

**PROCYONID**  
*(Procyonidae)*  
**CARE MANUAL**

CREATED BY THE  
**AZA Small Carnivore Taxon Advisory Group**  
IN ASSOCIATION WITH THE  
**AZA Animal Welfare Committee**

## **Procyonid (Procyonidae) Care Manual**

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

## Table of Contents

<b>Introduction .....</b>	<b>5</b>
Taxonomic Classification .....	5
Genus, Species, and Status .....	5
General Information .....	5
<b>Chapter 1. Ambient Environment .....</b>	<b>9</b>
1.1 Temperature and Humidity .....	9
1.2 Light .....	9
1.3 Water and Air Quality .....	10
1.4 Sound and Vibration .....	10
<b>Chapter 2. Habitat Design and Containment .....</b>	<b>11</b>
2.1 Space and Complexity .....	11
2.2 Safety and Containment .....	14
<b>Chapter 3. Transport .....</b>	<b>17</b>
3.1 Preparations .....	17
3.2 Protocols .....	17
<b>Chapter 4. Social Environment.....</b>	<b>19</b>
4.1 Group Structure and Size .....	19
4.2 Influence of Other Species and Conspecifics .....	20
4.3 Introductions and Reintroductions .....	21
<b>Chapter 5. Nutrition .....</b>	<b>23</b>
5.1 Nutritional Requirements.....	23
5.2 Diets .....	26
5.3 Nutritional Evaluations.....	31
<b>Chapter 6. Veterinary Care .....</b>	<b>33</b>
6.1 Veterinary Services.....	33
6.2 Identification Methods.....	35
6.3 Transfer Examination and Diagnostic Testing Recommendations.....	35
6.4 Quarantine.....	35
6.5 Preventive Medicine.....	37
6.6 Capture, Restraint, and Immobilization.....	41
6.7 Management of Diseases, Disorders, Injuries and/or Isolation.....	42
<b>Chapter 7. Reproduction.....</b>	<b>47</b>
7.1 Reproductive Physiology and Behavior .....	47
7.2 Assisted Reproductive Technology .....	49
7.3 Pregnancy and Parturition .....	49
7.4 Birthing Facilities .....	51
7.5 Assisted Rearing .....	51
7.6 Contraception.....	55
<b>Chapter 8. Behavior Management .....</b>	<b>57</b>
8.1 Animal Training.....	57
8.2 Environmental Enrichment.....	58
8.3 Staff and Animal Interactions .....	61
8.4 Staff Skills and Training.....	62
<b>Chapter 9. Program Animals.....</b>	<b>64</b>
9.1 Program Animal Policy .....	64

9.2 Institutional Program Animal Plans..... 64

9.3 Program Evaluation ..... 67

**Chapter 10. Research..... 68**

10.1 Known Methodologies ..... 68

10.2 Future Research Needs..... 69

**Acknowledgements ..... 71**

**References..... 72**

**Appendix A: Accreditation Standards by Chapter..... 78**

**Appendix B: Acquisition/Disposition Policy..... 81**

**Appendix C: Recommended Quarantine Procedures ..... 85**

**Appendix D: Program Animal Policy and Position Statement..... 87**

**Appendix F: Description of Nutrients (U.S. National Library of Medicine)..... 96**

**Appendix G: Small Carnivore Medical Management Guidelines..... 99**

**Appendix H: Commonly Trained Behaviors for Procyonids (AAZK, Inc.) ..... 105**

**Appendix I: Resources for Enrichment and Training..... 106**

**Appendix J: Sample Procyonid Enrichment Items and Techniques..... 109**

**Appendix K: Reproduction in the Kinkajou (*Potos flavus*)..... 111**

**Appendix L: Significant Contributors to Procyonid Care Manual ..... 113**

**Appendix M: AZA Small Carnivore TAG Necropsy Protocol and Forms ..... 114**

## Introduction

### Preamble

Association of Zoos & Aquariums (AZA) accredited institutions are required to comply with all relevant local, state, and federal wildlife laws and regulations in addition to all AZA accreditation standards.

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 ([www.aza.org](http://www.aza.org)) which might not be included in this manual.

### Taxonomic Classification

Table 1: Taxonomic classification for Procyonidae

Classification	Taxonomy	Additional information
Kingdom	Animalia	
Phylum	Chordata	
Class	Mammalia	
Order	Carnivora	
Suborder	Caniformia	
Family	Procyonidae	
Subfamily	Potosinae	Kinkajou & olingo
	Procyoninae	Raccoon, coati, cacomistle, ringtail

### Genus, Species, and Status

Table 2: Genus, species, and status information for Procyonid species recommended for management by the AZA SCTAG (AZA SCTAG RCP 2009).

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
<i>Potos</i>	<i>flavus</i>	Kinkajou	Not Listed	Least Concern	PMP
<i>Bassariscus</i>	<i>astutus</i>	Ringtail	Not Listed	Least Concern	PMP
<i>Nasua</i>	<i>narica</i>	White-nosed coati	Not Listed	Least Concern	PMP
<i>Procyon</i>	<i>lotor</i>	Raccoon	Not Listed	Least Concern	DERP

### 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), 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* procyonid populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for procyonids 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 procyonids management and care, which will ensure superior procyonids welfare at AZA-accredited institutions. Ultimately, success in our procyonids management and care will allow AZA-accredited institutions to contribute to procyonids conservation, and ensure that procyonids are in our future for generations to come.

#### AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state, and federal wildlife laws and regulations. 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.

**Taxa Specific Terminology:** A young raccoon is called a “kit” or “cub;” multiple young are sometimes referred to as “kittens.” Dictionary searches turn up no standard listings for kinkajou or coati.

**Regulatory Agencies:** All state and federal regulations should be followed regarding the care and transportation of these species. Institutional Registrars and curators should consult these fish and wildlife agencies annually for any changes in pertinent regulations. Ringtails are considered a fur-bearer species; therefore they fall under the jurisdiction of state fish and wildlife agencies if taken from the wild.

**List of Species:** Olingo species: *Bassaricyon alleni*, *B. beddardi*, *B. gabbi*, *B. lasius*, *B. pauli*; Ringtail (*Bassariscus astutus*), Cacomistle (*B. sumichrasti*); Brown-nosed or Ring tailed coati (*Nasua nasua*), White-nosed coati (*Nasua narica*), Island coati (*Nasua nelsoni*), Mountain coati (*Nasuella olivacea*); Kinkajou (*Potos flavus*); Raccoon species: Crab-eating raccoon (*Procyon cancrivorus*), Common raccoon (*P. lotor*), Cozumel/Pygmy raccoon (*P. pygmaeus*).

**Taxonomy:** Six procyonid genera (IUCN 1995) are currently recognized (see below); the number depends on where the *Ailuridae* are placed. The genera are: *Bassaricyon* (five species); *Bassariscus* (two species; *Jentinkia* is now included with *Bassariscus*); *Nasua* (three species); *Nasuella* (one species), *Potos* (one species) and *Procyon* (three species); the *Ailuridae* are no longer considered to be a subfamily of *Procyonidae* and are dealt with in a separate document. All procyonids have a nearctic or neotropical distribution (Roberts 1997).

**Morphology, Ecology, and Natural History:** The morphological characteristics uniting procyonids relate primarily to adaptations for the location (sensory, anatomy, and physiology), capture (limb morphology) and processing (dentary and masticatory anatomy) of food. The most significant common adaptations, reduction in size and carnassialization of premolars and modifications of the molars for crushing and chewing, are the consequence of a primarily frugivorous/omnivorous diet (Roberts 1997).

Procyonids are diverse in their ecology and behavior and are found in such diverse New World habitats as North American temperate boreal forests (raccoon), neotropical rain forests (coati, kinkajou, olingo, and raccoon) and semi-arid North and South American scrub forest habitats montane forests (coati, kinkajou, olingo), and montane grasslands (coati) (Rodríguez-Bolanos et al. 2000). Locomotory adaptations are similarly varied. Some species are essentially terrestrial (coati and raccoon), others arboreal (kinkajou and olingo) and still others scansorial (ringtail and cacomistle). Coatis and raccoons also spend a great deal of time in trees. Social organizations run the gamut ranging from gregarious (coati females) to sometimes semi-gregarious (ringtail, cacomistle, and kinkajou) and solitary (raccoon, ringtail, cacomistle, and kinkajou - the latter three are considered to be primarily solitary). Some species exhibit mixed social systems (coati) and there appears to be considerable intra-specific social plasticity as well (Roberts 1997).

Clearly, procyonids are an ecologically, morphologically, and behaviorally complex group about which few gross generalizations can be made. However, there is some commonality in their feeding ecology as most are omnivorous. As might be expected, the range of foods eaten and the means by which they are procured differ considerably among genera. Raccoons forage for invertebrates and small vertebrates along small bodies of water. Ringtails, cacomistles, and kinkajous are largely arboreal. Ringtails and cacomistles search for small vertebrates. Kinkajous search for fruit in the trees. Coatis forage for invertebrates, small vertebrates, eggs, and fruit on the forest floor and in trees. Anatomical and behavioral adaptations for finding and processing food can be quite specialized in some species. For example, kinkajous possess extremely long, protrusible tongues, presumably for the obtaining of food items in crevices, and a prehensile tail that permits terminal branch feeding. Raccoons have highly prehensile forepaws that are used to search for, manipulate, and capture prey that cannot be easily seen underwater (Roberts 1997). Coatis (Gompper 1995; Gompper & Decker 1998) and ringtails (Trapp 1972) can reverse

hind foot posture to descend from trees headfirst. The table (Table 3) below gives generalized information on each species.

Table 3: Morphological and ecological information on procyonid species

Species	Head-Body Length (centimeters)	Social System (S-solitary, P-pair, G-group)	Arboreal/ Terrestrial	Carnivore/ Omnivore	Noct/Diurn/ Crepuscular
Olingo	35-48cm	S, P	A	O	N
<b>Ringtail</b>	<b>30.5-42cm</b>	S, P	<b>A/T</b>	<b>C/O</b>	<b>N</b>
C.A. cacomistle	30-47cm	S, P	A	O	N
<b>White-nosed coati</b>	<b>41-67cm</b>	<b>G*</b>	<b>B</b>	<b>O</b>	<b>D</b>
Brown-nosed coati	49-54cm	G*	B	O	D
Island coati	74.4-78.5cm	G*	B	O	D
Mountain coati	36-39cm	G*	A,B	O	D
<b>Kinkajou</b>	<b>45-75cm</b>	<b>S, P</b>	<b>A</b>	<b>O</b>	<b>N</b>
Crab-eating raccoon	54-65cm	S, G(females)	B, W	O	N
<b>Raccoon</b>	<b>45-65cm</b>	<b>S, G(females)</b>	<b>B, W</b>	<b>O</b>	<b>N</b>

Social System codes indicate how they have been kept in zoos, where available, or what is known of their social system in the wild. An \* is used to indicate species in which the males are primarily solitary. Arboreal/Terrestrial indicates where they spend most of their time. Species listed as both are those that are considered terrestrial but are known to climb well. A 'W' has been given to species that swim well, or appear to enjoy water features in their exhibits. Carnivore/Omnivore – species are listed as carnivorous if they predominantly eat animal protein however, they may eat some vegetation as well. An Omnivorous listing was given to those that are known to eat vegetative matter regularly. They are given a C/O if they lean more towards carnivorous habits but are known to regularly eat fruit, etc. Nocturnal (N), Diurnal (D), or Crepuscular (C) codes indicate their typical, peak activity periods (Nowak 1999; Rodriguez-Bolanos et al. 2000; Reed-Smith et al. 2003).

The AZA Small Carnivore TAG has designated four species of Procyonidae to be managed under the AZA Taxon Advisory Group (2009 SCTAG Regional Collection Plan). These are the ringtail (*Bassariscus astutus*), white-nosed coati (*Nasua narica*), kinkajou (*Potos flavus*) and common raccoon (*Procyon lotor*). The brown-nosed coati (*Nasua nasua*) and Central American cacomistle (*B. sumichrasti*) previously managed are currently recommended for Phase Out. The following guidelines are designed specifically with these species in mind; however some individuals of other Procyonidae species are housed in AZA institutions and may be used as related-species examples.

**Conservation Status:** The following table (Table 4) provides information on the conservation status of procyonid species, based on CITES and IUCN lists.

