack of observed copulations does not indicate that the pair is behaviorally incompetent. Copulations may occur in the evening or early morning when less activity is occurring around the animal enclosure.

There is some evidence that reproduction is socially facilitated in *E. macaco* and *E. mongoz* (Hearn et al., 1996). The housing of reproductive groups of these species of lemurs next to conspecific groups may aid in reproduction. However, this effect was not found for *E. fulvus*. More recent data from the *E. mongoz* studbook show that this species will also reproduce in the absence of conspecifics, especially in animals paired at a young age (3–5 years).

The presence of natural arboreal furnishings (e.g., branches) may positively influence copulation for *E. mongoz* housed in zoos and aquariums, and when preferred copulation surfaces and/or sites are lacking reproduction may be negatively affected (Perry et al., 1992).

Separation of parent-offspring: As with differences in social composition, there are species differences in the age of emigration. Male *E. fulvus* have been documented to leave their group between 3–4.5 years of age, while *E. macaco* males tend to emigrate between one and two years of age (Overdorff et al., 1999; Bayart & Simmen, 2005).

In zoos and aquariums, young females are typically housed in their family groups until their first ovulation occurs. Generally, parents of juvenile *E. mongoz* and *E. rubriventer* start to eject their offspring when they reach 3–5 years of age. Young females are sometimes driven out of their groups by the dominant female (i.e., their mother) at that point of maturity. The mother will chase her constantly until the young female is removed. Fathers may tolerate their sons for the majority of the year, but may become aggressive towards them leading up to the estrus of the dominant female. If animals are held in large enough spaces, or are free ranging, it may be possible to house male offspring with the natal group longer. The biggest concern when housing offspring in natal groups following sexual maturity is avoiding mating between parents and offspring.

In one study, infant development appeared to differ among free ranging *E. rubriventer* and *E. rufus*; in the former species, males provide parental care and infants reach developmental milestones more quickly than the latter species (Overdorff, 1996). Additionally, when encouraging breeding behavior in zoos, it may be necessary to separate previous offspring from parents, as one zoological institution speculated that housing a *Eulemur* breeding pair with their female offspring interfered with successive reproduction efforts by the pair, although this is not a common occurrence (Hearn et al., 1993). There are institutions that have had success by breeding pairs in the presence of older offspring (Lemur Conservation Foundation; Mogilewsky, personal communication, 2008).

The space surveys in the past several Prosimian Regional Collection Plans have revealed that space for individuals evicted from their natal groups is a priority issue. Institutions that are seeking to house juvenile offspring with their parents should be prepared to separate the younger individual if necessary. It may be possible to alleviate this space issue by keeping young females in their natal group as long as possible and using contraception to prevent unwanted breeding. Male offspring can remain in natal groups for several years, as long as the sire maintains dominance over the sons.

Reproductive hormonal tracking: Perry et al. (1992) used testicular indices to determine reproductive states in *E. mongoz* males and used hormone assays (progesterone and estradiol) and vaginal cytology in females. *E. mongoz* females exhibit a "pseudoestrus," prior to the fertile cycle, with elevated serum estradiol and low progesterone concentrations lasting the length of an estrous cycle (31.4 days) (Perry et al., 1992).

Pregnancy was reliably determined using fecal estrogens at 47 days in *E. mongoz*, and at 40–45 days in *E. rufus* (Curtis et al., 2000; Ostner & Heistermann, 2003). Additionally, Ostner & Heistermann (2003) reported that females with male fetuses showed increased estrogen levels during the last third of gestation. This pattern was not found for females carrying female fetuses.

More information is needed related to the starting and stopping of reproduction in *Eulemur* females, particularly after a female has been contracepted for many years. Further investigation is also needed related to the age that each species becomes post-reproductive and can be removed from contraception without the risk of unwanted pregnancy.

7.2 Assisted Reproductive Technology

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

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

Artificial insemination has not been extensively studied in *Eulemur* species, and limited information is currently available. In the past, artificial insemination attempts have been unsuccessful in *Eulemur*. Electroejaculation has resulted in health concerns, as well as the collection of poor quality or non-viable sperm. Also, an extremely narrow estrus period makes it difficult to successfully fertilize females. Many *Eulemur* females do not have a well-advertised estrus cycle (to humans), which makes the timing of AI difficult to determine.

7.3 Pregnancy and Parturition

It is extremely important to understand the physiological and behavioral changes that occur throughout an animal's pregnancy. Visual physical changes are rarely apparent in E*ulemur* species. Weight gain is relatively minimal and not noticeable until towards the end of the third trimester. There are no reference ranges established for these species for blood or urine hormone levels during gestation. Pregnancy is confirmed either via ultrasound or palpation. Gestation is 120–128 days in *Eulemur* species, and palpations are not usually reliable until about 60 days post-breeding. See Table 8 for information regarding detailed gestation period for each species of *Eulemur* in zoos and aquariums.

Table 8. Gestation length data for *Eulemur* species from individual studbooks

Species	Gestation (days)
E. albifrons [1]	128
E. collaris [1]	128
E. coronatus [2]	125
E. flavifrons [3]	129
E. fulvus [1]	128
E. macaco [4]	129
E. mongoz [5]	121–129
E. rubriventer [6]	125
E. rufus [1]	128
E. sanfordi [1]	128

[1] (Becker, 2007); [2] (Elder, 2007); [3] (Porton, 2007a); [4] (Porton, 2007b); [5] (Schoffner, 2007); [6] (Trull, 2007)

Endocrine profiles during pregnancy were also investigated in both wild and managed mongoose lemurs (*Eulemur mongoz*) by analyzing fecal progestagens and estrogens (Curtis, 2000). Estrous cycle characterization was not possible, as most females appeared to conceive during the first estrus of the breeding season. Conception was preceded by a pseudo-estrus with no discernible luteal phase. Pregnancy was reliably determined approximately 47 days after conception, when progestagen and estrogen excretion increased above breeding season concentrations. Gestation was further characterized by high progestagen concentrations and a decline in estrogen excretion 70–80 days after conception. Post-partum, progestagens declined, but estrogen excretion increased to exceed breeding season concentrations (Curtis, 2000).

In a study focusing on behavior of lactating brown lemurs, Tarnaud (2006b), found that female brown lemurs do not devote more time to feeding during the infant growth period. The data show that female brown lemurs increased their food intake during the early-lactating period when the frequency of suckling is the highest, and before infants begin to eat substantial amounts of solid foods. The most significant lactating cost for the brown lemur occurs during the early lactation period (Tarnaud, 2006b). Drastic behavioral changes are rare in *Eulemur* species during pregnancy. Animals move around normally, activity and appetite seem to remain unchanged. A mild increase in aggression by pregnant females has been noted, but this is rare.

Impending parturition can occasionally be recognized by a few small behavioral cues, including a slight increase in pacing followed by a hunched over posture with legs stretched straight out in front. Contractions may be noticeable, as well as increased genital grooming. For most parent-reared dams, pregnancy, parturition, and the subsequent raising of offspring require little to no intervention from animal care staff. First time dams, older dams (18 years or older), and hand-reared dams may require special consideration. As parturition approaches, consider moving the mother out of the group and into a separate enclosure. This separation may reduce social stress and encourage maternal behavior. However, depending on the female, this move may have the opposite effect. The mother should be watched closely during the separation for any signs of stress or anxiety.

It is best to keep the dam and infant within visual and olfactory contact with the rest of the group so that reintroductions can occur as soon as possible and with as little difficulty as possible. A separate enclosure would preferably be a small area that can be provided with additional heat sources. By providing external heat you may extend the time that infants can be off the mother without having to intervene. This may allow new moms the time to adjust to the infant. The use of a small kennel has been recommended to immediately reintroduce an infant to its mother. The enclosed space may trigger maternal behaviors.

In these cases, it is recommended to communicate with the species coordinator and veterinary staff about procedures for assisted birth. See section below about birth plan. In crowned lemurs, it is particularly critical to separate dams from males during impending parturition due to higher incidence of infanticide in this species.

When an infant is discovered in an enclosure, the senior keeper/technician, manager/curator, and veterinarian should be notified immediately. Only experienced managers, keepers, or technicians and vet staff are allowed to handle dams and their infants. Gloves, facemasks, and clean lab coats should be worn when handling infants. If veterinary intervention is warranted during parturition, the animal care staff would not be responsible for any other equipment or supplies needed; this would become the responsibility of the veterinary department.

Further investigation is needed to understand the high incidence of stillborns in *Eulemur*.

7.4 Birthing Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed."

Housing: Housing of the female should be evaluated once a breeding recommendation is received, or in the case of an unplanned birth, as soon as the female is confirmed pregnant. In many cases, births and the rearing of offspring in mixed-species groups or groups containing multiple adult males and females and/or the previous year's offspring have not been successful. Successful reproduction has been seen in mixed-species groups or groups with older offspring. Institutions should contact the AZA Prosimian TAG and the AZA *Eulemur* SSP coordinator prior to the birth to evaluate the situation. Also, exhibit construction should be examined to ensure a safe environment for infants. It is recommended that enclosure wire measure 2.54 cm x 2.54 cm (1 in. x 1 in.) or smaller when infants are present (see Chapter 2.2).

Institutions should consider moving the breeding pair out of the group and into a separate enclosure once the recommendation is received. This separation may reduce social stress and encourage maternal behavior (Meyer, 1982). This may be very important for first time mothers. Complete visual isolation from the social group should be avoided as this may result in permanent group fractioning.

If the decision is made to leave the pair in the group, institutions should closely monitor the behavior of the female within the group to ensure other group members are not harassing her.

If separation is warranted late in pregnancy, consider plans that would minimize stress to the female. Determine if other members of the group be can moved or separated. If not, keeping the pair together during the move may help reduce stress from the move/separation. In some cases, particularly when a female has had problematic birth, it may be advisable to house a pregnant female alone during the late stages of pregnancy. In this case she could be housed in visual and olfactory contact with the sire and/or other group members.

A separate enclosure would preferably be a small area that can be provided with additional heat sources. By providing external heat, the time that infants can be off the mother without having to intervene will be extended. This may allow new mothers the time to adjust to the infant. As *Eulemur* infants are not found off of their mothers unless they are extremely weak or have been removed by the mother (see Chapter 4.5), careful observation should be conducted to determine the reason the infant is off the female.

The *Eulemur* infant should be found clinging to its mother after birth; when this occurs, additional birthing materials are not necessary. There is the possibility that the infant will be weak and unable to cling, and may fall to the floor after birth. If the floor of the birthing enclosure is concrete, cement, or a very hard surface, a layer of wood shavings may be appropriate to cushion a fall.

If it becomes necessary to remove an infant from the mother for some reason, the use of a small kennel has been recommended to immediately reintroduce an infant to its mother. The enclosed space may trigger maternal behaviors (see Chapter 4.5).

Management: Institutions should evaluate any other factors that may encourage or discourage maternal care and make appropriate management changes. Examples of factors that may impact maternal care include:

- Loud noises
- High traffic areas
- Proximity to other groups
- Number of training sessions
- Exposure (visual or auditory) to other infants
- Exposure to conspecifics other than parents
- Removal of the infant in the first 24 hours following birth, and perhaps in the first 72 hours
- The majority of *Eulemur* dams acclimate immediately to birth, particularly in that most females give birth in their home enclosure

7.5 Assisted Rearing

Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in *ex-situ* populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these offspring if necessary.

The goal of the AZA *Eulemur* SSP is to encourage the rearing of infants by their mothers or lemur surrogates as often as possible. Care should be taken to avoid the premature removal of infants due to anticipated or perceived maternal incompetence. Hand rearing has been implicated in later behavioral deficits in a number of species, and there is some evidence that hand rearing could have a negative impact on copulatory behavior in male *E. macaco* (Niebruegge & Porton, 2006). If hand-rearing is deemed necessary and all other possible solutions have been exhausted, infants should be housed singularly to avoid suckling on one another, and a soft stuffed toy or rolled towel should be provided as a surrogate for the infant to cling to (Gage, 2002). When hand rearing, keeping the neonate warm is critical and an incubator is recommended. For neonates, ambient temperature should be 35.5–36.7 °C (96–98 °F), with humidity at 50–65% (Gage, 2002). As the infant ages and is able to thermoregulate, temperature can gradually be decreased. Infants that are at least 1 month of age may be kept under a heat lamp or with a warm water circulating blanket (Gage, 2002). See Williams (2002) for additional information on hand rearing lemurs.

As the social and reproductive situation varies greatly between individuals and institutions, the AZA *Eulemur* SSP encourages individual institutions to consult with the AZA Prosimian TAG Chair and the AZA *Eulemur* SSP Coordinator as soon as a female is confirmed pregnant. The following generalized guidelines are suggested to maximize the likelihood of successful parent rearing.