Table 4: Procyonid species conservation status

Species*	Common name	CITES listing	IUCN status
<i>Bassaricyon alleni</i> <sup>1</sup>	Olingo species	---	---
<i>B. beddardi</i> <sup>1</sup>	Olingo species	---	Lower risk/near threatened***
<i>B. gabbii</i> <sup>1</sup>	Bushtailed olingo**	---	Lower risk/near threatened***
<i>B. lasius</i> <sup>1</sup>	Harris' olingo**	---	Endangered***
<i>B. pauli</i> <sup>1</sup>	Chiriqui olingo**	---	---
<i>Potos flavus</i>	Kinkajou	Appendix III*	---
<i>Bassariscus astutus</i>	Ringtail**	---	---
<i>B. sumichrasti</i>	C. A. Cacomistle**	Appendix III*	Lower risk/near threatened***
<i>Nasua narica</i>	White-nosed coati	Appendix III*	---
<i>N. nasua</i>	Brown-nosed coati	Appendix III*	---
<i>N. nelsoni</i>	Cozumel coati***	---	Endangered***
<i>Nasuella olivacea</i>	Mountain coati**	---	Data deficient***
<i>Procyon cancrivorus</i>	Crab-eating raccoon**	---	---
<i>P. lotor</i>	N. A. raccoon	---	Least Concern
<i>P. pygmaeus</i>	Cozumel raccoon	---	Critically Endangered***

<sup>1</sup> Many authors recognize these as one species, *Bassaricyon gabbii*

\* Wilson & Reeder 1992.

\*\* Corbet & Hill 1991.

\*\*\* IUCN Red List of Threatened Species 2009 ([www.redlist.org](http://www.redlist.org))

## Chapter 1. Ambient Environment

### 1.1 Temperature and Humidity

Animal collections within AZA-accredited institutions must be protected from weather detrimental to their health (AZA Accreditation Standard 1.5.7). Procyonids 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 procyonids normally living in warmer climates/water temperatures.

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).

**Temperature:** Some species (e.g., *Bassariscus*, *Nasua* and *Procyon*) are indeed relatively hardy and can be housed out of doors in moderate temperate climates if provided appropriate nest boxes and localized heat in the winter. Coatis should not be allowed to sleep outdoors when temperatures fall below 4.4°C (40°F); and all hammocks, nest boxes, etc. should be removed or placed under heat lamps. Coatis are susceptible to frostbite of their tails, which can easily suffer damage or break off (K.Schilling, personal experience).

Brooder or heat lamps as heat sources for nest boxes have been very successful, keeping temperatures within the box at over 10°C (50°F) in sub-zero temperatures (K.Schilling, personal experience; D. Bressler, personal communication).

The tropical and subtropical forms, *Potos* and *Bassaricyon* should be housed indoors if the temperature is expected to fall below 15.5 °C (60 °F) for a protracted period. These genera are physiologically adapted to stable environments found in the subtropics and tropics and can easily become hypothermic at low temperatures. Acute vasoconstriction of the extremities at low temperatures may also induce peripheral tissue necrosis (e.g., cacomistle) (Roberts 1997).

Temperatures below 0 °C (32 °F) and above ~38 °C (100 °F) should be avoided for ringtails and cacomistles. If these species are exposed to these temperatures they should have access to heated denning boxes and cooled shelters respectively (Partridge 1992). Temperatures below 4.4 °C (40 °F) should be avoided for the coati. If housed outdoors where they will be exposed to temperatures of 4.4 °C (40 °F) or lower, they should be provided with heated next boxes (K. Schilling, personal experience; D. Bressler, personal communication).

**Humidity:** Temperate species should be maintained at a neutral humidity when housed indoors; procyonids housed outside should be given plenty of shade to allow them some choice of ambient temperature, even though there is no control over humidity. There are no objective data relating to recommended humidity levels for procyonids, but a general recommendation is for relative humidity to be between 30-70%; this may be higher for the tropical forest species (Moore 1997). Animals showing signs of thermal stress should be given access to temperature/humidity controlled holding areas.

### 1.2 Light

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

Because all procyonids, except the coati, are strictly nocturnal or crepuscular, it may be difficult to exhibit them suitably to the public under natural lighting conditions. Many species or individuals react to public noise or movement by hiding or freezing. Exhibiting such animals behind sound dampening glass, under reversed blue or red lighting can alleviate these problems and encourage activity during public hours (Roberts 1997).

#### AZA Accreditation Standard

(1.5.7) The animal collection must be protected from weather detrimental to their health.

#### AZA Accreditation Standard

(10.2.1) Critical life-support systems for the animal collection, 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 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.

It is preferable that all species be kept in situations that account for the typical seasonal light changes that would be found in their native range (Roberts 1997). According to Poglayen-Neuwall (1995), it is important that artificial light is added year round to indoor exhibits, particularly for the ringtail in which light is a key factor in stimulating breeding.

Increasing winter photoperiod plays an important role in initiating reproduction for seasonally breeding procyonids (raccoon, ringtail, and cacomistle) (Poglayen-Neuwall 1995; Roberts 1997).

### 1.3 Water and Air Quality

AZA-accredited institutions must have a regular program of monitoring water quality for collections of 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 collections of 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:** The number of air changes per hour needed to maintain desired temperature ranges indoors will vary according to the volume of the enclosure. Standardized rates of change for various human-occupied enclosures suggest that pet shops require a rate of air exchange, on non-recirculated air equal to 1 cubic foot of air per minute per square foot of floor space in order to keep odors down to a level acceptable by the public. Depending on size, cubbing dens may well need higher rates of air exchange in order to maintain air quality (Anon 1981).

**Water Quality:** No standards have been set for non- or semi-aquatic species. Chemical residues, bacterial counts, mineral levels, and salts should be kept as low as possible. Fecal material and food remnants should be removed daily. The pH tolerance for procyonids is not known, but is not likely to be vitally important for these species. Turbidity, except for isolated areas, should be kept to a minimum to encourage use of water features.

### 1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by procyonids in the care of AZA-accredited zoos and aquariums. Many procyonids anecdotally show sensitivity to loud noises, particularly during parturition and early kit rearing. Every effort should be made to reduce loud or unusual noises and minimize continuous vibrations during these sensitive periods. Little is known about sound or vibration sensitivity in these species and should be investigated in the future.

## 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. Procyonids should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs (AZA Accreditation Standard 1.5.2).

The same careful consideration regarding exhibit size and complexity and its relationship to the animal'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).

**Enclosure Space and Complexity:** Previously published minimum space requirements for procyonids appear to be based on crude body size formulations without taking into account their modes of locomotion and high activity levels (see Table 5 for current AZA SCTAG exhibit size considerations contributing to recommendations). Most species travel extensively in search of food and if locomotion is overly constrained they may revert to stereotypy. Animals with insufficient space to exercise adequately may become obese and are much more likely to seek for, and find a way to escape from their enclosures. As alluded to above, enclosure complexity is as important as enclosure size in meeting locomotory requirements of most species. Enclosures should be large enough to provide appropriate locomotory substrates. (See Table 5)

#### AZA Accreditation Standard

**(1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

#### 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.

Table 5: AZA SCTAG exhibit size recommendations for 1-2 animals.

Species	Ave. HBL	Formula used or basis for recommendation	Exhibit area (floor space) (for 2 animals)*
Ringtail	40.6 cm (16 in)	Roberts 1997	8 m <sup>2</sup> /86 ft <sup>2</sup>
		Formula IIIb	7.4 m <sup>2</sup> /80 ft <sup>2</sup>
		<b>Formula IVb</b>	16.4 m <sup>2</sup> /177 ft <sup>2</sup>
Cacomistle	45.7 cm (18 in)	Roberts 1997	8 m <sup>2</sup> /86 ft <sup>2</sup>
		Formula IIIb	8.4 m <sup>2</sup> /90 ft <sup>2</sup>
		<b>Formula IVb</b>	21 m <sup>2</sup> /225 ft <sup>2</sup>
White-nosed coati	66 cm (26 in)	Standley 1992 (group exhibit)	70 m <sup>2</sup> /753.5ft <sup>2</sup>
		Roberts 1997	16 m <sup>2</sup> /172 ft <sup>2</sup>
		Formula IIb	12.1 m <sup>2</sup> /130 ft <sup>2</sup>
		<b>Formula IIIb</b>	43.6 m <sup>2</sup> /469 ft <sup>2</sup>

\* Provide an extra 25% for each additional animal

The formulas used to determine appropriate enclosure sizes are based on three factors: 1) species average head and body length; 2) typical home range size, daily travel distances, and activity level; and 3) professional experience with these species to date. The recommendations were then sent out for review by the AZA SCTAG Institutional Representatives and responses were incorporated. The exhibit size formulas below are based on HBL (head and body length) and are given in inches:

- **Formula I** –  $(HBL/12 \times X)^2$  (with a large home range/daily travel distance). Seven to eight feet vertical space should be allowed for more arboreal species. For highly terrestrial social species, go up one size group.
  - Small animals: 10-15 inches –  $(HBL/12 \times 6)^2 = \# \text{ feet}^2$
  - Medium animals: 15-30 inches –  $(HBL/12 \times 10)^2 = \# \text{ feet}^2$
  - Large animals: over 30 inches –  $(HBL/12 \times 12)^2 = \# \text{ feet}^2$

- **Formula II** –  $(HBL/12 \times X) \times$  given dimension for depth (with a small home range/daily travel distance). Seven to eight feet vertical space should be allowed for more arboreal species. For highly terrestrial social species go up one size group.
  - Small animals: 10-15 inches –  $(HBL \times 6)/12 \times 3$  feet = # feet<sup>2</sup>
  - Medium animals: 15-30 inches –  $(HBL \times 10)/12 \times 6$  feet = # feet<sup>2</sup>
  - Large animals: over 30 inches –  $(HBL \times 12)/12 \times 10$  feet = # feet<sup>2</sup>
- **Formula III** – A minimum of 8-10 feet vertical useable space and Formula II floor space.
- **Formula IV** – A minimum of 8-10 feet vertical useable space and Formula I floor space.

Previous authors have suggested a minimum of 8 m<sup>2</sup> (86 ft<sup>2</sup>) floor area and 2.5 m (8.2 ft) enclosure height for 1-2 kinkajou, olingo, ringtail, or cacomistle; this space should be provided with climbing apparatuses and nest boxes (see below for species specific information and current recommendations).

**Cacomistle and ringtail:** Ringtail and cacomistle engage in ricocheting, chimney stemming, and power leaping locomotion (Trapp 1972). As these colorful descriptions imply, such species may require special containment measures. Therefore, the AZA SCTAG suggests that these species be housed in completely contained exhibits (i.e., roofed) with 3.05-3.66 m (10-12 ft) of useable vertical space. The current AZA SCTAG recommendations call for a minimum exhibit size of 16.4 m<sup>2</sup> (177 ft<sup>2</sup>) for two ringtails and 21 m<sup>2</sup> (225 ft<sup>2</sup>) for two cacomistles (AZA Small Carnivore TAG unpublished recommendation 2005). Water moats can be used for ringtail and cacomistle (Roberts 1997). Studying ringtail in Texas, Ackerson and Harveson (2006) determined a mean summer home range size of 0.28 +/- 0.163 km<sup>2</sup> and mean winter home range size of 0.63 +/- 0.219 km<sup>2</sup>; 80.6% of dens found were located on slopes between 30-60°.

**Coati and raccoon:** Roberts (1997) states that the larger size and greater terrestriality of the raccoons and coatis dictate a floor area of at least 16 m<sup>2</sup> (172 ft<sup>2</sup>) for one to two animals. Due to their tendency to spend a fair amount of time in the trees, the AZA SCTAG recommends an enclosure height of at least 3.66 m (12 ft) of useable space (AZA Small Carnivore TAG recommendation 2005). Standley (1992) suggested larger group enclosures offering an example of a 70 m<sup>2</sup> (753.5 ft<sup>2</sup>) moated exhibit. The AZA SCTAG is recommending a minimum exhibit floor space of at least 43.6 m<sup>2</sup> (469 ft<sup>2</sup>) for two animals with an increase of 25% for each additional animal (AZA Small Carnivore TAG recommendation 2005). Outdoor, moated enclosures are ideal for raccoons and coatis as long as the perimeters are secured to prevent escape through climbing, jumping, or digging. Any enclosures with scalable walls (e.g., wire mesh or roughly textured surfaces) should be completely contained to prevent escape (Roberts 1997). Exhibits should have escape-proof substrates, hard surfaces, or a subsoil barrier of some kind (Standley 1992). Water moats can be used for coatis (Roberts 1997).

Hass (2002) quantified home-range size and overlap among white-nosed coati matriarchal troops and solitary males during a 4 year study in southeastern Arizona. "Home ranges of coatis averaged 13.57 km<sup>2</sup> ± 1.72 SE for troops (n=9) and 6.11 ± 1.42 km<sup>2</sup> for solitary males (n=7; kernel-density estimator)." She also documented an overlap of male home-ranges of ~61%, home-ranges of troops overlapped ~ 80%, and home ranges of males overlapped those of troops ~67% (Hass 2002 abstract).

**Kinkajou:** Roberts (1997) recommended 16 m<sup>2</sup> (172 ft<sup>2</sup>) exhibit space for one to two animals. The AZA SCTAG agrees with this recommendation. This species should be provided with at least 3.05-3.66 m (10-12 ft) of useable, complex vertical space.

**Enclosure Design:** For management purposes, all procyonids should be considered partly arboreal and be provided with ample climbing apparatuses as well as arboreal and terrestrial nesting/sleeping areas. Enclosure furnishings should enable animals to execute a full range of normal locomotor functions and provide visual isolation from the public and conspecifics. Logs and shrubs on enclosure floors, branches and hollows of various diameters set at different heights and angles in the upper reaches of the enclosure are ideal for most species. Rope hawsers suspended throughout the enclosure and sandboxes and mulch piles for digging are enriching additions to enclosures (Roberts 1997). The placement of ropes should be done with care to ensure there are no loops that an animal can become caught in, or entangle itself in (coatis have been known to become entangled in loops of ropes) (D. Bressler, personal communication).

The intimate association between locomotory and feeding behaviors in procyonids should be kept in mind when designing enclosure furniture. For example, kinkajous with their prehensile tails and highly flexible axial and appendicular skeletons are well suited for arboreal food acquisition (e.g., terminal

branch feeding) - their movements more closely resemble those of cebids than other carnivores. Enclosure furniture and feeding stations should be designed and located accordingly.

Coatis and raccoons find most of their food on the ground, and their limb morphologies and locomotory behaviors reflect this. Coatis are excellent diggers and probers and are viewed by many zoo and aquarium caregivers as having fine digital control equal to that of raccoons (K.Schilling, personal experience; D.Bressler, personal communication). Shilling (personal communication) reports coati are capable of turning round door knobs to open doors. Associated anatomical adaptations may also limit arboreal locomotion and preclude terminal branch feeding as seen in kinkajous. Raccoons have semi-digitigrade forelimbs, the locomotory postures, and fine digit control, but lack the convergent grip of kinkajous precluding locomotion on narrow supports (such as those traversed by kinkajous). Enclosure design should reflect these specific differences in each species' locomotory, social, and feeding biology (Roberts 1997).

As with all species, exhibit "furniture" should be changed periodically (at least twice a year), but not all at the same time. These changes can include repositioning features (e.g., moving deadfall) or bringing in new items. If nesting/sleeping/hiding areas are altered, at least one should be left the same, and scents should not be removed from those that are moved (Reed-Smith et al. 2003).

Animals housed indoors should be protected as much as possible from disturbance by the visiting public. Noise from environmental systems should be kept at a low level and parturient females should be housed away from loud noises and high traffic areas. Animals should always be provided with an area in their exhibit where they can retreat and feel safe when disturbed by loud noise, bright lights, or any other sudden disturbance.

**Water features:** Some of the procyonid species may benefit from a small pool or stream located in their exhibits. Misters and waterfalls also provide opportunities for the animals to cool off and explore other dimensions of their surroundings. All water features should be constructed in such a way to allow for easy cleaning. Space dedicated to pools/streams, etc. should be deducted from the usable floor-space calculations (Carnio 1996). Water features should have a variety of shallow depths, particularly for raccoon and coati that may benefit from an ability to explore shallows for enrichment items.

- **Ringtail:** In the wild, ringtails are seldom found more than 0.8 km (0.5 mi) from water, preferring habitats that include dense riparian growth, chaparral, and rocky hillsides (Trapp 1972).

**Substrates and bedding:** Natural substrates are recommended for all of the procyonid species (AZA Small Carnivore TAG recommendation 2005). Recommended surfaces include: dry sphagnum moss, hay, soil, sod, pine needles, leaves, pebbles, sand, wood shavings, wood wool, straw, small sticks, river rock, pebbles, or something similar. Bedding materials of all types can be used as long as caution is exercised that the animals do not 1) eat it, 2) chew it up, and 3) show an allergic reaction to it. Some wood shavings (e.g., conifers, some pine or fir) contain residues that can strip the water proofing/oils from their coats, and/or may cause sneezing. Cedar contains aromatic phenols, which are irritating to the skin and respiratory system. Several studies indicated that close, chronic contact with cedar shavings contributed to infant mortality (Burkhart & Robinson 1978), respiratory disease (Ayars et al. 1989), and liver damage (Vesell 1967) in rodents. Caution also should be exercised if using bedding such as towels because some individuals will eat the fabric (D. Bressler, personal communication; K. Schilling, personal experience).

**Species-appropriate Behaviors:** Forest species such as the kinkajou and olingo should be provided with good vertical and ground cover to mimic their natural forest habitat. More terrestrial species such as the coatis and raccoons should be provided with some vertical space, ground cover, and open areas (Roberts 1997). Arboreal species should be provided with extensive branching to allow for movement from one part of the exhibit to another without having to descend to the ground. These arboreal pathways should be of varying sizes and stability. Branches, vines, etc. should all be secured against falling, but not all should be fixed in place. Instead, some should be allowed to sway with the animal's weight (Roberts 1997).

All of the procyonid species will benefit from complex, well-furnished exhibits. Exhibits should include natural substrates such as soil, sand, river rock, and leaf litter. These can be placed on artificial surfaces making it easier to change them when they become soiled. Placement on artificial surfaces also will provide added security against escape due to the tendency of some of these species (e.g., coatis) to dig. Exhibits also should be provided with non-toxic (pre-approved by the veterinarian and horticultural staff) vegetation (trees, bushes, and grass), hollow logs, climbing ropes (caution should be used with ropes as

animals can become entangled in them), deadfall, rock piles, streams, pools, etc. All of the procyonids, particularly the coatis (Standley 1992), may benefit from decomposing logs that provide an opportunity for them to engage in natural foraging behaviors.

Nest boxes, feeding stations, waterers, and covered sleeping/hiding spots should be located in the trees (e.g., kinkajou, olingo; see photo at right by A. Moresco) or on the ground and elevated (e.g., raccoon) as appropriate for their species-typical behavioral pattern (i.e., arboreal or terrestrial) (M. Dulaney, personal communication). Nest box choices for raccoons and coatis should be placed terrestrially and arboreally. At least one sheltered resting area per animal should be provided with at least one location large enough to allow all animals to sleep together if they choose.



**Coati:** Coatis should be provided with complex climbing structures offering secured, swaying limbs and trunks large enough (able to hold their weight) for them to exhibit their ability to climb down headfirst. They also should be offered heated nest boxes or kept inside at temperatures of 4.4°C (40°F) or below because their tails suffer quickly from frostbite. A coati group should be provided multiple nest boxes or sleeping areas.

**Ringtail:** At least two nest boxes should be provided for singletons or pairs, more for a family group. Ringtails are known to use one box as a latrine and the other as a den. If they are not provided with enough boxes to accommodate this behavior they frequently use their den box for urination and defecation causing unhealthy conditions (D. Bressler, personal communication).

**Enclosure Cleaning:** Because many of the procyonid species are known to mark their environments with urine or other scents (e.g., ringtail, cacomistle, coati, and kinkajou) (IUCN 1995), furnishings in an exhibit should not all be cleaned at the same time. Instead, they should be cleaned as needed on a rotating basis. Fecal material and leftover food should be removed daily with the associated substrate cleaned or removed (Partridge 1992).

**Ringtail:** In the wild, ringtails mark their territory by urinating on rocks and branches (Grizmek 1972; Poglayen-Neuwall 1973). Latrine areas with accumulations of feces also have been found (Mead & Van Devender 1981; Thompson 2003).

## 2.2 Safety and Containment

Procyonids 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).

Procyonid exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). Exhibit design should be considered carefully to ensure that all areas are secure and particular attention should be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

Exhibits in which the visiting public may have contact with procyonids must have a guardrail/barrier that separates the two (AZA Accreditation Standard 11.3.6).

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 11.2.3).

### AZA Accreditation Standard

(11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to the animal collection, 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.

### AZA Accreditation Standard

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

### AZA Accreditation Standard

(11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

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

Emergency drills 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-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.4).

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 11.2.5).

AZA-accredited institutions which care for potentially dangerous procyonids must have appropriate safety procedures in place to prevent attacks and injuries by these animals (11.5.3).

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

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).

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).

**AZA SCTAG Recommendations:** Many procyonid species are expert escape artists and care should be taken to prevent them from digging, jumping, climbing, or swimming out of enclosures. It is recommended that open air exhibits be completely enclosed (ringtail, cacomistle, kinkajou) or have containment perimeters with inward facing overhangs at the top, unless they are smooth and are of a height that precludes an animal jumping over (AZA Small Carnivore TAG recommendation 2005). If an overhang is used, it should be made from a non-climbable material and protected with hot-wire as most procyonids (e.g. raccoons and coatis) are capable of climbing even inward-sloping overhangs if they can get their claws or feet in to it (as with chain link).

#### AZA Accreditation Standard

**(11.2.3)** 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. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

**(11.2.5)** 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 (sharks, whales, tigers, bears, 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.

Coati: The AZA SCTAG recommends containment walls for open-top exhibits are at least 2-2.44 m (6.6-8 ft) high with an inward facing overhang, of non-climbable material, at least 31-61 cm (1-2 ft) (AZA Small Carnivore TAG recommendation 2005). While water moats (3 m/10 ft wide at one facility) are used successfully, this species swims well and there should still be a low barrier with a 61 cm (2 ft) inward-facing overhang around water moats.

In open exhibits, trees, bushes, and other exhibit furniture should be placed away from the perimeter so they cannot be used as a means of escape. Coatis have been reported jumping across a distance of (~1.22 m (4 ft) landing on a surface roughly 15.25 cm (6 in) higher than the surface they started from (K. Kimble, personal experience). Outdoor exhibits should have security entrances with a secondary catch area for animals that sneak through the door. Security doors should be provided with snap hooks or padlocks because coatis and raccoons are capable of manipulating common gate latches and opening them (K. Schilling, personal experience).

Animals housed indoors should be maintained in exhibits that have been checked to insure there are no escape holes. Smaller coatis (adults and juveniles) are capable of squeezing through openings as small as 7.6 cm (3 in) (K. Schilling, personal experience).

Raccoon: This species has been maintained in open-air exhibits contained by smooth concrete walls 1.12-1.8 m (3.8-5.6 ft) high, with an 46 cm (18 in) inward overhang topped with a 31 cm (12 in) electrified fence on the top of the containment wall (A. Dosch, personal communication). Ideally this species should be kept in enclosed exhibits to prevent escape and ingress by wild raccoons.

Ringtail: This species should be kept in completely contained exhibits as they have been reported capable of ascending or descending steep or vertical surfaces. One animal was observed walking upside down sloth-like on a 0.5 cm (0.2 in) cord strung between two supports, and another walking upside down along a board in the ceiling of its exhibit (Trapp 1972). The ringtail is capable of rotating its hind foot 180°, allowing them to climb downward like a tree squirrel (Trapp 1972).

## 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). Safe animal transport requires the use of appropriate conveyance and equipment that is in good working order.

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

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.

When transporting procyonids there should always be at least two people present; if animals have been anesthetized the veterinarian should always be present. Staff involved in transports should understand their duties and have a clear idea of the institution's policies regarding transports. The AZA SCTAG has no specific recommendations regarding staff roles in transports, but does recommend procedures and policies be clearly defined and understood in advance by all participating staff.

**AZA SCTAG Recommendations:** All possible relevant regulatory agencies should always be checked for shipping, health, and permit requirements before transporting animals (USF&W, State, CITES, etc.). The International Air Transport Association (IATA) publishes specific guidelines for transport containers used for animal shipments. These guidelines are available from the Publication Assistant, IATA, 2000 Peel Street, Montreal, Quebec, Canada, H3A 2R4 (Ott Joslin & Collins 1999). An alternate address for IATA is: International Air Transport Association, 800 Place Victoria, P.O. Box 113, Montreal, Quebec, Canada, H4Z 1M1. The Live Animals Regulations document is available in print or CD ROM format and can be ordered from [sales@iata.org](mailto:sales@iata.org).