Birth plan: An institutional birth plan should be developed as soon as a breeding recommendation is received or as soon as a female is determined to be pregnant. This birth plan provides guidelines whereby senior staff, animal managers, veterinarians, and keepers are all clear on contingency plans for addressing a female's failure to provide appropriate maternal care.

This birth plan should include a review of the social, reproductive, and medical history of the pregnant female, staff assignments, determination of due date, pre-partum plan, birthday plan, and other considerations relating to the birth. It should also include history of the expectant female, discussion of intervention types, record keeping or documentation, housing situations, previous maternal skills, labor and delivery, problems associated with birth and delivery, physical appearance of the newborn, postpartum behavior, diet and supplementation during lactation. Each birth event and neonate/mother relationship should be evaluated on a case-by-case basis.

Pre-birth training: If not already in place, institutions should incorporate a training program with pregnant animals to ensure females come to the mesh, fencing, or exhibit perimeter for food or a training session. These sessions will allow closer examination of the infant and increase the ability to conduct supplemental feedings without removing the infant from the female. In addition to rewarding for coming to the mesh or wire, training sessions should focus on desensitizing the female to having her back and stomach touched. This may increase a new female's tolerance to having an infant cling to her.

Nutritional supplementation vs. hand-rearing: Nutritional support is necessary when infants are weak, fail to gain weight, become ill or orphaned, or in the event of maternal illness, neglect, or abuse. Low birth weight by itself is not a reason to intervene as long as the mother is attentive and the infant is vigorous and gains weight steadily. See Table 9 for a range of birth weights in *Eulemur* infants, taken on day of birth or day after birth. All infant weights included in this range were from infants born at one zoological institution and survived more than 2 weeks.

Table 9. Summary of *Eulemur* reproductive data from one zoological institution over approximately 30 years of reproduction and management

Species	Peak breeding season (N. America)	Peak birth season (N. America)	Length of receptivity (days)	Time between cycles (days)	Typical # of cycles per season	Sperm plugs?	Gestation (days)
E. fulvus	Nov–Jan	Mar–May	1	30	2–3		120–128
E. collaris	Nov–Jan	Mar–May	1	30	2–3		120–128
E. rufus	Oct–Dec	Feb–Apr	1	30	2–3		120–128
E. albifrons	Dec–Jan	Apr–May	1	30	2–3		120–128
E. sanfordi	Dec–Jan	Apr–May	1	30	2–3		120–128
E. macaco	Oct–Jan	Mar–May	1	33	2–3	Y	120–129
E. flavifrons	Nov–Dec	Mar–Apr	1	33	2–3	Y	120–129
E. rubriventer	Nov–feb	Mar–Jun	1		2–3		120–127
E. mongoz	Nov–feb	Mar–Jun	1	30–38	2–3	Y	120–128
E. coronatus	Dec–Jan	Apr–May	1	34	2–3	Y	120–126

Table 9 cont'd.

Species	# of infants	Infant weight ranges @ DLC (grams)	Lowest birth weight to survive @ DLC (grams)	Average weaning age	Youngest dam age at conception (months)	Oldest dam age at conception (years)	Youngest sire age at conception (months)	Oldest sire age at conception (years)	Ideal adult weight ranges (kg)
E. fulvus	1–2	60–90		3–4 m	16	23	15	28	2.0–2.4
E. collaris	1–2	60–90		3–4 m	19	23	21	22	2.0–2.4
E. rufus	1–2	60–90		3–4 m	18	23	9	25	2.0–2.4
E. albifrons	1–2	60–90		3–4 m	18	21	19	16	2.0–2.4
E. sanfordi	1–2	60–90		3–4 m	19	19	24	8	2.0–2.4
E. macaco	**1–3	60–90		3–4 m	9	25	8	29	2.0–2.4
E. flavifrons	**1–2	60–90	55	3–4 m	18	17	20	21	2.0–2.4
E. rubriventer	1–2	60–90		3–4 m	16	14	34	14	2.0–2.4
E. mongoz	1–2	55–60	51.5	3–4 m	19	24	18	20	1.4–1.6
E. coronatus	1–2	40–50		3–4 m	16	19	20	16	1.4–1.8

**singletons are most common

If an infant is not able to nurse or is prevented from nursing by the dam, milk can be manually expressed from the mother and fed by syringe. Alternately, many dams will allow infants to be manually placed on the nipple to suckle if lightly sedated and gently restrained. Keeping a dam's mammary glands emptied also encourages continued milk production, which is important if infants are to be reunited with their mothers.

The term "supplementation" is used in this document to indicate nutritional support given while an infant is housed with its dam or other members of its own species. Hand-rearing is used to refer rearing infants in a nursery environment away from members of its own species. Although the AZA Prosimian Taxon Advisory Group has not formally developed a policy on hand-rearing, there are several reasons supplementing infants is preferred over hand-rearing. Hand-reared infants are more likely to exhibit abnormal social or behavioral traits making it difficult to reintegrate them with members of their own species after weaning. Hand-reared infants are more likely to develop human directed aggression, and infants that nurse from their dams, even on a limited basis, are less likely to develop nutritional deficiencies that may occur in fully formula-reared infants.

Information on the composition of normal lemur milk is limited but available data indicates composition varies widely between species. In general, species that carry their young produce dilute milk low in energy, fat, and protein. True lemurs (*Eulemur* spp.) fall in this category. Infants nurse on demand and ingest small amounts of milk frequently. If the use of artificial formulas becomes necessary the formula should approximate as closely as possible the composition of normal mother's milk for the species being raised. While lemurs have been successfully raised on cow milk formulas, formulas using human infant formula or Zoologic® Milk Matrix (PetAg Inc., 261 Keyes Ave., Box 396, Hampshire, IL 60140, 1-800-323-0877; www.petag.com) as a base are preferable because the balance of vitamins, minerals, and micronutrients are likely to be more appropriate for young, growing primates. It is important to note that if human or Milk Matrix formulas are used, supplemental pediatric vitamins should be avoided, as the combination can lead to overdoses of certain vitamins and minerals, particularly iron. When human formulas are used, low iron varieties are preferred. More details on formulas and feeding protocols appropriate for lemurs can be found in the book "Hand-Rearing Wild and Domestic Mammals" (Gage, 2002).

Institutions should prepare for the need to supplementary feed an infant by having the proper formula materials and dosages available to all keeper staff. Williams (2002) recommended using one of two formulas:

- Formula 1: Mix 30 ml human infant formula prepared according to directions with 30 ml nonfat milk, and 3 ml 50% dextrose (total volume = 63 ml)
- Formula 2: Zoologic® Milk Matrix 20/14. Add 10 g powder to 100 ml water

Additionally, 5–10% dextrose in water has been used as a first feeding for infants that are not being nursed. This may provide infants some immediate fluid and allow for an immediate reintroduction attempt.

A source of supplementary heat may be used to warm up infants before giving them back to their mother. Easy access to this heat source may allow quicker reintroduction attempts. When providing supplementary heat, always provide areas where the infant, and dam if present, can get away from the heat source to prevent overheating.

Supplementation or assisted rearing is always preferable to hand-rearing. Hand-reared infants are more likely to exhibit abnormal social behaviors and be aggressive as adults. Infants that nurse on their dams, even on a limited basis are also less likely to develop nutritional deficiencies. Even complete supplemental nutrition can be provided while the infants remain with the dam or others in the family group.

If in an extreme case, if an infant has to be removed into a nursery setting, every attempt should be made to re-introduce the infant to the dam as soon as possible after infant is warmed, hydrated, and appears strong enough to cling to the dam. Maternal rejection might occur after even 24 hours of separation, but other females might accept the re-introduced infant after a longer separation. In general, longer separations are tolerated better for older infants than for younger. Housing the infant in close visual, olfactory and auditory proximity to the dam improves chances of a successful reintroduction. The rate at which reintroductions can be accomplished varies greatly, depending on the specific case. The method of placing an infant back on a dam also may vary, depending on the dam's temperament. One method that has been used successfully is to restrain the female, place the infant on her abdomen and wait a few seconds till the infant clings tightly. Then return dam with infant to a kennel or small cage

(where her movement is restricted and the infant is less likely to fall off). A second method, often successful with assisted rearing when the infant is only removed from the dam for feeding, is to distract the dam with treats and then ease the infant back into position to cling on her abdomen.

After an infant has been reintroduced the dam, introductions of dam/infant to other group members should be done gradually and with close observation. Ideally if dam/infant are housed in an adjacent, connected enclosure, they can be introduced to one or multiple other groups members with continuous observation, gradually working up to all day together. Dam/infant may be separated in the adjacent enclosure overnight, until the social interaction is evaluated to be stable and affiliative.

7.6 Contraception

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size.

Mating behavior in *Eulemur* often goes unseen by human caretakers. In the majority of conceptions in *E. mongoz,* mating was never observed (T. Bettinger, personal communication, 2008). Therefore, a lack of apparent mating does not mean it is not occurring. It is strongly advised that contraception be used if an institution has no plans to breed a female. Furthermore, *Eulemur* species can interbreed, particularly those previously classified as brown lemurs (*E. fulvus*.) and black lemurs (*E. macaco*). Contraception should be used when housing males and females of two or more closely related species together to prevent interbreeding and birth of hybrids.

The AZA Mongoose Lemur SSP and *Eulemur* Studbook programs recommend permanent sterilization of all hybrid animals. Because the AZA Mongoose Lemur SSP and *Eulemur* Studbook programs are cooperatively managed, all individuals are part of the managed population. We therefore should provide hybrid individuals with the same standards of care we give other species, with the hope to eliminate hybrid animals through attrition so that their space can be turned over to other managed *Eulemur* species.

Separation of sexes: *Eulemur* species have been historically managed through separation of males and females if space allows during the breeding season. At one zoological institution, in order to prevent pregnancy in red-ruffed lemurs (*Varecia variegata rubra*) housed in a large mixed-sex group, signs of vaginal color (pinkness) were monitored (Kuhar et al., 2001). When a color change was observed, all females were separated from the males until no further signs of estrus were observed, after which the group was reunited. This management technique was successful in preventing pregnancies within this group, and could also be applied to *Eulemur* species, although it should be noted that estrus swellings are much more difficult to detect in many *Eulemur* species. Maintaining visual contact during periods of separation facilitates reintroduction of the animals once the breeding season is over.

Chemical contraception: The AZA Wildlife Contraception Center (WCC) recommends the use of MGA implants for *Eulemur* as a reversible contraception method. To minimize progestin exposure, implants should be inserted in October before the onset of breeding season and be removed in May after the breeding season. If the MGA implant is left in place, it has an expected effective period of a minimum of 2 years, but may in fact release hormone for much longer. If mating behavior in a female with an MGA implant is observed, this may indicate that the implant in not effective. Mating is not normally seen in *Eulemur* with MGA implants.

Another form of reversible female contraception used quite frequently is Depo-Provera injections. The AZA WCC recommended dose is 5 mg/kg body weight given every 30–45 days from November through March. One institution reported giving injections every 60 days with no unintended pregnancies in recent history (C. Williams, personal communication, 2008). However, there has been a confirmed pregnancy in a ruffed lemur during Depo-Provera treatment and care should be taken to give animals injections at regular intervals. Both MGA implants and Depo-Provera injections can cause weight gain, so diet should be monitored.

In males, gonadotropin releasing-hormone (GnRH) agonists are considered the safest reversible contraceptives but dosages and duration efficacy have not been well established for all *Eulemur* species. Side effects are similar to those following gonadectomy, especially weight gain. GnRH agonists are available as Suprelorin® (deslorelin) implants or Lupron® Depot injections. Please visit the Wildlife Contraception Center webpage for more information: http://www.stlzoo.org/contraception.

Contraception in females or males may lead to color change depending on the method used *(E. m. flavifrons* and *E. m. macaco*). For example, castration of males can lead to female coloration in sexually

dichromatic species. Also, Depo-Provera injections can cause male coloration in females because it has androgenic as well as progestin action. *Eulemur* species are typically sexually dichromatic.

Non-reversible contraception: For females, surgical, non-reversible methods of contraception include tubal ligation and ovario-hysterectomy; in males, non-reversible methods include vasectomy and castration. Please consult with the AZA *Eulemur* SSP coordinator and species managers before using a method of surgical, non-reversible contraception.

Chapter 8. Behavior Management

8.1 Animal Training

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

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

AZA-accredited institutions are expected to utilize reinforcing conditioning techniques to facilitate husbandry procedures and behavioral research investigations.