**Transport Container:** In general, the following crate design guidelines are true for all species and required by IATA (IATA 2009): 1) "Crates must be able to withstand external damage from other freight and any internal damage caused by the animal." 2) "Crate doors must not come open accidentally, but, must be securely fastened." 3) "All shipping crates must allow for adequate ventilation." 4) "Ventilation apertures must be small enough to prevent the escape of the animal and small enough that the animal cannot get any part of its body through the opening." 5) "Crates must be large enough to allow the animal to stand up and turn around" (IATA 2009).

**Coatis & Raccoons:** Crates used for coatis and raccoons should be additionally secured where the top meets the bottom (when using two-piece air-kennel type crates). This will prevent the animal from using force to physically separate the crate (K.Schilling, personal communication; D.Bressler, personal communication).

### 3.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. All materials required for a successful transport should be gathered in advance. The SCTAG recommends maintaining a transport protocol book for every species.

**Procyonids should always be shipped individually. Pregnant or lactating females should not be shipped.** The only exception to this would be the shipment of very young littermates that may fare better when shipped in pairs or groups (D.Bressler, personal communication).

**Food and Water:** While generally not required, or advised, "...the crate must allow for feeding and watering of the animal if needed" (IATA 2009). "The food and water ports should be clearly marked on the outside of the crate. Food/water dishes must be securely attached for shipping (IATA 2009) or animals

#### 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.

may remove them.” On long flights, provisions should be made for feeding in transit (this may necessitate shipping food with the animal).

In general, the Procyonid species should be fine for 24 hours without food and water. However, if long layovers or temperatures over 21.1°C (70°F) will be encountered, the need for provision of water should be considered (Roberts 1997). Water-heavy fruits, such as apples (or oranges for coatis) (Valenzuela 1998), are good sources of hydration during transportation and should be placed in the crate for all shipments of long duration (K.Schilling, personal experience).

Shipments requiring more than 24 hours should be accompanied with food and watering instructions. In these cases it may be necessary to make arrangements with a zoological facility close to one of the layover points.

**Bedding and Substrate:** The crate bottom should be leak-proof and bedded with some form of absorbent material. Some air carriers prohibit certain bedding materials, therefore in the case of air shipments the selected carrier should be consulted first for any specific restrictions.

**Temperature, Light, and Sound:** USFW and IATA regulations for shipments to the United States indicate that temperatures in the holding area, cargo, or terminal should be at least 12.8 °C (55 °F) and no higher than 26.7 °C (80 °F). Also, if ambient temperatures are higher than 23.9 °C (75 °F), ancillary ventilation should be provided (Ott Joslin & Collins 1999).

For shipments within the United States, the AWA requires that ambient temperatures in the holding area should not be less than 7.2 °C (45 °F) or more than 29.5 °C (85 °F) for more than four consecutive hours. Animals being transported between holding areas to the aircraft should not be exposed to ambient temperatures higher than 29.5 °C (85 °F) or colder than 7.2 °C (45 °F) for more than 45 minutes (Ott Joslin & Collins 1999). These guidelines are suitable for the procyonid species, but whenever possible shipments should be planned to avoid temperatures at either extreme, particularly at the high end for the raccoon species and the low end for the more tropical olingo, kinkajou, or cacomistle.

Mesh doors or side windows (as in air kennels) should be covered with a breathable, opaque material to allow for ventilation and privacy for the animal (Ott Joslin & Collins 1999), as well as preventing unauthorized personnel from making physical contact with the crated animal.

All openings should be covered with 1.27 cm (0.5 in) wire mesh. This should then be covered with air-permeable material that will help provide a sense of security for animals being shipped. All pieces of the crate should then be secured with wire or cable ties to prevent escapes during transit. Polite requests to the airline staff to place live animals in locations where loud noises are at a minimum during layovers and away from any other live animal shipments in the cargo hold are advised.

**Animal Monitoring:** Most small carnivores will not require anesthesia for crating. In the event that anesthesia is required, the animal should be fully recovered (standing and stable) prior to shipping. Ideally, an inhalant or reversible anesthetic should be used in these cases.

Transport periods greater than 24 hours in length should be accompanied with food and water instructions specific to the species. In these cases, it may be necessary to make arrangements with a zoological facility close to the lay-over points prior to shipping for food and water provisions. A contact number for the closest zoological facility should be provided, and after 24 hours (or less in some cases) the animals should be checked on by trained professionals from this facility; if needed, water and food should be provided. There is no definitive information available at this time as to whether there should be a maximum duration of transport for procyonids.

**Post-transport Release:** Shipping crates should be placed directly into the quarantine space and the animals allowed to exit on their own volition and at their own pace. It is recommended that all animals be weighed at this time. The crate and animal can be weighed first and the crate weighed again after the animal has exited.

## Chapter 4. Social Environment

### 4.1 Group Structure and Size

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

**Group Structure:** Procyonids exhibit a wide range of social organizations and even intra-specific social plasticity.

**Raccoon:** The raccoon tends to be solitary in the wild with the primary social unit being a mother and attendant young. During the mating season, males and females may assume temporary consortships, but this does not persist and no male parental care is known.

In zoos and aquariums, raccoons are known to be socially tolerant, except during the breeding season when levels of aggression can be elevated in non-neutered individuals. Generally, raccoons prefer denning together when housed as non-breeding groups (K. Schilling, personal experience). The past tendency to overpopulate raccoon enclosures should be strictly avoided. Overcrowded conditions inevitably lead first to social tensions and ultimately to medical difficulties stemming either from direct injury or social exclusion from food, nest sites, etc.

**Coati:** In the wild, the coati has a matriarchal social system in which up to 20 or more related females and juvenile males live in loose bands, which periodically break up and reform (e.g., during birthing season and when group size reaches some environmentally or socially mediated threshold). In the wild, adult males are solitary and join female bands briefly during the breeding season. Males remain subordinate to females during this association.

In zoos and aquariums, however, single adult males usually will be tolerated in female groups although they are subordinate and therefore the most likely to be injured during intra-group social disputes. Female coatis tend to isolate themselves from the group for parturition. Group enclosures should be provided with refugia (e.g., defensible retreats or adjacent enclosure modules) to accommodate subordinate males and reclusive mothers. Separate enclosures for males, which have been ostracized from the group also are advisable.

Coatis do well in group settings of one male and several females. Coati exhibits should be large enough to allow the male to remain separate from the females when he wishes (ideally a separate holding space for him should be provided especially when females have young) and to provide enough space for females so that they do not feel over-crowded. Each animal should be provided with its own nest/sleeping box (Campbell 2001). At least one sleeping site should be large enough to accommodate all the animals in the exhibit; others should allow room for bedding and an individual animal room to turn around. Multiple-male and non-breeding (neutered) mixed-gender groups also do well (K. Schilling, personal experience).

Multi-generational groups of female coatis can be maintained; multi-generational groups of males also can be maintained but success is higher if the animals are neutered (K. Schilling, personal communication; D. Bressler, personal communication). Non-breeding (neutered) mixed gender groups also do well. In these mixed gender groups, even with neutered animals, hierarchies (intra and inter-sex) will develop. Females will almost always be dominant within an enclosure. There are examples of subordinate females joining and denning with the male band in the exhibit. Micro-territories may develop within an enclosure, which are defended by the two bands (male and female) (K. Schilling, personal experience).

A hierarchy within an *ex situ* group of males will always form with an alpha animal clearly showing more dominance. While squabbling and wrestling may be witnessed, serious physical harm to members of the group is rare (K. Schilling, personal experience).

**Ringtail and cacomistle:** The social systems of ringtails and cacomistles may be intermediate between those of the raccoon and coati. The social affiliation of mated pairs may persist outside the mating season, but it is not known whether this is an exclusive pair bond or temporary association of individuals with overlapping home ranges.

In zoos and aquariums, female ringtails will not always accept a male. Some prefer a choice of males. Whenever possible, allow females a choice of mates; this will increase the likelihood of successful

breeding. While males also can be choosy, they will usually accept the female paired with them (Poglayen-Neuwall 1995). Although it is rare, male ringtails have been known to be overly aggressive during introductions to females or during breeding season. A few of these cases have resulted in the death of the female. The larger the enclosure, the less likely this is to occur. Keepers should monitor all interactions and be aware of unusually aggressive behavior (K. Schilling, personal experience). However, in general, adults may live together amicably in the same enclosure and even sleep peacefully together in the same nest box regardless of sex or season. Males apparently provide no direct parental care to infants.

Young from the previous litter can be kept with an adult pair until the onset of the next breeding cycle at which time they should be removed to eliminate the possibility of fighting and other interferences with reproduction.

Ringtails and cacomistles can be housed as heterosexual pairs or as one male/two female (1.2) trios (Partridge 1992). In the case of pairs, they can be introduced at any time during the year. Trios should all be introduced into the exhibit at the same time (Partridge 1992). Keepers should observe all interactions between new pairs/trios and monitor closely an unusually aggressive behavior.

**Kinkajou:** The social organizations of olingos and kinkajous are less well known. In the wild, kinkajous have been observed in aggregations around clumped resources, although solitary individuals are most commonly seen. In zoos and aquariums, kinkajous are socially tolerant although clear dominance hierarchies develop among individuals. Care should be taken to avoid overcrowding enclosures because overt aggression is not readily apparent. Kinkajous do well as pairs or trios. Introducing a second female to a pair can be done at any time with little to no tension between the individuals. Each animal should have separate sleeping quarters available should they choose to sleep alone (K. Schilling, personal communication; D. Bressler, personal communication). The following is a summary of a behavioral study conducted by Kays and Gittleman (2001):

“The social organization of the kinkajou *Potos flavus* is described from 380 hours of observations on habituated, free-ranging animals. Individuals were most often alone while feeding at night, yet they regularly interacted in stable social groups. Four social groups were observed, each consisting of a single adult female, two adult males, one sub-adult and one juvenile. At least one breeding female was solitary and did not reside within a group. Social groups were consolidated primarily at denning sites and large fruiting trees by group feeding, allogrooming and scent marking. However, kinkajous were most often observed solitarily, as social feeding only occurred in 19.6% of total feeding bouts (mainly among males) and individuals rarely travelled together. Although the composition of social groups was polyandrous, males also copulated with non-group females which suggests a promiscuous mating system. Female-biased dispersal and patterns of male association seem to be patrilineal and based on resource defense.”

## 4.2 Influence of Other Species and Conspecifics

**Mixed-species Enclosures:** Before any mixed exhibits are considered, the potential for inter-species aggression or disease transmission should be evaluated. Species appropriate sleeping platforms/nest boxes/rest areas, shade, feeding stations, watering spots, and visual barriers should be provided for each species within a mixed exhibit. These comfort and sustenance areas should be available to all individuals of every species housed in an exhibit.

Elevated areas such as dead/live trees, platforms, mock barns/buildings, etc. should be provided for the more arboreal species (raccoons, kinkajous). Ground surfaces of varied heights, vegetation, rock piles, deadfall, etc. should be provided as hiding places and visual barriers for the more terrestrial species. Measures should be taken to prevent woodchucks or other burrowing species from burrowing too deeply.



Photo credit: S. Carter

**Coati:** Neutered coatis have been successfully maintained in an enclosure with neutered raccoons, and one old coati was housed with a pair of striped skunks (K. Schilling, personal experience). These animals

were introduced as adults. Institution A successfully housed an adult male coati with an adult male capybara (S. Carter, personal communication).

At one AZA-accredited institution, coatis were exhibited with spectacled bear, while another institution exhibited them with squirrel monkeys. In the latter combination, the squirrel monkeys were reported as being prone to showing aggression towards coati young, even stealing and killing them at times.

**Raccoon:** Raccoons, striped skunks, and North American woodchucks have been housed together successfully with very little aggressive interaction. It is important that appropriate shelter and denning facilities be provided for each species, and that feeding/watering stations are established to minimize aggression over food (G. Granat, unpublished information, 2003).

Raccoons also have been housed with coatis (see above) and silver, red, and arctic fox (K. Schilling, personal experience). In the latter instances, there may be some aggression at feeding time, which should be anticipated and prevented by offering multiple feeding locations. In the past, *ex situ* populations of raccoons and fox have shown an inclination to share den boxes, especially in cold climates, even when multiple denning locations were provided (K. Schilling, personal experience).

### 4.3 Introductions and Reintroductions

Managed care for and reproduction of procyonids housed in AZA-accredited institutions are dynamic processes. Procyonids 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.

Since the potential for harm, or even fatalities, are always a possibility during the introduction of new animals, introductions should proceed slowly. The use of howdy doors, scent, visual and tactile acclimation are all useful tools when introducing new animals. The use of training techniques in the management of the procyonid species has not been explored as thoroughly as in some of the other mammal and avian species. However, there is no reason to assume these techniques would not be useful in some situations. Andrews (2001) stresses three components (1-3) for a successful introduction, to which we add three more (4-6):

1. Adequate space.
2. Know your animals.
3. Staff preparedness.
4. Familiarize the animals with their new space and allow them ample time to mark it with their scent.
5. Take the next step in the introduction process based on the animals' behavior not a preset timetable.
6. If possible, introduce new animals in neutral environments.

**Space:** Ideally, the exhibit and holding space should be designed so that each animal can be individually rotated through all areas without physical contact with a conspecific. Initial contact should be through a small mesh fabric (wire), providing visual, olfactory, and auditory contact, but not physical contact. If the approach of shared space is not possible, howdy cages or alternating between cages with only a small see-through partition is recommended. If one animal is noticeably more timid than the other, we recommend that this timid animal's cage be used for the physical introduction, thereby allowing it the advantage of being in familiar territory.

Sometimes it is helpful during physical introductions to temporarily "confuse" the olfactory senses of these species to minimize aggression. A drop or two of a non-toxic scent such as perfume or vanilla can be placed, or sprayed, on all animals involved in the introduction; this may be successful in thwarting aggression and replacing it with curiosity. Animals that are busy, or preoccupied, with the discovery of interesting (non-threatening) scents have less time for aggression. Becoming familiar with each other during this scent exploration is an inevitable by-product. However, this procedure does not guarantee successful cohabitation. If anything, it may be used when other efforts have failed. (K. Schilling, personal experience)

**Knowing Your Animals:** The decision to move from visual contact to physical contact should be made carefully. Things to consider during the initial physical introduction include making sure that each animal is fully aware of the other's presence. It is also recommended that no matter how compatible a pair may seem in the first meetings, the animals should be separated at night until they have consistently exhibited

positive behavior in full-day encounters and appear totally at ease with each other and their surroundings (AZA Small Carnivore TAG recommendation 2005). When introducing a new animal to a group it may be advisable to perform introductions with the least dominant animal first.

**Staff Preparedness:** Andrews (2001) recommends that during an introduction, staff should prepare for the worst-case scenario, planning strategies ahead of time. Planning should include knowing the availability of the veterinarian, location of transport carriers, and exact plan of action with intervention or distraction roles clearly defined (K. Schilling, personal experience).

**Familiarize Animals With Their Space:** New animals should be allowed to become familiar with the exhibit and holding areas before introductions are attempted.

**Take the Cues From the Animals:** Know your animals and let them dictate when the next step should take place. Some animals will take longer to acclimate to new surroundings and cohorts than others.

**Coati:** Coati can be difficult to introduce; some introductions proceed quickly and smoothly, others may require staff patience and extended periods of olfactory and visual introductions only. Animals should be “howdied” (placed in adjoining areas where they can see and smell but not touch each other) until they begin to show signs of affiliative behaviors (e.g. sleeping next to one another, etc.). Some institutions report difficulties with female-female introductions; in these cases moving slowly through the introduction steps, insuring both animals were familiar with the environment, and that the introduction did not occur in space considered home by the dominant (or older animal) facilitated the introduction. In cases of apparently incompatible animals introductions may succeed if conducted slowly or they may not succeed; however, all introductions should be observed closely and stopped if it appears the animals are becoming too aggressive (growling, lunging, biting at or striking at the other animal).

## Chapter 5. Nutrition

### 5.1 Nutritional Requirements

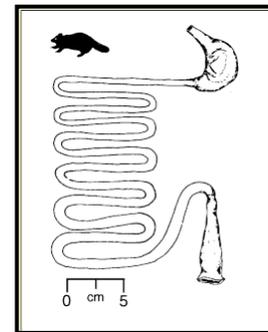
A formal nutrition program is recommended to meet the behavioral and nutritional needs of all procyonids (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Advisory Group's feeding guidelines ([www.nagonline.net/feeding\\_guidelines.htm](http://www.nagonline.net/feeding_guidelines.htm)), and veterinarians, as well as AZA Taxon Advisory Groups and Species Survival Plan® 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.

#### AZA Accreditation Standard

(2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

As a group, procyonids exhibit diverse natural feeding strategies and foraging behaviors. Although classified as carnivores, most procyonids are omnivorous, but the range of foods eaten and the means of procurement differ considerably among genera. Raccoons forage for invertebrates, small vertebrates, and fruits along bodies of water (Poglayen-Neuwall 1990; Nowak 1999). Ringtails and cacomistles feed primarily on small vertebrates, insects, and fruit (Poglayen-Neuwall 1990; Nowak 1999). Kinkajous are largely arboreal, mainly frugivorous, and have been observed to consume fruit pulp and seeds, flowers, honey, young leaves and buds, and small invertebrates and vertebrates (Ford & Hoffman 1988; Poglayen-Neuwall 1990; Denver 2003). Coatis forage for invertebrates, small vertebrates, and fruits on the forest floor and in trees (Poglayen-Neuwall 1990; Nowak 1999).

**Digestive System Morphology and Physiology:** Morphological and behavioral adaptations for foraging are diverse across procyonids. Kinkajous have a long, protrusible tongue, presumably for obtaining food from crevices, and prehensile tails which permit terminal branch feeding. Raccoons have highly prehensile forepaws, which they use to search for, manipulate, and capture prey that cannot be readily seen underwater. In general, the stomach of procyonids is simple (note figure to left, raccoon gastrointestinal tract; Steven and Hume 1995) and the distal segment of the stomach is marked only by a sudden change in mucosa. The intestine of the raccoon is longer than that of the dog or cat (2.7 times body length), and the hindgut is shorter, with neither a cecum nor a distinct ileocolonic valve (Stevens and Hume 1995). No grossly visible specialization for frugivory has been noted in kinkajous (Wright and Edwards 2009).



Steven and Hume 1995

**Energy Requirements:** Available information suggests that energy requirements are closely related to body mass, food habits, climate, and activity level, but these factors are all interrelated and some exert more influence than others. Work done by Muñoz-García and Williams (2005) on the basal metabolic rate (BMR) of 58 Carnivora species indicated, after controlling for body mass, a strong correlation between home range size (used as a proxy for level of activity), diet, and BMR (Table 6). Based upon this work, Muñoz-García and Williams (2005) concluded that "...species that eat meat have larger home ranges and higher BMR than species that eat vegetable matter."

Procyonids have lower than predicted metabolic rates as compared to the Kleiber curve, suggesting that relative energy requirements are lower than those of felids, canids, and mustelids of comparable size (McNab 1989). This has been attributed in part to reduced muscle mass of some of the arboreally adapted species in the group. Basal metabolic rates are not species constant and will be higher (as much as twice) for growing individuals compared to adults (Robbins 1993). See Table 6 for the Basal Metabolic Rate for selected procyonid species. Paradoxically, despite a depressed metabolic rate, some species (e.g., kinkajou, ringtail, and cacomistle) have limited ability to dissipate heat and may become hyperthermic at even moderately high ambient temperatures (>33 °C/91 °F). Observations of kinkajous indicate that they need approximately 50 kcals/d less than an equivalently sized mammal along the mouse-elephant (placental mammal) body curve because its BMR is 30-34% lower (Wright and Edwards 2009). Thus, a diet formulated for kinkajous based on a metabolic rate formula for other similarly sized mammals can provide too much food and increase risk for obesity.

Table 6: Basal Metabolic Rate (BMR) of selected procyonid species (from: Muñoz-Garcia &amp; Williams 2005, citing original sources)

Species	Body Mass (g)	BMR (kJ/d)	Diet (%) (meat/invert/veg)	Home range (km <sup>2</sup> ) (females only)
<i>Nasua nasua</i>	3,850 ± 212	486.02 ± 38	2/58/41	Not listed
<i>Nasua narica</i>	3,630 ± 548	573.25 ± 77	Not listed	Not listed
<i>Bassariscus astutus</i>	860.7	185.5	Not listed	1.85
<i>B. sumichrasti</i>	1,287.3 ± 133	305.24 ± 25	Not listed	Not listed
<i>Potos flavus</i>	2,688	447.71	0/21/78	0.2
<i>Procyon lotor</i>	4,847	742.23	0/73.5/26.5	1.22
<i>P. cancrivorus</i>	1,160	221.75	13.5/20.5/65.5	Not listed

**Nutrient Requirements:** Although we know many of the items consumed by procyonids, the nutrient content of these items has not been completely characterized. Beyond this, diversity within the family's feeding ecology precludes species or even genera-specific target nutrient levels. In the case of procyonids, target nutrient levels are based on those of well-studied omnivores. Ranges are provided to best describe the needs across a variety of genera, with the high ends of each range for growing and lactating animals. In most cases, they reflect the highest values reported. Based on the emphasis of foraging strategy of the genus or species in question, a range of target nutrient values has been provided for more omnivorous individuals (see Table 7). These ranges are provided in comparison to straight dog (NRC 1974; AAFCO 1999), Arctic fox (NRC 1982) and Mink (NRC, 1982). As additional information becomes available, these ranges should be adjusted to reflect new knowledge.

Table 7. Target nutrient ranges for baseline species (dry matter basis).

Nutrient	More Omnivorous <sup>1</sup>
	Kinkajou ( <i>potos flavus</i> ), Ringtail ( <i>bassariscus astutus</i> ), Coati ( <i>nasua narica</i> ), Raccoon ( <i>procyon lotor</i> )
Protein (%)	17.5-26.0 <sup>1a</sup>
Fat (%)	5-8.5
Linoleic Acid (%)	1.0-1.3
Vitamin A (IU/g)	0.5-5.9
Vitamin D (IU/g)	0.5-0.55
Vitamin E (mg/kg)	27-50
Thiamin (mg/kg)	1.0-2.25
Riboflavin (mg/kg)	1.6-10.5
Pantothenic acid (mg/kg)	7.4-15.0
Niacin (mg/kg)	11.4-20.0
Pyridoxine (mg/kg)	1.0-1.8
Folacin (mg/kg)	0.18-0.5
Biotin (mg/kg)	0.1-0.12
Vitamin B <sub>12</sub> (mg/kg)	0.022-0.035
Calcium (%)	0.3-1.2 <sup>1b</sup>
Phosphorus (%)	0.3-1.0 <sup>1b</sup>
Potassium (%)	0.4-0.6
Sodium (%)	0.04-0.3
Magnesium (%)	0.04-0.06
Iron (mg/kg)	30-90
Zinc (mg/kg)	50-120
Copper (mg/kg)	6.0-12.4
Iodine (mg/kg)	0.9-1.54
Selenium (mg/kg)	0.1-0.35

<sup>1</sup>Dog NRC (2006), Dog AAFCO (1999) (All numbers are based on requirement set for maintenance); Mink NRC (1982); Fox NRC (1982) (for mink and fox NRC protein is range of growth and maintenance, vitamins are for growth, and minerals for growth and maintenance).

<sup>1a</sup> Authors of this chapter are not comfortable recommending a 10% protein for maintenance as the Dog NRC 2006 suggests.

<sup>1b</sup> Authors of this chapter would caution feeding diets with 0.3% calcium and/or phosphorus as the Dog NRC 2006 suggests.

Several factors affect nutrient requirements. These factors include: age, physiological state, health status, environment, activity, and group dynamics. The target nutrient values in these standard recommendations encompass the needs for maintenance of adults and reproducing animals (gestation and lactation), as well as the needs of growing animals. The sample diets included in section 5.2 have supported all life stages.

**Seasonal changes in nutritional requirements:** Development of individual standard and predictable feeding behavior patterns based on seasons can serve as effective diet management tools.

**Coatis:** Male coatis appear particularly prone to weight gain in the fall; while this gain may be temporary, due to their tendency to have a reduced appetite during the winter months, care should be taken to make sure they do not become too obese during this period; weight gained in the fall is often naturally dropped in the spring (Standley 1992).