Routine husbandry is facilitated by physical components of exhibits such as natural lighting and multiple shift pens. Adequate physical environments should then allow for a variety of additional management tools to be implemented, such as operant conditioning, enrichment, and detailed observations. Animals should be managed in natural social groups when possible, with consideration for their natural behaviors. Detailed observations can alert staff to social/hierarchy changes, which is important information on which to base decisions on managing group dynamics, reproduction, and agonistic situations. Enrichment can serve to reduce stress, alleviate boredom, and break up the daily routine, helping to keep relations peaceful between group members. Operant conditioning can facilitate husbandry requirements such as shifting, routine weights, introductions and improving social relationships through stationing and crate training. Flexibility and complexity of environment allow for animals to be separated or combined during routine as well as non-routine times.

The ability to be flexible with management and housing will greatly enhance your ability to form and split groups as needed, such as during breeding season, or times of heightened aggression. Operant conditioning can be used to train lemurs for hand-injections, physical exams, taking medications, entering transfer crates and routine weighing. The following table (Table 10) includes a list of potential behaviors that can be trained with *Eulemur* species.

Table 10. Husbandry behaviors for *Eulemur* training programs

Behavior	Description/criteria
Sit	Sit in front of keeper, within 2 ft, keeper should be able to reach out and touch flank of animal. Animal is to remain seated until bridged regardless of what else happens. This is the base behavior for allowing a physical exam, checking eyes, stethoscope, injections, etc.
Station	Animal touches a target ball until bridged, ball is clipped to fence
Target	Touch target ball
Here	Move to keeper's hand
Scale	Sit on scale platform until bridged
Crate	Sit on milk crate
Kennel	Go into air kennel
Reach	Animal touches trainer's hand and allows physical manipulation of fingers/arm (both right and left cues)
Hold	Increases duration of any behavior
Recall to tone	Emergency recall to shift animals off exhibit into holding at specific sound cue
Shifting	Shift between stalls or on and off exhibit
Hand injection	Sit and receive injection
Tactile	Allow keeper to touch any part of body for investigation
Belly	Allows trainer to touch belly

Various species of *Eulemur* have been successfully trained to participate in research projects related to sensory perception and cognition (e.g., Brannon et al., 2008 ; Mahajan et al., 2008; Ruiz et al., 2008).

8.2 Environmental Enrichment

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

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

AZA Accreditation Standard

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

AZA Accreditation Standard

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

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

As *Eulemur* species are not particularly destructive, a wide variety of enrichment initiatives are available. Items should be chosen to stimulate the animal to engage in natural behaviors, such as locomotion through trees, branches, or vines, scent marking exhibit items and enrichment pieces, and investigation and foraging behaviors. Enrichment items should stimulate the five senses, and can included manipulata and novel foods. The items should preferably be something that engages the animal to return and examine the enrichment item over a period of time. An item that engages an animal once for 5 minutes is not effective over the other 23 hours and 55 minutes.

Items can be situated so that the animal has to engage in natural behaviors such as climbing, leaping, or over-scenting. Multiple items should be used in troops to prevent monopolization by more dominant animals. Enrichment items should be given at least once per day, should be rotated out after a day or two of interaction, and should be rotated throughout a set period of time with other items. Enrichment should also be discarded or thoroughly disinfected after use. However, an exception to this would be items from conspecifics in multiple troops that are swapped between the troops. These items do not need to be disinfected regularly unless current health status warrants, as the conspecific scent is stimulating to other animals.

Items can start out simple and be built upon for new enrichment, or begin as complex items with various components that can be broken down throughout time. Items can include food or other enticement and those items can be offered as the day progresses to increase use of the enrichment offered. Multiple items of varying difficulty would be appropriate for young animals, with the number of items offered and difficulty decreased for geriatric animals. A list of acceptable enrichment items that can be used for *Eulemur* species can be found in the table below. This table is a combination of ideas from several zoological institutions.

Table 11. Enrichment initiatives for *Eulemur* spp.

Enrichment initiative	Description
Boxes	String/tape removed
Bags	String/tape removed
Blocks	Colorful children's blocks, especially ones that rattle
Crates	Soft-sided dog crates- hang them up with bungee cords with the "door" open, may fill with shredded paper, hay, etc.
Hammocks	Carpet pieces, blankets, old nets, t-shirts
Logs	Put in with one troop for a day then move over to a second troop
Puzzle feeders	Can be as simple as holes drilled in a log for food to be stuffed in, hang log with an eye hook for increased difficulty, or fairly simple PVC ones with no more than one sliding piece to block a few holes
Ferret log	-
Sit 'n spin	This is a homemade device that spins when an animal jumps on it like a Ferris wheel, so they have to be pretty agile to get to the food item
Kongs® on a rope	-
Scents/spices	-
Grape vine balls	-
Formed "bird nests"	From craft stores as feeders
Swinging items	-
Milk crates	Hang several along a rope, they like to sit in them
Firehose triangle swings	-
Hay	-
Woodwool	-

8.3 Staff and Animal Interactions

Animal training and environmental enrichment protocols and techniques should be based on interactions that promote safety for all involved.

The AZA *Eulemur* SSPs strongly recommend a training program to facilitate husbandry behaviors and enrichment; however, too much human contact can have a negative effect on behavior. It is best to keep close human interactions restricted to training sessions. Too much human/animal interaction became a significant problem for the ruffed lemur reintroduction program. Animals that become too tame do not make good release candidates, either in the wild, or in free-ranging managed situations. There is also evidence that ex-pet lemurs in Madagascar at two zoological institutions have become aggressive towards humans. One zoological institution also reports a case of two *E. fulvus* from a national primate center that were very aggressive to humans. In this case it was presumed that the aggression was due to being kept singly in small laboratory cages. Ex-pet lemurs received in Madagascar (e.g., *Eulemur* and *Hapalemur*) were already aggressive when they arrived, and in most cases this was the reason their original "owners" donated them to a zoo. In the experience of the second zoo, the only lemurs that have been aggressive were those that were hand-raised or where human-animal tactile contact was encouraged for too long. These animals become aggressive when they are treated like pets and taught to lose all timidity in the presence of humans.

Lemurs that lose their fear of humans may become aggressive when encouraged to interact with them. The AZA *Eulemur* SSPs suggest that if the exhibit is big enough to allow lemurs to move away and the animals are not aggressive to people, staff may enter the exhibit to clean and feed. It is not encouraged for keepers to have direct human-animal interaction during this time, as lemurs have sharp canine teeth and can inflict serious wounds.

In the interest of keeper and animal safety, the AZA *Eulemur* SSPs recommend human/animal interactions through a barrier (i.e., protected contact) when animals are judged to be too aggressive to enter exhibit enclosures with them. Important enclosure design considerations for animal and keeper safety include multiple pens to allow for separation of individuals and mesh that allows for training with limited contact if so desired. Remote operation of shift doors in case of aggressive animals is very important for caretaker safety. Keepers operating doors should have visual access to all doors being remotely operated to ensure animals are entering/exiting and that doors are functioning properly. Lemurs are easily trained via operant conditioning for husbandry behaviors.

Other important design considerations include extra holding areas in case individual animals are expelled from groups or for other unforeseen circumstances. Multiple doors opening for shifting in off exhibit areas, as well as on and off exhibit will facilitate circular movement in stalls. If there is only one

shift door per stall, placing the door in the center of a wall when possible allows for better escape routes and does not create dead ends in movement patterns through holding.

8.4 Staff Skills and Training

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

Basic to advanced knowledge of operant conditioning, enrichment, natural history of the animals, knowledge of individuals, safe capture and restraint skills, and critical thinking skills are all important tools that should be stressed to those caring for and managing *Eulemur* species. Animal keepers working with *Eulemur* species would benefit from attending any AZA Prosimian TAG workshops or mini-workshops and meetings held at professional conferences such as American Association of Zoo Keepers (AAZK) annual conference.

Chapter 9. Program Animals

9.1 Program Animal Policy

AZA recognizes many public education and, ultimately, conservation benefits from program animal presentations. AZA's Conservation Education Committee's Program Animal Position Statement (Appendix F) summarizes the value of program animal presentations.

For the purpose of this policy, a program animal is described as an animal presented either within or outside of its normal exhibit or holding area that is intended to have regular proximity to or physical contact with trainers, handlers, the public, or will be part of an ongoing conservation education/outreach program.

Program animal presentations bring a host of responsibilities, including the welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that give program animal presentations to develop an institutional program animal policy that clearly identifies and justifies those species and individuals approved as program animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, sound and environmental enrichment, access to veterinary care, nutrition, and other related standards (AZA Accreditation Standard 1.5.4). In addition, providing program animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, housing may be reduced in size compared to a primary enclosure as long as the animal's physical and psychological needs are being met during the program; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

AZA Accreditation Standard

(1.5.4) A written policy on the use of live animals in programs must be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animals in the institution, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.

While it is understood that per the Conservation Education Committee (CEC) of AZA, "program animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places," certain taxa and species are not good choices to be used as program animals for a variety of reasons, including animal welfare. As with other primates social needs and potential zoonotic concerns impact prosimians. Hand-reared prosimians present their own set of long-term issues. While a number of institutions include eulemur species as program animals, the Prosimian TAG and related SSPs have begun a review of scientific findings related to the welfare of these species as program animals. This Manual will be updated if a science-based position emerges regarding their use as program animals, through a process similar to that used to inform AZA's Policy on the Presentation of Animals and White Paper on Apes in Media and Commercial Performances.

9.2 Institutional Program Animal Plans

AZA's policy on the presentation of animals is as follows: AZA is dedicated to excellence in animal care and welfare, conservation, education, research, and the presentation of animals in ways that inspire respect for wildlife and nature. AZA's position is that animals should always be presented in adherence to the following core principles:

- Animal and human health, safety, and welfare are never compromised.
- Education and a meaningful conservation message are integral components of the presentation.
- The individual animals involved are consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs.

AZA-accredited institutions that have designated program animals are required to develop their own Institutional Program Animal Policy that articulates and evaluates the program benefits (see Appendix G for recommendations). Program animals should be consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs. Education and conservation messaging must be an integral component of any program animal demonstration (AZA Accreditation Standard 1.5.3).

Animal care and education staff should be trained in program animal-specific handling protocols, conservation, and education messaging techniques, and public interaction procedures. These staff members should be competent in recognizing stress or discomfort behaviors exhibited by the program animals and be able to address any safety issues that arise.

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

Careful consideration must be given to the design and size of all program animal enclosures, including exhibit, off-exhibit holding, hospital, quarantine, and isolation areas, such that the physical, social, behavioral, and psychological needs of the species are met and species-appropriate behaviors are facilitated (AZA Accreditation Standard 10.3.3; AZA Accreditation Standard 1.5.2).

Similar consideration needs to be given to the means in which an animal will be transported both within the Institution's grounds, and to/from an off-grounds program. Animal transportation must be conducted in a manner that is lawful, safe, well planned, and coordinated, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11).

AZA Accreditation Standard

(1.5.3) If animal demonstrations are a part of the institution's programs, an educational/conservation message must be an integral component.

AZA Accreditation Standard

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

AZA Accreditation Standard

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

AZA Accreditation Standard

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to. Planning and coordination for animal transport requires good communication among all involved parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

9.3 Program Evaluation

AZA-accredited institutions that have Institutional Program Animal Plan are required to evaluate the efficacy of the plan routinely (see Appendix G for recommendations). Education and conservation messaging content retention, animal health and well-being, guest responses, policy effectiveness, and accountability and ramifications of policy violations should be assessed and revised as needed.

Chapter 10. Research

10.1 Known Methodologies

AZA Accreditation Standard

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

AZA believes that contemporary *Eulemur* management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research both in *in situ* and *ex situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. Participating in AZA Taxon Advisory Group (TAG) or Species Survival Plan® (SSP) Program sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials could help achieve this (AZA Accreditation Standard 5.3).

Eulemur species are managed under SSP and Studbook managed programs. These SSPs and programs are incorporated under the AZA Prosimian TAG, which also includes the AZA Ring-Tailed Lemur SSP, Ruffed Lemur SSP, the nocturnal prosimian SSPs and programs, and the Sifaka SSP. In addition to the numerous AZA zoos that house *Eulemur* species, the AZA *Eulemur* institutional membership also includes an AZA Certified Related Facility, the Lemur Conservation Foundation, Myakka City, Florida and a non-member participating institution, the Duke Lemur Center, located at Duke University, North Carolina. These centers both house and exhibit numerous species of lemur, and also participate in research and conservation efforts in Madagascar. The AZA *Eulemur* SSPs also support the work of the Madagascar Fauna Group, based at the St. Louis Zoo, St. Louis, MO, which is an international consortium of zoos and related organizations that works to conserve the biodiversity of Madagascar.

Research and conservation efforts for *Eulemur* species are significant to the protection of these species in the future. The populations of *Eulemur* species in the wild are vulnerable and declining, due to many threats, including habitat loss, poaching, and difficulty of protecting species due to Madagascar's political turmoil. Any *in situ* conservation can only benefit these species. In addition, research done by AZA institutions can help in many ways, including increasing the numbers of the managed population in zoos and aquariums, developing better husbandry techniques, and learning more general information about these species. All this information can be shared with both field researchers, and institutions worldwide, and one particular institution is working to protect *Eulemur* very close to their natural habitat, and has already begun release programs with some prosimian species.

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

Formalized research focused on managed *Eulemur* species has been ongoing for at least the last 50 years, in both university primate laboratory facilities and in zoological institutions. Research focus varies greatly and includes studies that are observationally and behaviorally focused, enrichment based, physiological and hormonal, and even some cognitively focused programs.

Positive reinforcement training has been successfully incorporated into husbandry, education, and research programs. Specifically for research, training has helped to reduce animal stress and increase data collection. Kennel training has helped to eliminate the need to net animals prior to taking them to the research room. Target and point-follow training has assisted trainers in the research room when animals are needed to be located in a specific spot or to move in a particular way. Requested behaviors are trained and conditioned prior to the arrival of a researcher or start of a research program that requires an animal to actively participate. A goal of including animals in research should be to use training to refine the data collection process by using calm animals and in a shorter amount of time.

There are multiple examples of *Eulemur* as subjects in research. One researcher is utilizing a training program to study how individual *Eulemur* temperament affects training success. This study is applicable to *ex situ* care, as it will help caretakers and researchers to better predict training success in their animals and to plan training in a way that will be most effective. Research training was also a fundamental basis to a long-term study of prosimian (including *Eulemur* species) cognitive abilities in which the study participants were taught to use touch-screen computers to complete a series of numerical based tasks. This study was high profile in the scientific community, and helps to better understand not only how lemurs learn, but also how they mentally process and understand their social and ecological environment.

Eulemur is also the focus of a large study investigating the hormonal and behavioral correlates of female dominance. To address the question of hormonal masculinization in Strepsirrhini females, they are focusing on six *Eulemur* species that express a gradient of social and reproductive behavioral variation (female dominant to co-dominance). Thus far, the researchers have established species-specific behavioral patterns between males and females and determined the hormonal correlates to behavior. Future studies plan to determine the causative relationship between female behavior and hormones via temporary hormonal manipulation.

All aspects of animal training can be enjoyable and enriching to any taxa. This includes research training. At one institution, the animals participate in non-invasive research trials—some animals seem that they enjoy participating in data collection to the point that it can be a challenge to get them back in their kennel. Sometimes the thought of "research training" can seem complicated and overwhelming. However, like any behavior that is trained, all aspects of the final research behavior need to be identified and broken down into achievable behavioral goals. This process can be a great learning opportunity for both staff and animals. For lemurs, there are certainly many more questions beyond what can be learned by observations alone, and training is an excellent method to increase knowledge while enriching the animals at the same time.

AZA-accredited institutions are required to have a clearly written research policy that identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, the animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified individual to oversee and direct its research program (AZA Accreditation Standard 5.1). If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by Taxon Advisory Groups (TAGs) or Species Survival Plans® (SSP) Programs.

AZA Accreditation Standard

(5.2) The institution must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

AZA Accreditation Standard

(5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

Any institution accepting a research proposal related to *Eulemur* should set clear guidelines and goals with the principle investigator, and management of the animals should not be changed during the duration of the study unless the study question is focused on a specific husbandry or management change. Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of the species being investigated and may provide results which benefit the health or welfare of animals in wild populations. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations and these types of programs are strongly encouraged by the AZA Prosimian TAG, *Eulemur* SSPs, and Studbook Programs.

Often institutions are approached by students at different levels (high school, college, graduate) for research related to class credit, or for a thesis or doctoral level research project. All students should follow the institution's research protocol and submit proposals to the IACUC listing the objectives, methodology and goals of the study. A meeting is often arranged between the student/advisor and zoo staff to discuss the proposed project. Many staff may be involved and give input, including staff related to animal health, curatorial and supervisory staff, and any specialists, such as nutrition, endocrinology, animal training, which might be affected by the project, or to give their input on the project. The decision to accept or deny a proposed research project should be made by the IACUC and those reviewing research. An appropriate supervisor should be identified to ensure animal welfare is not compromised and that progress is made on the project. Both the researcher and the staff should relay information and results when necessary.

The AZA Prosimian TAG, *Eulemur* SSPs, and Studbook Programs have not yet been contacted or approached at a TAG or population level to provide samples or include animals in large scale research programs, nor have TAG or SSP level research and conservation priorities been identified. Individual institutions, such as the Duke Lemur Center and the Lemur Conservation Foundation, do have active research programs. Contact these institutions directly to learn what is required to conduct research involving their *Eulemur* collections.

Numerous AZA institutions have contributed to conservation initiatives in Madagascar focused around lemur conservation but also more broadly in habitat and resource conservation and education. Some examples include the Madagascar Faunal Group (www.savethelemur.org) of which multiple AZA institutions are member organizations. Other examples include Wildlife Conservation Society's Madagascar Program (http://www.wcs.org/where-we-work/africa/madagascar.aspx), Omaha's Henry Doorly Zoo's Molecular Genetics Department Madagascar Program (http://www.omahazoo.com/conservation/molecular-genetics/madagascar/), and the Lemur Conservation Foundation's work in the Tampolo Reserve (http://www.lemurreserve.org/tampolo.html).

10.2 Future Research Needs

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

Chapter 1. Ambient Environment

Section 1.2 Light: More research to define light levels, composition, and cycles, particularly for *Eulemur* housed indoors.

Section 1.4. Sound and Vibration: More research to define parameters of hearing sensitivity would be beneficial in determining appropriate sound guidelines for *Eulemur* exhibits.

Chapter 5. Nutrition

Section 5.1. Nutritional Requirements: More information is necessary regarding acceptable weights at birth and during adulthood. As mentioned above, obesity is a problem in *Eulemur* at all ages, which has obvious effects on health and may also effect reproduction in these species.

Chapter 7. Reproduction

Section 7.1. Reproductive Physiology and Behavior: There is a need to address the unbalanced sex ratio in the population to determine why more males are being born in the managed population, and why males live much longer than females.

Section 7.2. Artificial Insemination: Artificial insemination has not been extensively studied in *Eulemur* and no further information is currently available. Documentation of any attempts to use any form of artificial insemination in *Eulemur* would be beneficial.

Section 7.3. Pregnancy, Parturition: The lack of successful breeding in most *Eulemur* species is a research priority; when females do get pregnant, many infants are stillborn.

Section 7.6. Contraception: if females have been contracepted or prevented from breeding for a few years, there is difficulty getting them to reproduce once contraception is stopped. This has implications for trying to balance breeding recommendations with available space for the species in institutions.

Chapter 8. Behavior Management

Section 8.2. Environmental Enrichment: Further research on music or sound as enrichment would be useful.

Chapter 11. Other Considerations

11.1 Record Keeping for Eulemur

Animal data recording: Animal records are the foundation upon which zoo and aquarium management programs are built, and they have an impact on the daily care and welfare of an institution's collection. Good decisions about both populations and individuals cannot be made without a complete and accurate set of data, and a large proportion of this data comes directly from animal keepers via their daily records keeping system. The AZA *Eulemur* SSPs encourage animal care staff to focus on good record keeping and observations of *Eulemur*.

General guidelines for good record keeping for *Eulemur* are as follows (adapted from a zoological institution housing *Eulemurs*):

- All keepers should submit electronic reports daily
- Be clear, concise, and avoid using slang terms
- Include appropriate accession numbers, sex, species, and house name
- Follow up on previous comments. If a change, problem, or concern is noted on one day, be sure to give an update or describe the outcome on preceding days
- Give an explanation for any changes, moves, treatments, etc.

Typical categories of information that should be reported:

- Births: Births should be reported as soon as possible after the event. Include all pertinent information such as sex (if known), time, location, behavior, condition, etc. List accession numbers of both dam and sire if known; if exact parentage cannot be determined, list accession numbers of all possibilities. Be sure to give an explanation if there are various possible parents.
- Deaths/disappearances: Deaths and disappearances should be noted when they occurs with as much detail as possible, including possible cause of death or evidence of theft or escape. If there is a possibility that the animal may reappear, a period of time may elapse before the animal is actually de-accessioned. Periodic updates should be noted until it can be reasonably determined that the animal is gone. A final notation should be made at this time.
- Other acquisitions: An accession report filled out by appropriate personnel should be turned in to the registrar as soon as possible after an animal is acquired. Please provide as much reliable information as possible on the accession report.
- Other dispositions: Note all pertinent information on daily reports.
- Unusual behavior or changes in behavior: Include information about possible causes.
- Reproductive behavior: Be as specific as possible. Note pre-copulatory behaviors and if copulation was achieved or attempted. Include times, durations, and individuals involved.
- New approved enrichment items: Describe what was offered and the reactions of the animal(s) involved.
- Diet changes: Be clear on whether diet amounts are for an individual or a group, and whether the amounts are given multiple times per day or are the total for the day. Diet changes need to be reviewed with the nutritionist or other person responsible for monitoring diets.
- Location changes: All moves should be reported with an explanation. If a change is short term, such as for exhibit repair, be sure to note when the animal is returned to its regular enclosure.
- Medical problems and treatments: Be specific when describing medical problems and outline treatment procedures given by the veterinary staff.
- Physical condition: This includes information such as weights, measurements, body condition, and physical events such as changes from juvenile to adult coloration.
- Social structure and interaction: Document observations related to social structure of individuals housed in groups, particularly aggressive, affiliative, and reproductive behaviors. Recording data

about the social structure of a group will be helpful to develop best management practices for each group.

The above categories and descriptions are not all-inclusive. Any information that is significant and may be needed in the future should be documented.

Observations and record keeping: Keen observational skills are extremely important skills for an animal keeper. They need to learn what "normal" behaviors are for each species and for individual animals, and to understand what the behaviors or observations mean and how to record these behaviors and observations.

Importance of good record keeping: Maintaining good records is extremely important for both current and long-term usage. Record keeping should be done in a clear, concise manner utilizing professional verbiage. Producing good records allows for managers, curators, animal keepers, and veterinarians to have a clear picture as to what has occurred with an animal. Also, the registrar will be able to transcribe this information into an animal's permanent record. These records are an important resource for husbandry, management and health issues regarding a specific animal or species.

Being able to provide good records is also invaluable for AZA Studbook Keepers and AZA SSP Coordinators. When making management decisions for an entire population, individual institutional records are the basis for good population management plans.

11.2 Necropsy Protocol for *Eulemur*

Prosimian Necropsy Protocol: The following are a recommended necropsy protocol and report form (which may be used if you do not have your own forms). This protocol was revised in January 2007.

Please send copies of necropsy reports to the appropriate veterinary advisor (see below) and the AZA Prosimian TAG Pathology Advisor (Dr. Ilse Stalis). Necropsy reports should include a thorough description of all lesions and a complete clinical history. If a second opinion is needed, please send duplicate histopathology slides to the TAG Pathology Advisor. **If a complete set or tissues could not be processed for histologic evaluation, to preserve valuable information please send a complete set of tissues to the pathology advisor if possible.** These tissues will be archived, but unfortunately, a report will not be generated for most cases.

CAUTION: Histopathology blocks (paraffin embedded tissues) are an extremely valuable resource. Some laboratories may discard the blocks after a few years. If your lab does not save these blocks, please ask for the blocks and save them at your facility. Please do not hesitate to contact us if you have questions or comments.

AZA Prosimian TAG Veterinary Advisor and AZA *Eulemur* SSP Advisor:
Randy Junge, DVM
Vice President for Animal Health
Columbus Zoo and The Wilds
9990 Riverside Drive
Powell, OH 43065
(614) 724-3654
rejunge@hotmail.com

Pathology Advisor:
Ilse Stalis, DVM
U.S. Postal Service address:
Wildlife Disease Laboratories
PO Box 120551
San Diego Zoo
San Diego, CA 92112-0551

Courier service shipping address:
Wildlife Disease Laboratories
San Diego Zoo
1354 Old Globe Way

San Diego, CA 92101
Phone: 619-231-1515, ext. 4487
Fax: 619-232-1643
E-mail: IStalis@sandiegozoo.org

A necropsy is an excellent source of information about diseases. This procedure may seem too involved for people who are severely short on time. However, the more tissues there are to look at, the more information there will be and the better the results. Examination of organs not directly involved in the death of an animal provides control samples and gives a better understanding of other disease that may occur in that species. Diseases often affect more than one organ and sampling only one or a few organs limits the amount of information available and our understanding of diseases. A necropsy can be very time consuming, but the more time you can devote to a necropsy and the more samples you take (including formalin-fixed and frozen), the more likely that a pathologist can give a complete answer. The better our understanding of disease, the better we will be able to treat and prevent disease.