**Raccoons:** Raccoons may lose as much as 30-50% of their peak autumn body weight during the winter dormant period. Thus, the normal weight dynamic patterns of raccoons over parts of their range may be considerably more variable than those for subtropical or tropical species or other procyonid genera (Roberts 1997). Raccoons are somewhat unusual among the procyonids in that they undergo variable periods of dormancy during the winter over much of their range (from central United States to Canada). Interestingly, it is the appearance of a permanent snow cover, rather than low temperatures per se, which appears to initiate the onset of dormancy in free-ranging raccoons. This suggests that the (lack of)

availability of resources may play a role in triggering this phenomenon. Dormancy should not be confused with hibernation or torpor, as dormant raccoons are easily aroused. However, activity and food consumption drop dramatically during exposure to prolonged low temperatures, and animals rely on accumulated fat stores to meet energy requirements.

## 5.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's nutritional, psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Food preparation must be performed in accordance with all relevant federal, state, or local regulations (AZA Accreditation Standard 2.6.1). Meat processed on site must be processed following all USDA standards.

If browse plants are used within the animal's diet or for enrichment, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the species. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available.

**Sample Diets:** There is a wide range of diets that can be appropriate for procyonids. As omnivores, diets that contain a variety of food items and food groups appear most appropriate, with emphasis added toward the vertebrate and invertebrate portions of the diet for more carnivorous members of the group (raccoon, coati, ringtail and cacomistle) and fruits for the more frugivorous members (kinkajou). It should be noted that the nutrient content of all items consumed (whole prey, nutritionally complete foods, produce, etc) should be known and included in the nutrient analysis of the diet. This will help to develop and maintain a diet which meets both the nutritional needs of the species and also avoid incidence of metabolic problems (metabolic bone disease, obesity, anorexia, etc).

In this case, sample diets are provided as examples only. The goal is to provide a diet that meets target nutrient values and is readily consumed. Ideally, a palatable nutritionally complete food item should be used as the base of the diet, to which vertebrate and invertebrate prey, and produce may be added as appropriate based on feeding strategy. Offering hard food items (bones, biscuits, etc) will encourage natural tooth abrasion and promote dental health. Although the North American raccoon is not managed within the AZA SCTAG, two diets are provided for additional reference in Table 8.

### AZA Accreditation Standard

**(2.6.3)** Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

### AZA Accreditation Standard

**(2.6.1)** Animal food preparations must meet all local, state/provincial, and federal regulations.

### AZA Accreditation Standard

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

Table 8. Sample diets from AZA institutions of procyonid species as fed daily\*

Species	Common Name	Institution	Food Item <sup>1</sup>	grams/day	% in diet		
<i>Potos flavus</i>	Kinkajou	Institution B	Seasonal fruit – used apple	115	43.00		
			Insectivore- Reliable Protein Prod	60	22.43		
			ZuPreem Feline canned	60	22.43		
			Nectar Mix <sup>2</sup>	30	11.22		
			Purina Labdiet 5045 High Protein	2	0.75		
			Crickets	0.4	0.15		
			Mealworms	0.07	0.03		
			Total	267.47	100		
			Institution C	Mazuri Omnivore Biscuit	86	33.34	
		Vegetable – used carrot		86	33.33		
		Fruit – used apple		86	33.33		
		Total		258	100		
		Institution D	Corn on the cob	50	13.24		
			Apple	50	13.24		
			Hill's Science Canine Light dry	50	13.24		
			Hill's Science Original Adult dry	50	13.24		
			IAMS Adult Chicken Entrée can	28	7.41		
			Mazuri Browse Biscuit	12	3.18		
			Night crawlers (4g Sun)	0.57	0.15		
			Cantaloupe (50 g T/Th)	14.2	3.78		
			Kiwi (50 g W)	7.1	1.89		
			Papaya (50 g Th)	7.1	1.89		
			Mealworms (0.1 g W)	0.01	0.004		
			Grapes	50	13.24		
			Banana (40 g M,W,F)	17.1	4.54		
			Fig (40 g M,Th,F)	17.1	4.54		
			Egg, hard-boiled (40 g M,T,W,F)	22.8	6.05		
			DAK primate Gel (10g Sun)	1.4	0.38		
			Total	377.7	100		
<i>Bassariscus astutus</i>	Ringtail/Cacomistle		Institution B	Nebraska Special Beef Feline	35	22.22	
				Chicks (30 g M,W,F)	12.8	8.16	
		Mouse (30 g Su,T,Th,Sa)		17.1	10.88		
		Fruit – used apple		35	22.22		
		Insectivore– Reliable Protein Prod		35	22.22		
		Egg, Hard-boiled		22.5	14.29		
		Total		157.4	100		
		Institution E		Natural Balance Carnivore 5%	24	37.33	
				Premium Edge Chicken/Rice Dog	11.1	17.33	
			Egg, hard-boiled	3.4	5.33		
			Fruit used apple	7.7	12.0		
			Vegetable used carrot	7.7	12.0		
			Mealworms	1.7	2.67		
			Crickets	0.57	0.89		
			Mouse (56 g Th- only mouse fed)	8	12.44		
			Total	64.17	100		
		Institution C	Fruit Mix <sup>3</sup>	55	53.40		
			Natural Balance Carnivore 10%	29	28.16		
			ZuPreem Feline Canned	10	9.71		
			Mouse	9	8.74		
			Total	103	100		
		<i>Nasua narica</i>	Coati (white nosed)	Institution B	Fruit used apple	120	23.83
					Vegetable used carrot	120	23.83
					Nebraska Special Beef Feline	120	23.83
					ZuPreem Feline can	60	11.91
					Purina Labdiet 5045 high protein	60	11.91
					Egg, hard-boiled	19.3	3.83
					Cooked Roast Beef	4.3	0.85
				Total	503.6	100	
Institution E	Natural Balance Carnivore 5%			43	20.84		

Species	Common Name	Institution	Food Item <sup>1</sup>	grams/day	% in diet		
<i>Potos flavus</i>	Kinkajou	Institution B	Seasonal fruit – used apple	115	43.00		
			Premium Edge Chicken/Rice Dog	60	29.09		
			Lake Smelt	4.3	2.08		
			Mealworms	8	3.88		
			Crickets	8	3.88		
			Egg, hard-boiled	28	13.57		
			Apple	28	13.57		
			Banana	27	13.09		
			Total	206.3	100		
			Institution C (brown nosed)	Mazuri Omnivore	103	41.56	
				Egg, hard-boiled	33	13.32	
				Banana	10.8	4.38	
		Apple		20.0	8.07		
		Grapes		6.4	2.59		
		Orange		17.0	6.86		
		Sweet potato cooked		9.3	3.75		
		Mealworms		8.1	3.29		
		Crickets		10.8	4.38		
		Mice		29.2	11.8		
		Total	247.8	100			
		<i>Procyon lotor</i>	Raccoon	Institution D	Hill's Science Original Adult dry	85.0	63.33
					Grapes	16.0	11.92
Carrots	9.7				7.24		
Cantaloupe	0.85				0.64		
Apple	0.85				0.64		
Banana	0.43				0.32		
Super worms	0.85				0.64		
Cricket (3/4")	0.21				0.16		
Sweet Potato	6.0				4.47		
Apple Juice Concentrate	14.3				10.64		
Total	134.2				100		
Institution F	Apple				8	4.15	
	Grape			9	4.66		
	Carrot			16.5	8.55		
	Sweet Potato			16.5	8.55		
	Leafy Mix <sup>4</sup>			27	13.99		
	Sports Mix Dog Food dry			58	30.05		
	Purina Labdiet 5038 Monkey			58	30.05		
	Total			193	100		

<sup>1</sup> Reliable Protein Products, Phoenix, AZ 85050; Zupreem, Shawnee, KS 66214; PMI Nutrition International, Grays Summit, MO 63039; Hill's Pet Nutrition, Inc. Topeka, KS 66603; P&G Pet Care (IAMS), Cincinnati, OH 45220; Central Nebraska Packing, Inc. North Platte, NE 69103; Natural Balance Pet Foods, Inc. Pacoima, CA 91331; Premium Edge Brand® Meta, MO 65058; Midwestern Pet Foods, Inc. Evansville, IN 47725.

<sup>2</sup> Nectar mix from Omaha contains 9% raw egg, 5% Roudybush nectar 3 powder, 2% dry rice baby cereal, 4% honey, and 80% water.

<sup>3</sup> Fruit mix from Institution C is a combination of 16.26% apple, 27.49% banana, 6.71% grape, 3.47% orange, 6.35% papaya, 11.73% pear, 4.27% white potato, 13.63% sweet potato, 6.76% carrot, and 3.33% hard-boiled egg; Vegetable mix is a combination of 11.15% apple, 6.15% carrots, 8.92% pear, 1.44% collard greens, 6.34% green beans, 3.70% kale, 13.74% romaine, 10.94% pear, 9.87% white potato, 5.21% spinach, and 22.54% sweet potato.

<sup>4</sup> Institution F Leafy Mix is 45% iceberg lettuce, 11% kale, 22% spinach, and 22% celery shredded.

\* The AZA SCTAG does not specifically endorse the use of any mentioned products.

The following table (Table 9) provides a comparison of the sample diets listed in Table 8 to target nutrient levels identified in section 5.1.

Table 9. Nutrient content of sample diets<sup>1</sup> (dry matter basis)

<b>Nutrient</b>	Institution B	Institution C	Institution D	More Omnivorous
	Kinkajou	Kinkajou	Kinkajou	
Protein (%)	28.2	21.9	21.3	17.5-26.0
Fat (%)	16.7	6.7	10.5	5-8.5
Vitamin A (IU/g)	9.2	92 <sup>2</sup>	6.2	0.5-5.9
Vitamin D (IU/g)	0.45	3.1	0.27	0.5-0.55
Vitamin E (mg/kg)	56.9	70	183	27-50
Thiamin (mg/kg)	7.3	14.0	1.7	1.0-2.25
Riboflavin (mg/kg)	8.0	6.3	2.3	1.6-10.5
Pantothenic acid (mg/kg)	18.7	19.0	8.6	7.4-15.0
Niacin (mg/kg)	52.6	78.9	11.9	11.4-20.0
Pyridoxine (mg/kg)	3.4	9.7	2.9	1.0-1.8
Folacin (mg/kg)	0.95	2.3	1.2	0.18-0.5
Biotin (mg/kg)	0.26	0.16	0.03	0.1-0.12
Vitamin B <sub>12</sub> (mg/kg)	0.03	0.04	0.01	0.022-0.035
Calcium (%)	0.38	2.0	0.54	0.3-1.2
Phosphorus (%)	0.31	1.4	0.46	0.3-1.0
Potassium (%)	0.36	1.1	0.72	0.4-0.6
Sodium (%)	0.12	0.30	0.21	0.04-0.3
Magnesium (%)	0.03	0.20	0.10	0.04-0.06
Iron (mg/kg)	118	481	36	30-90
Zinc (mg/kg)	66	157	15.3	50-120
Copper (mg/kg)	5.4	13.4	3.5	6.0-12.4
Iodine (mg/kg)	0.77	1.2	0.18	0.9-1.54
Selenium (mg/kg)	0.02	0.45	0.07	0.1-0.35

<b>Nutrient</b>	Institution B	Institution E	Institution C	More Omnivorous
	Ringtail	Ringtail	Ringtail	
Protein (%)	38.4	40.8	33.2	17.5-26.0
Fat (%)	21.8	18.4	19.7	5-8.5
Vitamin A (IU/g)	9.0	95.6	61.9	0.5-5.9
Vitamin D (IU/g)	1.3	0.55	0.72	0.5-0.55
Vitamin E (mg/kg)	195	261	174	27-50
Thiamin (mg/kg)	29.9	5.2	8.1	1.0-2.25
Riboflavin (mg/kg)	9.2	8.9	12.0	1.6-10.5
Pantothenic acid (mg/kg)	13.9	21.3	24.6	7.4-15.0
Niacin (mg/kg)	35.2	96.4	84.2	11.4-20.0
Pyridoxine (mg/kg)	5.9	6.4	10.2	1.0-1.8
Folacin (mg/kg)	1.4	0.22	11.8	0.18-0.5
Biotin (mg/kg)	0.15	0.57	0.81	0.1-0.12
Vitamin B <sub>12</sub> (mg/kg)	0.09	0.05	0.06	0.022-0.035
Calcium (%)	1.1	0.97	1.1	0.3-1.2
Phosphorus (%)	0.89	0.68	0.54	0.3-1.0
Potassium (%)	0.50	0.40	0.65	0.4-0.6
Sodium (%)	0.28	0.26	0.49	0.04-0.3
Magnesium (%)	0.07	0.19	0.18	0.04-0.06
Iron (mg/kg)	164	82.4	109	30-90
Zinc (mg/kg)	74.6	121	120	50-120
Copper (mg/kg)	10.5	9.2	11.8	6.0-12.4
Iodine (mg/kg)	0.69	0.40	0.68	0.9-1.54
Selenium (mg/kg)	0.29	0.43	0.12	0.1-0.35