Recommended sampling procedures
General recommendations: A detailed examination of the exterior of the animal should be done before dissection in preformed. Carcass weights and measurements should be collected. Radiographs should be considered as well to assist in detection of subtle bone changes.

Histopathology: Tissue sections should be no thicker than 1 cm. Exceptions are: healthy lung, which may be slightly thicker; eyes, which should be fixed whole and intact (i.e., not punctured); and brain which should be fixed whole. Ideally, flat tissues such as intestine, skin, and sciatic nerve should be placed on cardboard during fixation to prevent curling of tissues. Tissues should be placed in 10% neutral buffered formalin with *formalin at 10 times the volume of tissues*. Otherwise, inadequate fixation will occur. Once tissues are completely fixed they can be mailed or saved in a smaller volume of formalin.

For toxicological studies: Tissues should be saved wrapped in aluminum foil or saved in glass. If stored in plastic, leaching of plastic compounds can occur and interfere with toxicological analysis. Tissues for toxicology can be saved in a regular freezer (-20 °C [-4 °F]). Some tissues to save for toxicological studies are liver, kidney, fat and stomach contents, but if toxicity is suspected, a toxicologist should be consulted for proper tissue collection and preservation.

Infectious disease studies: Tissues should be saved at -70 °C (-94 °F) (organisms tend to survive better at this temperature).

Biomaterial banking: Several sections (2–5 cm cubes) of heart, skeletal muscle, and liver should be collected and saved at -70 °C (-94 °F). These may be submitted to the AZA Prosimian TAG Tissue Bank for long-term storage. Submit samples to St. Louis Zoo (address above) with complete animal identification—ARKS printout is preferred.

Weigh the major organs (especially heart, liver, kidney, brain)

Instructions for specific tissues:

Heart: Three longitudinal sections to include: left and right free walls such that atrium, ventricle, and A-V valve are included in the section (include papillary muscle in this section); and a similarly oriented section of septum such that atrium, septal leaflet of right A-V valve and aortic outflow tract are included.

Lymph nodes: If lymph nodes are grossly abnormal or if lymph node disease is suspected, lymph nodes should be labeled as to location (e.g., in bags, laundry tags or separate containers) since they all look the same under the microscope.

Endocrine organs: Submit the entire organ from both left and right sides. Adrenal glands should be cut transversely to assess the ratio of cortex to medulla.

Gastrointestinal tract: Open along long axis. If intestine is abnormal or GI disease is suspected clinically, label each section as to location.

Additional necropsy procedures for neonates:
- Fix umbilical stump and surrounding tissues
- Examine fetus or neonate for malformations, including cleft palate, and deformed limbs/spine

- Assess level of hydration and evidence of nursing
- Determine if breathing occurred (do lungs float in formalin?)
  Include placenta

Female reproductive tracts have been requested by Dr. Dalen Agnew at the Diagnostic Center for Populations and Animal Health. Tissue should be shipped to:

Dr. Dalen Agnew
Attn: Histo Research
Diagnostic Center for Population and Animal Health
4125 Beaumont Rd.
Lansing, MI USA 48910-8104
Phone: 517-353-1683.
Email: agnewd@dcpah.msu.edu

See the Wildlife Contraception Center's website for submission forms:
http://www.stlzoo.org/animals/scienceresearch/contraceptioncenter/contraceptionrecommendatio/healthsurveillanceprogram.htm

Checklist of tissues to sample:

- Heart (left and right free walls and septum)
- Aorta
- Lung (sections from several lobes, including a major bronchus)
- Trachea
- Thymus
- Thyroid (leave intact)
- Parathyroid (leave intact)
- Adrenal
- Pituitary
- Lymph nodes (cervical, anterior mediastinal, bronchial, mesenteric, lumbar, prescapular—at least one internal and one external should be collected)
- Spleen (Two cross sections including capsule)
- Liver (3–5 sections from different areas—include capsule)
- Gallbladder
- Pancreas (sections from two areas—can leave attached to duodenum)
- Tongue (cross section)
- Esophagus
- Stomach (cardia, fundus, antrum)
- Small intestine (duodenum, jejunum, ileum)
- Large intestine (cecum, colon)
- Kidney (transverse section to include coner, medulla, papilla)
- Urinary bladder
- Uterus (body and horn)
- Placenta
- Ovary (section of each)
- Testis, epididymis (transverse section of each)
- Prostate, accessory sex glands
- Brain (At least 1/2 of the brain [right or left] should be submitted intact. In some cases of neurological disease it may be advisable to formalin fix the entire brain.)
- Spinal cord (Remove entire cord, if possible, and submit whole. Because this is a somewhat labor intensive procedure, this is probably only necessary for animals with neurological signs referable to the spinal cord.)
- Eye (fix intact—do not puncture)
- Skin (1–2 cm/0.4–0.8 in square section of ventral and dorsal skin)
- Skeletal muscle (1 x 1 x 0.5 cm [0.4 x 0.4 x 0.2 in.]) piece from thigh—longitudinal section in direction of muscle fibers

- Bone (submit 1/2 femur in longitudinal section; include growth plate). For large animals, submit costochondral junction of a rib (to include growth plate) and bone marrow from the proximal femur.
- Bone marrow

Necropsy findings necropsy #		
Species:	Studbook No.:	
Institution:	Prosector:	
Birth Date/Age:	Sex:	Proven Breeder?: Yes No
Date and time of death:	Contraceptive History:	
Body weight:	Date and time of necropsy:	
Parent or hand reared?:	Enclosure ID (indoor/outdoor?):	
Weather conditions of enclosure when found dead:		

In addition to completing the checklist on the next page please include a detailed description of gross lesions and indicate if pictures were taken and of which organs.

Diet (list ingredients, brand names):

Clinical History (Presentation, circumstances of death, attach copy of lab results, use additional sheets if necessary):

Gross Description of lesions:

Tissue checklist

Organ	Status	Micro	Cy	-20/70	Organ	Status	Micro	Cy	-20/70
Skin,					Bone marrow				
Subcutis					Kidney				
Mammary gland					Ureters				
Umbilicus					Urinary bladder				
Body orifices					Urethra				
Thoracic cavity					Ovaries				
Abdom cavity					Uterus				
Heart/ sac					Vagina				
Aorta/ vessels					Vulva				
Nasal cavity					Testes				
Trachea/bronchi					Access. glands				
Lungs					Penis/prepuce				
Oral cavity/teeth					Muscles				
Esophagus					Bones/joints				
Stomach					Brain				
Small intestine					Leptomeninges				
Cecum					Peripheral nerve				
Colon					Spinal cord				
Liver					Thyroid				
Gallbladder					Parathyroid				
Pancreas					Pituitary				
Tonsil					Adrenal				
Spleen					Eyes/cornea/lens				
Thymus					Ears				
GALT*					Lymph nodes				

Status: WNL = within normal limits, AB = abnormal, NE = not examined, NP = not present, NF = not found.
Micro: AE=aerobic, AN=anaerobic, P=parasite, F=fungus **Cy**=cytology, **-20°C ,-70°C** = freezing temp
*GALT = gut-associated lymphatic tissue

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Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to *Eulemur* are taken from the AZA Accreditation Standards and Related Policies (AZA, 2011) and are referenced fully within the chapters of this animal care manual:

General Information

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

Chapter 1

(1.5.7) The animals must be protected from weather, and any adverse environmental conditions.

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a recordkeeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

(1.5.9) The institution must have a regular program of monitoring water quality for fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

Chapter 2

(1.5.1) Animals should be presented in a manner reflecting modern zoological practices in exhibit design, balancing animals' functional welfare requirements with aesthetic and educational considerations.

(1.5.2) All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single animals should be avoided unless biologically correct for the species.

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

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

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

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

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

(11.3.6) In areas where the public is not intended to have contact with animals, some means of deterring public contact with animals (e.g., guardrails/barriers) must be in place.

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

(11.2.5) Live-action emergency drills must be conducted at least once annually for each of the four basic types of emergency (fire; weather/environment appropriate to the region; injury to staff or a visitor;

animal escape). Four separate drills are required. These drills must be recorded and evaluated to determine that procedures are being followed, that staff training is effective, and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills must be maintained and improvements in the procedures documented whenever such are identified.

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

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

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

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

(11.5.2) All areas housing venomous animals, or animals which pose a serious threat of catastrophic injury and/or death (e.g. large carnivores, large reptiles, medium to large primates, large hoofstock, killer whales, sharks, venomous animals, and others, etc.) must be equipped with appropriate alarm systems, and/or have protocols and procedures in place which will notify staff in the event of a bite injury, attack, or escape from the enclosure. These systems and/or protocols and procedures must be routinely checked to insure proper functionality, and periodic drills must be conducted to insure that appropriate staff members are notified.

(11.5.1) Institutions maintaining venomous animals must have appropriate antivenin readily available, and its location must be known by all staff members working in those areas. An individual must be responsible for inventory, disposal/replacement, and storage of antivenin.

Chapter 3

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to. Planning and coordination for animal transport requires good communication among all involved parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

(1.5.10) Temporary, seasonal and traveling live animal exhibits (regardless of ownership or contractual arrangements) must meet the same accreditation standards as the institution's permanent resident animals.

Chapter 5

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

(2.6.1) Animal food preparations must meet all applicable laws and regulations.

(2.6.3) The institution should assign at least one person to oversee appropriate browse material for the collection.

Chapter 6

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

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

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

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

(1.4.7) Animal records must be kept current, and data must be logged daily.

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

(1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

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

(1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions at the institution.

(1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

(2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines contained within the *Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals* developed by the American Association of Zoo Veterinarians (AAZV), which can be obtained at: http://www.aazv.org/associations/6442/files/veterinary_standards_2009_final.docx.

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

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

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

(2.5.1) Deceased animals should be necropsied to determine the cause of death. Cadavers must be stored in a dedicated storage area. Disposal after necropsy must be done in accordance with local/federal laws.

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

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

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

(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical signs of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not diagnose illnesses nor prescribe treatment.

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

(1.5.8) The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution in a timely manner, and without retribution.

Chapter 8

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

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

Chapter 9

(1.5.4) A written policy on the use of live animals in programs must be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animals in the institution, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.

(1.5.3) If animal demonstrations are part of the institution's programs, an educational/conservation message must be an integral component.

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

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

(1.5.2) All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single animals should be avoided unless biologically correct for the species.

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable laws and/or regulations must be adhered to. Planning and coordination for animal transport requires good communication among all involved parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

Chapter 10

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

(5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

(5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

Appendix B: Acquisition/Disposition Policy

I. Introduction: The Association of Zoos and Aquariums (AZA) was established, among other reasons, to foster continued improvement in the zoological park and aquarium profession. One of its most important roles is to provide a forum for debate and consensus building among its members, the intent of which is to attain high ethical standards, especially those related to animal care and professional conduct. The stringent requirements for AZA accreditation and high standards of professional conduct are unmatched by similar organizations and also far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. AZA member facilities must abide by a Code of Professional Ethics—a set of standards that guide all aspects of animal management and welfare. As a matter of priority, AZA institutions should acquire animals from other AZA institutions and dispose of animals to other AZA institutions.

AZA-accredited zoological parks and aquariums cannot fulfill their important missions of conservation, and science without living animals. Responsible management of living animal populations necessitates that some individuals be acquired and that others be removed from the collection at certain times. Acquisition of animals can occur through propagation, trade, donation, loan, purchase, capture, or rescue. Animals used as animal feed are not accessioned into the collection.

Disposition occurs when an animal leaves the collection for any reason. Reasons for disposition vary widely, but include cooperative population management (genetic or demographic management), reintroduction, behavioral incompatibility, sexual maturation, animal health concerns, loan or transfer, or death.

The AZA Acquisition/Disposition Policy (A/D) was created to help: (1) guide and support member institutions in their animal acquisition and disposition decisions; and (2) ensure that all additions and removals are compatible with the Association's stated commitment to "save and protect the wonders of the living natural world." More specifically, the AZA A/D Policy is intended to:

- Ensure that the welfare of individual animals and conservation of populations, species and ecosystems are carefully considered during acquisition and disposition activities
- Maintain a proper standard of conduct for AZA members during acquisition and disposition activities
- Ensure that animals from AZA member institutions are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them
- Support the goal of AZA's cooperatively managed populations and associated programs, including Species Survival Plans (SSPs), Population Management Plans (PMPs), and Taxon Advisory Groups (TAGs)

The AZA Acquisition/Disposition Policy will serve as the default policy for AZA member institutions. Institutions may develop their own A/D Policy in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and disposition standards.