<b>Nutrient</b>	Institution B	Institution E	Institution C	More Omnivorous
	Coati	Coati	Coati (brown-nosed)	
Protein (%)	31.9	33.8	29.8	17.5-26.0
Fat (%)	20.2	17.6	13.4	5-8.5
Vitamin A (IU/g)	229 <sup>2</sup>	4.4	28.7 <sup>2</sup>	0.5-5.9

Nutrient	Institution B	Institution C	Institution D	More Omnivorous
	Kinkajou	Kinkajou	Kinkajou	
Protein (%)	28.2	21.9	21.3	17.5-26.0
Vitamin D (IU/g)	2.8	0.26	3.0	0.5-0.55
Vitamin E (mg/kg)	175	244	70.3	27-50
Thiamin (mg/kg)	13.7	2.6	13.2	1.0-2.25
Riboflavin (mg/kg)	7.9	5.6	6.7	1.6-10.5
Pantothenic acid (mg/kg)	34.0	13.9	20.7	7.4-15.0
Niacin (mg/kg)	73.2	45.7	72.3	11.4-20.0
Pyridoxine (mg/kg)	8.4	4.8	7.8	1.0-1.8
Folacin (mg/kg)	4.2	0.25	2.2	0.18-0.5
Biotin (mg/kg)	0.20	0.27	0.16	0.1-0.12
Vitamin B <sub>12</sub> (mg/kg)	0.05	0.03	0.04	0.022-0.035
Calcium (%)	1.0	0.36	1.9	0.3-1.2
Phosphorus (%)	0.82	0.32	1.4	0.3-1.0
Potassium (%)	1.0	0.37	0.94	0.4-0.6
Sodium (%)	0.35	0.17	0.32	0.04-0.3
Magnesium (%)	0.14	0.11	0.19	0.04-0.06
Iron (mg/kg)	218	31.7	471	30-90
Zinc (mg/kg)	115	124	162	50-120
Copper (mg/kg)	13.1	5.3	13.6	6.0-12.4
Iodine (mg/kg)	1.0	0.19	1.2	0.9-1.54
Selenium (mg/kg)	0.27	0.47	0.54	0.1-0.35

Nutrient	Institution F	Institution D	More Omnivorous
	Raccoon	Raccoon	
Protein (%)	19.3	22.1	17.5-26.0
Fat (%)	6.8	13.6	5-8.5
Vitamin A (IU/g)	95.7 <sup>2</sup>	43.6 <sup>2</sup>	0.5-5.9
Vitamin D (IU/g)	3.3	<sub>3</sub>	0.5-0.55
Vitamin E (mg/kg)	31.6	2.1 <sup>3</sup>	27-50
Thiamin (mg/kg)	5.1	0.34 <sup>3</sup>	1.0-2.25
Riboflavin (mg/kg)	4.8	0.42 <sup>3</sup>	1.6-10.5
Pantothenic acid (mg/kg)	31.7	1.2 <sup>3</sup>	7.4-15.0
Niacin (mg/kg)	64.1	2.6 <sup>3</sup>	11.4-20.0
Pyridoxine (mg/kg)	7.4	0.77 <sup>3</sup>	1.0-1.8
Folacin (mg/kg)	3.7	0.04 <sup>3</sup>	0.18-0.5
Biotin (mg/kg)	0.05	<sub>3</sub>	0.1-0.12
Vitamin B <sub>12</sub> (mg/kg)	0.01	0.03 <sup>3</sup>	0.022-0.035
Calcium (%)	0.48	0.63	0.3-1.2
Phosphorus (%)	0.27	0.58	0.3-1.0
Potassium (%)	0.45	0.72	0.4-0.6
Sodium (%)	0.14	0.25	0.04-0.3
Magnesium (%)	0.08	0.12	0.04-0.06
Iron (mg/kg)	95.6	3.0 <sup>3</sup>	30-90
Zinc (mg/kg)	58.7	1.1 <sup>3</sup>	50-120
Copper (mg/kg)	7.2	0.47 <sup>3</sup>	6.0-12.4
Iodine (mg/kg)	0.46	<sub>3</sub>	0.9-1.54
Selenium (mg/kg)	0.11	<sub>3</sub>	0.1-0.35

<sup>1</sup>Target nutrient levels listed in Table 7.

<sup>2</sup> High due to beta carotene from the carrots and sweet potato in diet.

<sup>3</sup>Missing most of the nutrient information on the Hills Science Diet Adult dry so nutrients most likely meet targets set.

**Provision of Food and Water:** Heavy water bowls made from metal, or a sturdy, non-chewable plastic can be used for water and food. Small pools with running water may also be used as watering points. All food and water containers should be cleaned and disinfected daily. Water containers used for ringtails and coatis should be heated in winter, otherwise their body temperatures may drop too low as they drink ice cold water. Ice-cold water also may prevent them from drinking an adequate amount of water (D.Bressler, personal communication). Water should always be available, but it is particularly important for ringtails if they are not provided with enough fruit (from which they naturally obtain water) in their diet (Reed-Smith et al. 2003).

In general, only foods that can easily be contaminated by dirt (e.g., moist foods or fruit) should be placed in containers, the rest should be scattered or hidden for the animals to find (K. Schilling, personal experience). This portion of the daily diet should be reserved for use as enrichment during the course of the exhibit day. Dry foods, or foods that can be left whole, should be scattered or hidden around the exhibit. Fruit can be placed on branches or skewered onto heavy bolts placed in branches. This will promote activity and provide the animals an opportunity to engage in natural foraging behaviors. The provision of decomposing logs that can be torn apart, or logs with holes for hiding insects, larvae, fruit, etc. also will encourage foraging behaviors.

Procyonids eat a wide variety of foods. Procyonids should be provided with food at least twice a day, preferably three, and it is recommended that the diet be provided in ways that promote species-appropriate foraging and feeding behaviors (e.g., hidden, scattered, hung, etc.), where appropriate. Given that coatis can spend 95% of their active time foraging in the wild (Kaufmann 1962), it is important that the frequency of food delivery, and the means of presenting the food to these animals, be closely based on the natural history of the species in order to promote species-appropriate foraging, and prevent the development of abnormal behaviors.

**Ringtail and cacomistle:** The AZA SCTAG recommends that a well-balanced diet includes a variety of items as noted in previous sections and that animals' weight and physical condition should be checked regularly. Carbohydrate consumption (including fruit and vegetable forms) should be monitored, particularly the amounts offered males, as ringtails and cacomistles are prone to obesity (D. Bressler, personal communication).

**Coati:** Coatis benefit from a scattered feeding approach, allowing them to exercise their natural foraging approach to feeding. All items can be scattered or hidden as long as keepers monitor that all individuals are feeding, and leftover food is cleaned up daily.

**Kinkajou:** The unfortunate title "honey bear" for kinkajou has often led to the erroneous assumption that this species requires honey or other sweets in its diet. Overindulgence in sweets can have disastrous dietary and medical consequences and should be avoided (Roberts 1997).

**Species-appropriate Foraging and Feeding:** Most procyonids are nocturnal or crepuscular, meaning active at or between dusk and dawn; the notable exception is the coati, which forages during the day (Denver 2003). While it is not possible to mimic the same diet (or environment) for *ex situ* populations of animals as their free-ranging conspecifics would utilize, it is recommended that the diet is offered during the period of the day when the animals would typically be expected to actively forage (AZA Small Carnivore TAG recommendation 2005). This will not only discourage pest species, but will encourage typical foraging behavior. Easily soiled food such as meat products should be offered in containers that are cleaned and sanitized after each use.

Procyonids have been observed to consume anything from soft fruits and berries to acorns and crayfish, and most have well developed canines and a strong dentition. Many are highly dexterous or have relatively well developed prehensile abilities, thus altering diet item size or form and scattering part of the diet can contribute to stimulating natural foraging behaviors, encourage problem solving, and in general provide variety in daily activity patterns.

Feeding soft foods only (such as canned dog food, cottage cheese, etc.) will promote dental tartar, which, if left untreated, can lead to gingivitis and eventual loss of teeth (Roberts 1997). However, soft foods should not be completely ruled out as occasional enriching treats (K.Schilling, personal experience).

### 5.3 Nutritional Evaluations

Group dynamics often play a role in the nutrient content of the diet consumed by individuals in the group. When housed in groups, procyonids should be observed to insure the subordinate animals consume the correct proportions of diet ingredients. Often increasing the number of feeding times per day, placing the food in several locations, distracting some of the animals to allow others adequate access to food, or separating animals when possible are necessary in a group of procyonids.

Diets should be formulated taking into account an animal's size, activity level, age, and over-all health. Target weights should be set for each animal and diets formulated to maintain that weight. Procyonids have been noted to become obese from overfeeding, lack of exercise, or a combination of the two. "Goal weights" for individuals should be established (ideally, general, and seasonal), and body

weight checked frequently, so that diet adjustments can be made in a timely fashion to avoid over or under-condition.

Ringtails and cacomistles have been noted to easily gain weight in zoos and aquariums. This can be managed by regularly monitoring their weight and adjusting diets as needed.

**Health Status:** Increased or decreased requirements for illness, thermoregulation, or activity can be met by offering diets ad libitum and monitoring body weight and condition over time. In general, diets should be offered so that a small amount of food is remaining at the end of the feeding period; however this should be managed on an individual basis to avoid obesity.

Analysis of weight fluctuations can be a valuable tool for managing individuals and populations. Weight changes can reflect nutritional problems (obesity and under-conditioning), illness (cancer, organ failure, etc.), other medical conditions (intestinal blockage, etc.), changes in reproductive condition (e.g., pregnancy or weight loss during lactation), and hormonally or environmentally induced changes in metabolism (e.g., prior to dormancy and the onset of the breeding season). Correlating weight changes with key life history parameters will enable animals to be managed much more effectively and efficiently.

## 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). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV) [www.aazv.org/associations/6442files/zoo\\_aquarium\\_vet\\_med\\_guidelines.pdf](http://www.aazv.org/associations/6442files/zoo_aquarium_vet_med_guidelines.pdf). The current SCTAG Veterinary Advisor is Dr. Anneke Moresco, Institution G, ([anneke\\_moresco@hotmail.com](mailto:anneke_moresco@hotmail.com)).

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.

Animal recordkeeping is an important element of animal care and ensures that information about individual procyonids 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 duplicated and 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).

Following are some general recommendations that can be used as guidelines of a basic healthcare protocol. However, each situation is unique and the health care protocol should take into account the relative risk of each animal. The veterinary staff should design the preventive health protocol that is ultimately implemented. The design should take into consideration the weather, location, species involved, and institutional management policies. The AAZV's 'Small Carnivore Medical Management Guidelines' (Manharth & Shellebarger 2003) also can be found in Appendix G, and should be carefully consulted.

**Animal Records:** Thorough and accurate medical records are essential to learn and understand more about the medical problems of any of our *ex situ* population species. Medical records should be systematic and entries should identify the history, physical findings, procedures performed, treatments

#### AZA Accreditation Standard

(2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

#### 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.

#### 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.

#### 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 animal collection.

#### AZA Accreditation Standard

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

#### 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.

#### 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.

administered, differential diagnosis, assessment, and future plans for treatment. A computerized medical record system, which can help track problems and can be easily transmitted from one institution to the next, is extremely beneficial. The AZA SCTAG encourages the use of ZIMS (Zoological Information Management System) when it becomes available to replace MedARKS (International Species Information System, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, U.S.A.) as a universal medical record program. Many institutions use MedARKS, making it easy to transfer information between them. The medical record should include the following information:

- Medical history
- Identification (current ARKS record, transponder numbers, tattoos, etc.)
- Clinical notes (including exam findings, diagnoses, vaccination history, etc.)
- Parasitology
- Anesthesia
- Clinical pathology
- Treatments (current medications, recent treatments, etc.)
- Pathology
- Reproductive status (contracepted, cycle details or abnormalities, etc.)
- Nutritional information (nutritional deficiencies, supplements, allergies, etc.)
- Behavioral/social group notes (social traumas, aggression, training for medical procedures, etc.)
- Any pertinent group history should be included as well, especially if there is a history of infectious disease within the group or exhibit.
- As small carnivores are prone to dental disease, a thorough history of dental problems and, preferably, a dental chart noting extractions, root canals, problems, etc. is recommended.