Violations of the AZA Acquisition/Disposition Policy will be dealt with in accordance with the AZA Code of Professional Ethics. Violations can result in an institution's or individual's expulsion from membership in the AZA.

II. Group or Colony-based Identification: For some colonial, group-living, or prolific species, such as certain insects, aquatic invertebrates, schooling fish, rodents, and bats, it is often impossible or highly impractical to identify individual specimens. These species are therefore maintained, acquisitioned, and disposed of as a group or colony. Therefore, when this A/D Policy refers to animals or specimens, it is in reference to both individuals and groups/colonies.

III. Germplasm: Acquisition and disposition of germplasm should follow the same guidelines outlined in this document if its intended use is to create live animal(s). Ownership of germplasm and any resulting animals should be clearly defined. Institutions acquiring or dispositioning germplasm or any animal parts or samples should consider not only its current use, but also future possible uses as new technologies become available.

IV(a). General Acquisitions: Animals are to be acquisitioned into an AZA member institution's collection if the following conditions are met:

1. Acquisitions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all acquisitions.
3. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals.
4. Animals that are acquired for the collection, permanently or temporarily, must be listed on institutional records. All records should follow the Standards for Data Entry and Maintenance of North American Zoo and Aquarium Animal Records Databases®.
5. Animals may be acquired temporarily for reasons such as, holding for governmental agencies, rescue and/or rehabilitation, or special exhibits. Animals should only be accepted if they will not jeopardize the health, care or maintenance of the animals in the permanent collection or the animal being acquired.
6. The institution must have the necessary resources to support and provide for the professional care and management of a species, so that the physical and social needs of both specimen and species are met.
7. Attempts by members to circumvent AZA conservation programs in the acquisition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to acquire SSP species and adhere to the AZA Full Participation policy.
8. Animals are only to be acquired from sources that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this policy. Any convictions of state, federal, or international wildlife laws should be reviewed, as well as any previous dealings with other AZA-accredited institutions.
9. When acquiring specimens managed by a PMP, institutions should consult with the PMP manager.
10. Institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved Regional Collection Plans (RCPs) when making acquisition decisions.

IV(b). Acquisitions from the Wild: The maintenance of wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. To accomplish these goals, it may be necessary to acquire wild-caught specimens. Before acquiring animals from the wild, institutions are encouraged to examine sources including other AZA institutions or regional zoological associations.

When acquiring animals from the wild, careful consideration must be taken to evaluate the long-term impacts on the wild population. Any capture of free-ranging animals should be done in accordance with all local, state, federal, and international wildlife laws and regulations and not be detrimental to the long-term viability of the species or the wild or captive population(s). In crisis situations, when the survival of a population is at risk, rescue decisions are to be made on a case-by-case basis.

V(a). Disposition Requirements—living animals: Successful conservation and animal management efforts rely on the cooperation of many entities, both within and outside of AZA. While preference is given to placing animals within AZA member institutions, it is important to foster a cooperative culture among those who share the primary mission of AZA-accredited facilities. The AZA draws a strong distinction between the mission, stated or otherwise, of non-AZA member organizations and the mission of professionally managed zoological parks and aquariums accredited by the AZA.

An accredited AZA member balances public display, recreation, and entertainment with demonstrated efforts in education, conservation, and science. While some non-AZA member organizations may meet minimum daily standards of animal care for wildlife, the AZA recognizes that this, by itself, is insufficient to warrant either AZA membership or participation in AZA's cooperative animal management programs.

When an animal is sent to a non-member of AZA, it is imperative that the member be confident that the animal will be cared for properly.

Animals may only be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all dispositions.
3. Any disposition must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics. Specifically, "a member shall make every effort to assure that all animals in his/her collection and under his/her care are disposed of in a manner which meets the current disposition standards of the Association and do not find their way into the hands of those not qualified to care for them properly."
4. Non-domesticated animals shall not be disposed of at animal auctions. Additionally, animals shall not be disposed of to any organization or individual that may use or sell the animal at an animal auction. In transactions with AZA non-members, the recipient must ensure in writing that neither the animal nor its offspring will be disposed of at a wild animal auction or to an individual or organization that allows the hunting of the animal.
5. Animals shall not be disposed of to organizations or individuals that allow the hunting of these animals or their offspring. This does not apply to individuals or organizations which allow the hunting of only free-ranging game species (indigenous to North America) and established long-introduced species such as, but not limited to, white-tailed deer, quail, rabbit, waterfowl, boar, ring-necked pheasant, chukar, partridge, and trout. AZA distinguishes hunting/fishing for sport from culling for sustainable population management and wildlife conservation purposes.
6. Attempts by members to circumvent AZA conservation programs in the disposition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to deacquisition SSP species and adhere to the AZA Full Participation policy.
7. Domesticated animals are to be disposed of in a manner consistent with acceptable farm practices and subject to all relevant laws and regulations.
8. Live specimens may be released within native ranges, subject to all relevant laws and regulations. Releases may be a part of a recovery program and any release must be compatible with the AZA Guidelines for Reintroduction of Animals Born or Held in Captivity, dated June 3, 1992.
9. Detailed disposition records of all living or dead specimens must be maintained. Where applicable, proper animal identification techniques should be utilized.
10. It is the obligation of every loaning institution to monitor, at least annually, the conditions of any loaned specimens and the ability of the recipient to provide proper care. If the conditions and care of animals are in violation of the loan agreement, it is the obligation of the loaning institution to recall the animal. Furthermore, an institution's loaning policy must not be in conflict with this A/D Policy.
11. If live specimens are euthanized, it must be done in accordance with the established policy of the institution and the Report of the American Veterinary Medical Association Panel on Euthanasia (Journal of the American Veterinary Medical Association 218 (5): 669-696, 2001).
12. In dispositions to non-AZA members, the non-AZA member's mission (stated or implied) must not be in conflict with the mission of AZA, or with this A/D Policy.
13. In dispositions to non-AZA member facilities that are open to the public, the non-AZA member must balance public display, recreation, and entertainment with demonstrated efforts in conservation, education, and science.

14. In dispositions to non-AZA members, the AZA members must be convinced that the recipient has the expertise, records management practices, financial stability, facilities, and resources required to properly care for and maintain the animals and their offspring. It is recommended that this documentation be kept in the permanent record of the animals at the AZA member institution.
15. If living animals are sent to a non-AZA member research institution, the institution must be registered under the Animal Welfare Act by the U.S. Department of Agriculture Animal and Plant Health Inspection Service. For international transactions, the receiving facility should be registered by that country's equivalent body with enforcement over animal welfare.
16. No animal disposition should occur if it would create a health or safety risk (to the animal or humans) or have a negative impact on the conservation of the species.
17. Inherently dangerous wild animals or invasive species should not be dispositioned to the pet trade or those unqualified to care for them.
18. Under no circumstances should any primates be dispositioned to a private individual or to the pet trade.
19. Fish and aquatic invertebrate species that meet ANY of the following are inappropriate to be disposed of to private individuals or the pet trade:
    a. Species that grow too large to be housed in a 72-inch long, 180 gallon aquarium (the largest tank commonly sold in retail stores)
    b. Species that require extraordinary life support equipment to maintain an appropriate environment (e.g., cold water fish and invertebrates)
    c. Species deemed invasive (e.g., snakeheads)
    d. Species capable of inflicting a serious bite or venomous sting (e.g., piranha, lion fish, blue-ringed octopus)
    e. Species of wildlife conservation concern
20. When dispositioning specimens managed by a PMP, institutions should consult with the PMP manager.
21. Institutions should consult WCMC-approved RCPs when making disposition decisions.

V(b). Disposition Requirements—dead specimens: Dead specimens (including animal parts and samples) are only to be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions of dead specimens must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. Maximum utilization is to be made of the remains, which could include use in educational programs or exhibits.
3. Consideration is given to scientific projects that provide data for species management and/or conservation.
4. Records (including ownership information) are to be kept on all dispositions, including animal body parts, when possible.
5. SSP and TAG necropsy protocols are to be accommodated insofar as possible.

VI. Transaction Forms: AZA member institutions will develop transaction forms to record animal acquisitions and dispositions. These forms will require the potential recipient or provider to adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy, and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities.

Appendix C: Sample of an Animal Transaction Confirmation

This form is an example of an Animal Transaction Confirmation form. It may be used or adapted to meet your institutions needs. It is recommended that this form not be used as an invoice, but should be signed and returned prior to shipment of animals.

Animal Transaction Confirmation Form

[ ] sale [ ] donation [ ] trade [ ] loan Date:

TO: Any Zoo
20 Zoo Drive
Zoo City, NC

Lemur catta (ring-tailed lemur)
IA XXXX male (SB 3329) "Alexander" B: 18 March 2005. Transponder: XX-XXX-XXXX
IA XXXX female (SB 3448) "Fern" B: 25 April 2007. Transponder: XX-XXX-XXXX

The receiving party agrees that this transfer and any subsequent transfer of the animal(s) will be accomplished in accordance with the following conditions:

- Adherence to the AZA Code of Professional Ethics and institutional guidelines for the disposition of animals received.
- Specimen(s) will not be sold, traded, loaned or donated to, or used in an inhumane research program; will not be sold, traded, loaned or donated to any individual or organization which may use the specimen in an animal auction attended by the general public, or disposed of by the undersigned in any such auction; will not be sold, traded or otherwise transferred to any organization or individual known to abuse, neglect, hunt or otherwise mistreat animals.
- Specimen(s) will be housed, fed and maintained in a manner that will ensure its health and well-being.
- All paperwork and permits related to this transaction must be received by the Institution A prior to shipment. The offer for transactions involving endangered or threatened species is contingent upon receipt of appropriate permits.
- This transaction can be terminated by either party by written notice prior to shipment.

_____	_____
Accepted By	Consignor/Consignee
_____	_____
Print name	Print name
_____	_____
Title	Title
_____	_____

Appendix D. Sample of an Animal Loan Agreement

This form is an example of an Animal Loan Agreement. It may be used or adapted to meet your institution's needs.

Animal Loan Agreement
Between Institution A and Any Zoo

Whereas, the **Institutions A**, herein called the **IA**, is interested in the propagation and preservation of wildlife, and

Whereas, **Any Zoo**, herein called **AZ,** is interested in the propagation and preservation of wildlife;

Therefore, both parties do hereby enter into an agreement defined by the terms listed below, regarding the following specimens:

***Eulemur mongoz* (mongoose lemur)**
IA XXXX (SB1XXX) "Felipe" B: 11 April, 1996, Transponder: XXX-XXXX-XXXXX

1. AZ has received the above-mentioned specimen(s) for the purposes of: **SSP mandated breeding**
2. AZ agrees to provide necessary housing, food, and veterinary care for the specimen(s) in accordance with Animal Welfare Act regulations. In the event of serious injury, illness, or death of the specimen, AZ will promptly inform the IA of the condition and consult with them.
3. AZ agrees to follow (to the very best of its ability) any special housing, husbandry, breeding, parturition and veterinary guidelines as provided by the DLC for this species' care and management, and to consult with IA in the case of any constraints in following guidelines.
4. In the case of a loan for propagation, AZ will attempt to breed the specimen(s) and any viable young produced by such breeding and born during the term of this agreement, or within a period after termination of this agreement measured by the normal gestation length of the species, will be divided between AZ and the IA according to the following terms:
   - **Holding institution (AZ) will own 1st, 3rd, 5th, etc. viable offspring, regardless of sex**
   - **Owner of sire (IA) will own 2nd, 4th, 6th etc. viable offspring regardless of sex (viable = surviving for longer than 30 days)**
5. In the case of a loan for display, AZ agrees not to breed the specimen(s) without prior consultation with and approval from the IA.
6. In the event of termination of this agreement, transportation of the specimen to the IA shall be borne by the party requesting termination of the loan.
7. AZ agrees to provide the IA with a written report at the end of each calendar year which lists the status of the specimen covered by this agreement, the number of young born during the previous year, and the number of specimens that died along with the cause of death.
8. For any research project in which the specimen may be subjected to manipulation, stress or high risk procedures (i.e., any research which is not purely observational), permission must first be obtained, in writing, from the IA Research Coordinator.
9. In the event of the specimen's death, the carcass and its parts remain property of the IA. The IA Research Coordinator should be contacted as soon as possible after death. The final disposition of the carcass and parts will be the decision of the IA.
10. This agreement shall remain in effect for the lifetime of the specimens, unless one of the parties terminates the agreement by giving the other party 60 days written notice.

11. This agreement may be amended or modified in writing by the mutual consent of both parties hereto. Such amendments shall be incorporated into this agreement as an addendum.
12. Neither this agreement nor any rights or privileges granted hereunder shall be assigned to a third party without the prior written consent of both parties.
13. IA agrees that in the event of disease, injury, or death of any animal, AZ and its employees or volunteers shall not be responsible to IA, unless the disease, injury, or death was the result of negligence or intentional acts of AZ or its employees or volunteers. The IA hereby waives any claim of any kind against AZ.
14. AZ agrees to indemnify and hold Institution A harmless from any liability for personal injury or property damage resulting from any accident, escape of the loaned specimens, aggressive behavior of the specimens or any other mishap occurring during the period that the specimens are on loan to AZ.

FOR: Institution A

Signature: _____

Name (print): _____

Title: _____ Date: _____

FOR: Any Zoo

Signature: _____

Name (print): _____

Title: _____ Date: _____

Appendix E. Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a 70 °C (-94 °F) frost-free freezer or a 20 °C (-4 °F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for *Eulemur*:

Eulemur:

Required:

1. Direct and floatation fecals
2. Vaccinate as appropriate

Strongly recommended:

1. CBC/sera profile
2. Urinalysis
3. Appropriate serology (FIP, FeLV, FIV)
4. Heartworm testing in appropriate species

Appendix F: Program Animal Policy and Position Statement

Program Animal Policy

Originally approved by the AZA Board of Directors—2003
Updated and approved by the Board—July 2008 & June 2011

The Association of Zoos & Aquariums (AZA) recognizes many benefits for public education and, ultimately, for conservation in program animal presentations. AZA's Conservation Education Committee's *Program Animal Position Statement* summarizes the value of program animal presentations (see pages 42–44).

For the purpose of this policy, a Program Animal is defined as "an animal whose role includes handling and/or training by staff or volunteers for interaction with the public and in support of institutional education and conservation goals." Some animals are designated as Program Animals on a full-time basis, while others are designated as such only occasionally. Program Animal-related Accreditation Standards are applicable to all animals during the times that they are designated as Program Animals.

There are three main categories of Program Animal interactions:

1. On Grounds with the Program Animal Inside the Exhibit/Enclosure:
    a. Public access outside the exhibit/enclosure. Public may interact with animals from outside the exhibit/enclosure (e.g., giraffe feeding, touch tanks).
    b. Public access inside the exhibit/enclosure. Public may interact with animals from inside the exhibit/enclosure (e.g., lorikeet feedings, 'swim with' programs, camel/pony rides).
2. On Grounds with the Program Animal Outside the Exhibit/Enclosure:
    a. Minimal handling and training techniques are used to present Program Animals to the public. Public has minimal or no opportunity to directly interact with Program Animals when they are outside the exhibit/enclosure (e.g., raptors on the glove, reptiles held "presentation style").
    b. Moderate handling and training techniques are used to present Program Animals to the public. Public may be in close proximity to, or have direct contact with, Program Animals when they're outside the exhibit/enclosure (e.g., media, fund raising, photo, and/or touch opportunities).
    c. Significant handling and training techniques are used to present Program Animals to the public. Public may have direct contact with Program Animals or simply observe the in-depth presentations when they're outside the exhibit/enclosure (e.g., wildlife education shows).
3. Off Grounds:
    a. Handling and training techniques are used to present Program Animals to the public outside of the zoo/aquarium grounds. Public may have minimal contact or be in close proximity to and have direct contact with Program Animals (e.g., animals transported to schools, media, fund raising events).

These categories assist staff and accreditation inspectors in determining when animals are designated as Program Animals and the periods during which the Program Animal-related Accreditation Standards are applicable. In addition, these Program Animal categories establish a framework for understanding increasing degrees of an animal's involvement in Program Animal activities.

Program animal presentations bring a host of responsibilities, including the safety and welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that make program animal presentations to develop an institutional program animal policy that clearly identifies and justifies those species and individuals approved as program animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that education and conservation messages must be an integral component of all program animal presentations. In addition, the accreditation standards require that the

conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, appropriate environmental enrichment, access to veterinary care, nutrition, and other related standards. In addition, providing program animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, free-flight birds may receive appropriate exercise during regular programs, reducing the need for additional exercise. However, the institution must ensure that in such cases, the animals participate in programs on a basis sufficient to meet these needs or provide for their needs in their home enclosures; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

Program Animal Position Statement

Last revision 1/28/03
Re-authorized by the Board June 2011

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of program animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective (emotional) messages about conservation, wildlife and animal welfare.
Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of program animals has been demonstrated to result in lengthened learning periods, increased knowledge acquisition and retention, enhanced environmental attitudes, and the creation of positive perceptions concerning zoo and aquarium animals.

Audience Engagement
Zoos and aquariums are ideal venues for developing emotional ties to wildlife and fostering an appreciation for the natural world. However, developing and delivering effective educational messages in the free-choice learning environments of zoos and aquariums is a difficult task.
Zoo and aquarium educators are constantly challenged to develop methods for engaging and teaching visitors who often view a trip to the zoo as a social or recreational experience (Morgan & Hodgkinson, 1999). The use of program animals can provide the compelling experience necessary to attract and maintain personal connections with visitors of all motivations, thus preparing them for learning and reflection on their own relationships with nature.

Program animals are powerful catalysts for learning for a variety of reasons. They are generally active, easily viewed, and usually presented in close proximity to the public. These factors have proven to contribute to increasing the length of time that people spend watching animals in zoo exhibits (Bitgood, Patterson & Benefield, 1986, 1988; Wolf & Tymitz, 1981).

In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey, 2002; Povey & Rios, 2001), visitors viewed animals three and four times longer while they were being presented in demonstrations outside of their enclosure with an educator than while they were on exhibit. Clearly, the use of program animals in shows or informal presentations can be effective in lengthening the potential time period for learning and overall impact.

Program animals also provide the opportunity to personalize the learning experience, tailoring the teaching session to what interests the visitors. Traditional graphics offer little opportunity for this level of personalization of information delivery and are frequently not read by visitors (Churchman, 1985; Johnston, 1998). For example, Povey (2001) found that only 25% of visitors to an animal exhibit read the accompanying graphic; whereas, 45% of visitors watching the same animal handled in an educational presentation asked at least one question and some asked as many as seven questions. Having an animal accompany the educator allowed the visitors to make specific inquiries about topics in which they were interested.

Knowledge Acquisition
Improving our visitors' knowledge and understanding regarding wildlife and wildlife conservation is a fundamental goal for many zoo educators using program animals. A growing body of evidence supports the validity of using program animals to enhance delivery of these cognitive messages as well.

- MacMillen (1994) found that the use of live animals in a zoomobile outreach program significantly enhanced cognitive learning in a vertebrate classification unit for sixth grade students.
- Sherwood and his colleagues (1989) compared the use of live horseshoe crabs and sea stars to the use of dried specimens in an aquarium education program and demonstrated that students made the greatest cognitive gains when exposed to programs utilizing the live animals.
- Povey and Rios (2002) noted that in response to an open-ended survey question ("Before I saw this animal, I never realized that . . . "), visitors watching a presentation utilizing a program animal provided 69% cognitive responses (i.e., something they learned) versus 9% made by visitors viewing the same animal in its exhibit (who primarily responded with observations).
- Povey (2002) recorded a marked difference in learning between visitors observing animals on exhibit versus being handled during informal presentations. Visitors to demonstrations utilizing a raven and radiated tortoises were able to answer questions correctly at a rate as much as eleven times higher than visitors to the exhibits.

Enhanced Environmental Attitudes

Program animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991), and Davison and her colleagues (1993) evaluated the effect live animal shows had on visitor attitudes. Both found their shows successfully influenced attitudes about conservation and stewardship.
- Yerke and Burns (1993) also evaluated a live bird outreach program presented to Oregon fifth-graders and recorded a significant increase in students' environmental attitudes after the presentations.
- Sherwood and his colleagues (1989) found that students who handled live invertebrates in an education program demonstrated both short and long-term attitudinal changes as compared to those who only had exposure to dried specimens.
- Povey and Rios (2002) examined the role program animals play in helping visitors develop positive feelings about the care and well-being of zoo animals.
- As observed by Wolf and Tymitz (1981), zoo visitors are deeply concerned with the welfare of zoo animals and desire evidence that they receive personalized care.

Conclusion

Creating positive impressions of aquarium and zoo animals, and wildlife in general, is crucial to the fundamental mission of zoological institutions. Although additional research will help us delve further into this area, the existing research supports the conclusion that program animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

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Appendix G: Developing an Institutional Program Animal Policy

Last revision 2003
Re-authorized by the Board, June 2011

Rationale

Membership in AZA requires that an institution meet the AZA Accreditation Standards collectively developed by our professional colleagues. Standards guide all aspects of an institution's operations; however, the accreditation commission has asserted that ensuring that member institutions demonstrate the highest standards of animal care is a top priority. Another fundamental AZA criterion for membership is that education be affirmed as core to an institution's mission. All accredited public institutions are expected to develop a written education plan and to regularly evaluate program effectiveness.

The inclusion of animals (native, exotic, and domestic) in educational presentations, when done correctly, is a powerful tool. CEC's **Program Animal Position Statement** describes the research underpinning the appropriate use of program animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective messages about conservation and wildlife.

Ongoing research, such as AZA's Multi-Institutional Research Project (MIRP) and research conducted by individual AZA institutions will help zoo educators to determine whether the use of program animals conveys intended and/or conflicting messages and to modify and improve programs accordingly and to ensure that all program animals have the best possible welfare.

When utilizing program animals our responsibility is to meet both our high standards of animal care and our educational goals. Additionally, as animal management professionals, we must critically address both the species' conservation needs and the welfare of the individual animal. Because "wild creatures differ endlessly," in their forms, needs, behavior, limitations and abilities (Conway, 1995), AZA, through its Animal Welfare Committee, has recently given the responsibility to develop taxon- and species-specific animal welfare standards and guidelines to the Taxon Advisory Groups (TAG) and Species Survival Plan® Program (SSP). Experts within each TAG or SSP, along with their education advisors, are charged with assessing all aspects of the taxons' and/or species' biological and social needs and developing Animal Care Manuals (ACMs) that include specifications concerning their use as program animals.

However, even the most exacting standards cannot address the individual choices faced by each AZA institution. Therefore, each institution is required to develop a program animal policy that articulates and evaluates program benefits. The following recommendations are offered to assist each institution in formulating its own Institutional Program Animal Policy, which incorporates the AZA Program Animal Policy and addresses the following matters.

The Policy Development Process

Within each institution, key stakeholders should be included in the development of that institution's policy, including, but not limited to representatives from:

- The Education Department
- The Animal Husbandry Department
- The Veterinary and Animal Health Department
- The Conservation & Science Department
- The Behavioral Husbandry Department
- Any animal show staff (if in a separate department)
- Departments that frequently request special program animal situations (e.g., special events, development, marketing, zoo or aquarium society, administration)

Additionally, staff from all levels of the organization should be involved in this development (e.g., curators, keepers, education managers, interpreters, volunteer coordinators).

To develop a comprehensive Program Animal Policy, we recommend that the following components be included:

I. Philosophy

In general, the position of the AZA is that the use of animals in up close and personal settings, including animal contact, can be extremely positive and powerful, as long as:

1. The use and setting is appropriate.
2. Animal and human welfare is considered at all times.
3. The animal is used in a respectful, safe manner and in a manner that does not misrepresent or degrade the animal.
4. A meaningful conservation message is an integral component. Read the AZA Board-approved Conservation Messages.
5. Suitable species and individual specimens are used.

Institutional program animal policies should include a philosophical statement addressing the above, and should relate the use of program animals to the institution's overall mission statement.

II. Appropriate Settings

The Program Animal Policy should include a listing of all settings both on and off site, where program animal use is permitted. This will clearly vary among institutions. Each institution's policy should include a comprehensive list of settings specific to that institution. Some institutions may have separate policies for each setting; others may address the various settings within the same policy. Examples of settings include:

1. On-site programming
    a. Informal and non-registrants:
        i. On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
        ii. Children's zoos and contact yards
        iii. Behind-the-scenes open houses
        iv. Shows
        v. Touch pools
    b. Formal (registration involved) and controlled settings
        i. School group programs
        i. Summer camps
        ii. Overnights
        iii. Birthday parties
        iv. Animal rides
        v. Public animal feeding programs
    c. Offsite and outreach
        i. PR events (TV, radio)
        ii. Fundraising events
        iii. Field programs involving the public
        iv. School visits
        v. Library visits
        vi. Nursing home visits (therapy)
        vii. Hospital visits
        viii. Senior centers
        ix. Civic group events

In some cases, policies will differ from setting to setting (e.g., on-site and off-site use with media). These settings should be addressed separately, and should reflect specific animal health issues, assessment of distress in these situations, limitations, and restrictions.

III. Compliance with Regulations

All AZA institutions housing mammals are regulated by the USDA's Animal Welfare Act. Other federal regulations, such as the Marine Mammal Protection Act, may apply. Additionally, many states, and some cities, have regulations that apply to animal contact situations. Similarly, all accredited institutions are bound by the AZA Code of Professional Ethics. It is expected that the Institution Program Animal Policy address compliance with appropriate regulations and AZA Accreditation Standards.

IV. Collection Planning

AZA accredited institutions should have a collection planning process in place. Program animals are part of an institution's overall collection and must be included in the overall collection planning process. The AZA Guide to Accreditation contains specific requirements for the institution collection plan. For more information about collection planning in general, please see the Collection Management pages in the Members Only section.

The following recommendations apply to program animals:

1. Listing of approved program animals (to be periodically amended as collection changes). Justification of each species should be based upon criteria such as:
    a. Temperament and suitability for program use
    b. Husbandry requirements
    c. Husbandry expertise
    d. Veterinary issues and concerns
    e. Ease and means of acquisition / disposition according to the AZA code of ethics
    f. Educational value and intended conservation message
    g. Conservation Status
    h. Compliance with TAG and SSP guidelines and policies
2. General guidelines as to how each species (and, where necessary, for each individual) will be presented to the public, and in what settings
3. The collection planning section should reference the institution's acquisition and disposition policies.

V. Conservation Education Message

As noted in the AZA Accreditation Standards, if animal demonstrations are part of an institution's programs, an educational and conservation message must be an integral component. The Program Animal Policy should address the specific messages related to the use of program animals, as well as the need to be cautious about hidden or conflicting messages (e.g., "petting" an animal while stating verbally that it makes a poor pet). This section may include or reference the AZA Conservation Messages.

Although education value and messages should be part of the general collection planning process, this aspect is so critical to the use of program animals that it deserves additional attention. In addition, it is highly recommended to encourage the use of biofacts in addition to or in place of the live animals. Whenever possible, evaluation of the effectiveness of presenting program animals should be built into education programs.

VI. Human Health and Safety

The safety of our staff and the public is one of the greatest concerns in working with program animals. Although extremely valuable as educational and affective experiences, contact with animals poses certain risks to the handler and the public. Therefore, the human health and safety section of the policy should address:

1. Minimization of the possibility of disease transfer from non-human animals to humans, and vice-versa (e.g., hand washing stations, no touch policies, use of hand sanitizer).
2. Safety issues related to handlers' personal attire and behavior (e.g., discourage or prohibit use of long earrings, perfume and cologne, not eating or drinking around animals, smoking, etc.).

AZA's Animal Contact Policy provides guidelines in this area; these guidelines were incorporated into accreditation standards in 1998.

VII. Animal Health and Welfare

Animal health and welfare are the highest priority of AZA accredited institutions. As a result, the Institutional Program Animal Policy should make a strong statement on the importance of animal welfare. The policy should address:

1. General housing, husbandry, and animal health concerns (e.g. that the housing and husbandry for program animals meets or exceeds general AZA standards and that the physical, social and psychological needs of the individual animal, such as adequate rest periods, provision of enrichment, visual cover, contact with conspecifics as appropriate, etc., are accommodated).

2. Where ever possible provide a choice for animal program participation, e.g., retreat areas for touch tanks or contact yards, evaluation of willingness/readiness to participate by handler, etc.)
3. The empowerment of handlers to make decisions related to animal health and welfare; such as withdrawing animals from a situation if safety or health is in danger of being compromised.
4. Requirements for supervision of contact areas and touch tanks by trained staff and volunteers.
5. Frequent evaluation of human / animal interactions to assess safety, health, welfare, etc.
6. Ensure that the level of health care for the program animals is consistent with that of other animals in the collection.
7. Whenever possible have a "cradle to grave" plan for each program animal to ensure that the animal can be taken care of properly when not used as a program animal anymore.
8. If lengthy "down" times in program animal use occur, staff should ensure that animals accustomed to regular human interactions can still maintain such contact and receive the same level of care when not used in programs.

VIII. Taxon Specific Protocols

We encourage institutions to provide taxonomically specific protocols, either at the genus or species level, or the specimen, or individual, level. Some taxon-specific guidelines may affect the use of program animals. To develop these, institutions refer to the Conservation Programs Database.

Taxon and species -specific protocols should address:

1. How to remove the individual animal from and return it to its permanent enclosure, including suggestions for operant conditioning training.
2. How to crate and transport animals.
3. Signs of stress, stress factors, distress and discomfort behaviors.

Situation specific handling protocols (e.g., whether or not animal is allowed to be touched by the public, and how to handle in such situations):

1. Guidelines for disinfecting surfaces, transport carriers, enclosures, etc. using environmentally safe chemicals and cleaners where possible.
2. Animal facts and conservation information.
3. Limitations and restrictions regarding ambient temperatures and or weather conditions.
4. Time limitations (including animal rotation and rest periods, as appropriate, duration of time each animal can participate, and restrictions on travel distances).
5. The number of trained personnel required to ensure the health and welfare of the animals, handlers and public.
6. The level of training and experience required for handling this species
7. Taxon/species-specific guidelines on animal health.
8. The use of hand lotions by program participants that might touch the animals

IX. Logistics: Managing the Program

The Institutional Policy should address a number of logistical issues related to program animals, including:

1. Where and how the program animal collection will be housed, including any quarantine and separation for animals used off-site.
2. Procedures for requesting animals, including the approval process and decision-making process.
3. Accurate documentation and availability of records, including procedures for documenting animal usage, animal behavior, and any other concerns that arise.

X. Staff Training

Thorough training for all handling staff (keepers, educators, and volunteers, and docents) is clearly critical. Staff training is such a large issue that many institutions may have separate training protocols and procedures. Specific training protocols can be included in the Institutional Program Animal Policy or reference can be made that a separate training protocol exists.

It is recommended that the training section of the policy address:

1. Personnel authorized to handle and present animals.

2. Handling protocol during quarantine.
3. The process for training, qualifying and assessing handlers including who is authorized to train handlers.
4. The frequency of required re-training sessions for handlers.
5. Personnel authorized to train animals and training protocols.
6. The process for addressing substandard performance and noncompliance with established procedures.
7. Medical testing and vaccinations required for handlers (e.g., TB testing, tetanus shots, rabies vaccinations, routine fecal cultures, physical exams, etc.).
8. Training content (e.g., taxonomically specific protocols, natural history, relevant conservation education messages, presentation techniques, interpretive techniques, etc.).
9. Protocols to reduce disease transmission (e.g., zoonotic disease transmission, proper hygiene and hand washing requirements, as noted in AZA's Animal Contact Policy).
10. Procedures for reporting injuries to the animals, handling personnel or public.
11. Visitor management (e.g., ensuring visitors interact appropriately with animals, do not eat or drink around the animal, etc.).

XI. Review of Institutional Policies

All policies should be reviewed regularly. Accountability and ramifications of policy violations should be addressed as well (e.g., retraining, revocation of handling privileges, etc.). Institutional policies should address how frequently the Program Animal Policy will be reviewed and revised, and how accountability will be maintained.

XII. TAG and SSP Recommendations

Following development of taxon-specific recommendations from each TAG and SSP, the institution policy should include a statement regarding compliance with these recommendations. If the institution chooses not to follow these specific recommendations, a brief statement providing rationale is recommended.

Appendix H: *Eulemur* Enclosure Dimensions

Summary of exhibit dimensions of some *Eulemur* holding institutions from 2008 (measurements are listed in feet)

Institution	Holding (H), Indoor exhibit (I) Outdoor exhibit (O)	Length/ width/ height	Cubic feet	Species held[1]	No. of individuals	Notes
Institution E	H	12/12/10	1440	1, 10	3	
Institution E	O	30/30/18	16200	1, 10	3	Open top
Institution C	H	24/10/10	2400	1, 10	7	
Institution C	O	24/10/10	2400	1, 10	7	
Institution C	H	8/10/10	800	3, 9	8	5 connecting stalls
Institution C	H	7/12/10	840	3, 9	8	5 connecting stalls
Institution C	H	5/8/10	400	3, 9	8	5 connecting stalls
Institution C	H	8/8/10	640	3, 9	8	5 connecting stalls
Institution C	H	5/8/10	400	3, 9	8	5 connecting stalls
Institution C	O	60/25/20	30000	3, 9	8	
Institution C	H	12/12/10	1440	2, 10	8	3 connecting stalls
Institution C	H	14/14/10	1960	2, 10	8	3 connecting stalls
Institution C	H	12/8/10	960	2, 10	8	3 connecting stalls
Institution C	O	20/20/18	7200	2, 10	8	Open top
Institution G	H	12/5/8	480	4, 8, 10	9	Other bird and mammal species
Institution G	O	100/30/20	60000	4, 8, 10	9	Other bird and mammal species
Institution H	O	15/8/6	720	5	2	
Institution I	O			7, 9, 10	8	8 acres
Institution I	I	10/10/8	800	9	2	
Institution I	O	20/20/7	2800	9	2	
Institution I	I	10/10/8	800	9	3	
Institution I	O	20/20/7	2800	9	3	
Institution I	I	10/10/8	800	5	2	
Institution I	O	20/20/7	2800	5	2	
Institution I	I	10/10/8	800	6	3	
Institution I	O	20/20/7	2800	6	3	
Institution I	I	7/7/8	392	5	2	
Institution I	O	10/10/7	700	5	2	
Institution I	I	7/7/8	392	5	2	
Institution I	O	10/10/7	700	5	2	
Institution I	I	7/7/8	392	6 hybrid	2	
Institution I	O	10/10/7	700	6 hybrid	2	
Institution J	I	11.5/9/14.5	1500.75	3	2	
Institution J	I	14/9/14.5	1827	5	2	
Institution J	I	12/9/14.5	1566	1	2	
Institution K	H	5/5/8	200	4, 8, 10	9	
Institution K	O	50/20/18	18000	4, 8, 10	9	Open top
Institution L	H	5/3.5/8	140	3	2	
Institution L	I	30/20/20	12000	3	2	
Institution M	H	33/6.5/12	2574	3, 4, 9, 10	8	
Institution M	O	47/61/20	57340	3, 4, 9, 10	8	
Institution N	H	8/6/8	384	1	2	

Institution	Holding (H), Indoor exhibit (I) Outdoor exhibit (O)	Length/ width/ height	Cubic feet	Species held[1]	No. of individuals	Notes
Institution N	O	45/25/15	16875	1, 8, 10	7	
Institution O	H	12/12/8	1152	2, 8, 9, 10	14	
Institution O	I	20/8/8	1280	2, 8, 9, 10	14	
Institution O	O	200/100/18	360000	2, 8, 9, 10	14	Open top
Institution O	H	12/12/8	1152	2, 10	5	
Institution O	O	12/12/10	1440	2, 10	5	
Institution P	H	14/16/12	2688	5	3	
Institution P	O	51/35/25	44625	5, 9	5	
Institution Q	H	8/4/6	192	5	2	
Institution Q	I	10.7/11.2/ 10.5	1269.84	5	2	
Institution R	H	15/10/8	1200	1	3	
Institution R	I	15/8/10	1200	1	3	
Institution R	O	100/100/18	180000	1	3	Open top
Institution S	H	10/4.5/7.5	337.5	1	2	
Institution S	O	18/20/12	4320	1	2	
Institution T	H	10/12/8	960	5, 10	3	
Institution T	I	54/24/48	139968	5, 10	3	Other bird and mammal species
Institution U	I	20/10/8	1600	2	3	
Institution U	O	15/10/12	1800	2	3	
Institution V	H	16/5/10	800	6, 10	8	
Institution V	I	22/12/10	2640	6, 10	8	
Institution V	O	86/49/18	75852	6, 10	8	Open top
Institution V	H	9/6/13	702	5	2	
Institution V	I	17/12/10.5	2142	5	2	
Institution W	H	25/12/8	2400	4, 5, 10	7	
Institution W	I	24/22/8	4224	4, 5, 10	7	
Institution W	O	22/12/12	3168	4, 5, 10	7	
Institution X	H	12/12/7	1008	4, 8	5	
Institution X	I	19.5/10.5/7	1433.25	4, 8	5	
Institution X	O	71.5/18/18	23166	4, 8	5	Open top
Institution Y	H	12/6/6	432	3	2	
Institution Y	I	20/13/25	6500	3	2	

[1] *E. collaris* (1); *E. coronatus* (2); *E. m. flavifrons* (3); *E. m. macaco* (4); *E. mongoz* (5); *E. fulvus* (6); *E. sanfordi* (7); *V. variegata* (8); *V. rubra* (9); *L. catta* (10)