**Necropsy:** All small carnivores that die should receive a thorough necropsy in a timely manner. This will help establish cause of death, provide valuable insight into the health of the collection, and help protect the other animals in the social grouping by delineating any immediate concerns. The following protocol is adapted from the AAZV 'Small Carnivore Medical Management Guidelines' (Manharth & Shellebarger 2003) (see Appendix G and Appendix M):

1. Blood: serum banking
2. Radiographs post-mortem (if possible)
3. External exam, including weight and description of condition of body
4. Internal exam
  - a. A detailed written report should be completed.
  - b. Cultures should be submitted, if indicated
  - c. Photo documentation, if possible
  - d. Submission of a representative sample of all lesions AND routine tissues:
    - Skin, muscle, sciatic nerve, bone (femur), tongue, salivary gland, eye, brain, pituitary, trachea, thyroid, parathyroid, thymus, esophagus, lymph nodes (thoracic and abdominal), lung, bronchus, heart, aorta, liver, gall bladder, diaphragm, spleen, pancreas, stomach, duodenum, jejunum, ileum, ileocolic jxn, colon, adrenal, kidneys, bladder, ureter, urethra, reproductive organs
    - It is recommended that a pathologist familiar with non-traditional species be used for histopathology.
    - Reproductive organs should be submitted to: Dr. Linda Munson, VM -Pathology Microbiology & Immunology, 4206 Vet Med 3A, One Shields Ave Davis, CA 95616, as a standing request. Tissues should be fixed in 10% formalin and accompanied by a submission form. More detailed submission instructions and the submission form are available at: [www.stlzoo.org/animals/scienceresearch/contraceptioncenter/](http://www.stlzoo.org/animals/scienceresearch/contraceptioncenter/).
    - Frozen set of tissues should be stored: heart, liver, kidney, brain, serum, lesions
    - Any stones (uroliths, renoliths, etc.) should be submitted for analysis to: Minnesota Urolith Center, Dept. of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Minnesota, 1352 Boyd Avenue, St. Paul, MN 55108

A complete report, including histopathology and test results, should be submitted to the veterinary advisor on an annual basis.

## 6.2 Identification Methods

Ensuring that procyonids are identifiable through various means increases the ability to care for individuals more effectively. Procyonids 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 member institutions must inventory their population at least annually and document all animal 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 procyonids on loan to and from the institution (AZA Accreditation Standard 1.4.2).

The AZA SCTAG recommends that all animals be identified as soon as possible after birth with a transponder chip placed subcutaneously in the intrascapular area or neck. The location should be recorded in the animal's medical record. If it is not possible to identify the animal with a transponder chip, they should be tattooed on the inside of their thigh with their studbook number or institutional identifier. See Appendix G for additional recommendations on identification methods for small carnivores.

## 6.3 Transfer Examination and Diagnostic Testing Recommendations

The transfer of procyonids between AZA-accredited institutions or certified related facilities due to AZA SSP or PMP 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.

All procyonids should receive a thorough pre-shipment physical examination as outlined in Appendix G. A copy of the complete medical record, including pre-shipment physical exam findings and laboratory work should be sent to the veterinarian at the receiving institution before the animal is transferred (in addition or in coordination with the copy that the curator receives). If an animal has a current medical condition requiring ongoing treatment, the case should be discussed between the shipping and receiving institutions' veterinarians before the animal is moved. All animal shipments should be accompanied by a hard copy of the medical record, as well as a health certificate and the USDA acquisition, disposition, or transport form (APHIS form #7020). Institutions using MedARKS (or ZIMS) should provide the receiving institution with the medical records on a floppy disc or send them via e-mail (Petriani 1998). Contact the veterinarian at the receiving institution to find out which tests the receiving institution requires. Also contact the state veterinarian, if the animal is crossing state borders as different states may have different requirements. See Appendix G for a complete list of testing recommended before transferring any small carnivores.

## 6.4 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived procyonids 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

### AZA Accreditation Standard

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

### AZA Accreditation Standard

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

### 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.

### 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.

standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix C). 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 procyonids 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 AALAS accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

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 procyonids, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers should care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Equipment used to feed, care for, and enrich procyonids 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.

Quarantine durations span 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 should 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.

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 C). A complete physical, including a dental examination if applicable, should be performed. Procyonids 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 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. Procyonids 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.

Procyonids which die during the quarantine period should have a necropsy performed to determine the cause of death 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 from the body organs should be submitted for histopathological examination. See Section 6.1 and Appendix G and Appendix M for necropsy protocols for small carnivores.

#### AZA Accreditation Standard

(2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

#### 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.

#### AZA Accreditation Standard

(11.1.3) A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

#### AZA Accreditation Standard

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

After it has been decided by authorized staff that euthanasia is indicated, these species can be anesthetized (see anesthesia section). Once the animal is adequately anesthetized, an injection of pentobarbital can be given intravenously or intraperitoneally. NOTE that pentobarbital is a controlled substance and DEA regulations for its use should be followed. Heart should be auscultated to ensure the animal has died prior to disposing of the animal according to institutional guidelines. For more detailed information on alternative methods and on euthanasia guidelines please refer to the AVMA guidelines on euthanasia, a copy can be found at: [www.avma.org/issues/animal\\_welfare/euthanasia.pdf](http://www.avma.org/issues/animal_welfare/euthanasia.pdf).

**AZA SCTAG Recommendations:** Foot baths should be used in all quarantine situations; gloves and masks should be used around sick animals or animals that came in from the wild (e.g. raccoons, rehab ringtail, etc.).

The importance of a preventive medical program for zoo animals cannot be emphasized enough. Animals entering a collection should undergo quarantine in an isolated facility designed to allow handling of the animals and proper cleaning and sanitizing of the enclosures. The shipping crate should be cleaned and disinfected before it leaves the quarantine area, and the crate's contents disposed of appropriately. Quarantine facilities require barriers against ingress of potential vectors and vermin. Animals in quarantine should be cared for by separate keepers who are skilled at recognizing signs of stress and disease and who will carefully monitor feed intake and fecal characteristics. Since diets change between institutions it is recommended that the sending institutions diet be obtained in advance of the animal's arrival. This enables the receiving institution to provide a familiar diet to the animal upon arrival and for the first week of quarantine. The sending institution may want to send some of the regular diet with the animal.

After the first week of quarantine, if the animal is doing well, the new diet should slowly be introduced. If this is done at a rate of approximately 25% of new diet exchanged for old per week, the animal should be converted to the new diet by the end of quarantine, and should avoid any problems associated with dietary change.

#### **AZA Accreditation Standards and Related Policies**

See Appendix A for specific animal care and management recommendations for small carnivore quarantine, which are included in the AZA Accreditation Standards and Related Policies (AZA 2008).

During quarantine, animals should receive appropriate vaccinations and diagnostic testing (see section 6.2). They should be examined for ecto- and endoparasites and treated appropriately. Depending on what has been done at the shipping institution, before release from quarantine the animal should receive physical and laboratory examinations, including hematology, serum biochemistry, urinalysis, and radiographs. Serum should be frozen (banked) for future reference and possible epidemiologic studies. All procedures and results should be recorded and become the start of the animal's record.

A minimum of three consecutive negative fecals (fresh direct and float or sedimentation), each one week apart, should be obtained before clearing from quarantine. Appropriate treatment for any parasites should be administered while in quarantine and three negative fecals should be obtained post-treatment.

Cultures and special stains should be repeated during this time if there has been a history of infectious disease in this animal or its previous group. In the event of an infectious bacterial intestinal disease (e.g., salmonellosis), it is recommended that repeated cultures be submitted (three per week) in order to identify or document the condition.

## **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](http://www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf)).

As stated in Chapter 6.4, AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation

#### **AZA Accreditation Standard**

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

#### **AZA Accreditation Standard**

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

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.

Procyonids 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).

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 procyonids may vary from an initial quarantine test, to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species.

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

(11.1.3) A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

**Vaccinations:** Preventive medicine should be tailored to the risk of exposure, which varies by location and with management practices. The veterinary staff should set up a preventive protocol that is appropriate for the risk of exposure at each institution. Vaccination schedules should be viewed in light of the real risk of animals contracting these diseases and the consequences of clinical disease, keeping in mind that overly aggressive vaccination schedules may not be innocuous. Titers are useful if the assay that measures them has been validated for the species in particular. However, in many (most) zoo species it is not known for certain what constitutes a protective titer. That is, even if we know the test actually reflects the titers, what do they mean in terms of protection? In order to assess the latter point it is recommended that, if possible, institutions still gather titer information for use at a later date. Specifics on red pandas are addressed in a separate document. For more information also see the Guidelines for zoo and aquarium veterinary medical programs and veterinary hospitals available as a PDF at [www.aazv.org/Webaddit.pdf](http://www.aazv.org/Webaddit.pdf).

Specifics regarding type/lot of vaccine and site of injection should be recorded in the animal's record. Many of the following recommendations have been taken from the AAZV website and this can be checked for regular updates (Manharth & Shellebarger 2003).

**Rabies:** Rabies is recommended for all carnivores. Only a killed rabies vaccine product should be used. Imrab<sup>3</sup> (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) has been used extensively in small carnivores without apparent adverse effects. Dose: 1ml, i.m.. Frequency: once at 16 weeks of age, then annually thereafter. Animals experiencing an adverse reaction to a vaccine should be administered an antihistamine (e.g., diphenhydramine hydrochloride, 0.5-2mg/kg intravenously or intramuscularly) or for severe reactions, epinephrine (20µg/kg intravenously, intramuscularly, subcutaneously, or intratracheally), and supportive care (Fernandez-Moran 2003). PUREVAX<sup>3</sup> Feline Rabies (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) is a live canarypox vectored, nonadjuvanted recombinant rabies vaccine that is currently being used at some institutions for small carnivores. (1ml; i.m.). The frequency of vaccination should be once at age 8 weeks or older, then annually. This has been used without adverse effects in binturongs (A.Moresco, personal communication). Though it is recommended, use of rabies vaccines in these species will be extra-label and will not be considered protective in the event of a bite.

**Canine distemper:** Procyonids are susceptible to canine distemper (raccoon, coati, and kinkajou). All collection animals should be vaccinated against canine distemper. However, the safety and efficacy of modified live canine distemper vaccinations in exotic species of carnivores has been problematic. In fact, some exotic carnivores’ canine distemper can be induced by administering live or modified live vaccines (Carpenter et al. 1976; Pearson 1977). Therefore, it is recommended to NOT use live and modified live vaccines in procyonids (Blomqvist & Rudbäck 2001). Vaccination may be indicated for other diseases depending, as mentioned above, on the risk. Unfortunately, killed virus vaccines, with or without adjuvants, have failed to induce persistent high titers in any species.

Recently, a recombinant canarypox-vectored canine distemper virus vaccine (Purevax® Ferret Distemper vaccine by Merial, Ltd., Inc. Athens, Georgia) has been found safe and efficacious in herpestids (meerkats: Coke et al. 2005). Animals should be vaccinated annually (Roberts 1997; Fernandez-Moran 2003). Use 1ml i.m. (Coke et al. 2005). Vaccinate previously vaccinated adults yearly, unvaccinated adults twice 3-4 weeks apart, then annually and juveniles: three vaccinations, every three to four weeks from 8-16 weeks of age (e.g., 8, 12 and 16 weeks).

The USDA-approved Fervac-D (United Vaccines, Inc., Madison, Wisconsin 53744, USA) has induced disease in red pandas and anaphylaxis in some mustelids (notably ferrets) and viverrids (R.Montali, unpublished data). The use of multivalent vaccines containing CDV, such as Galaxy-6-MPH-L (Solvay), is discouraged, because of possible immunosuppression and clinical disease brought about by other MLV components. Data on maternal antibody interference with vaccination of raccoons and ferrets suggest that a final CDV vaccine should be administered at 18–20 weeks of age in raccoons (reviewed in Deem et al. 2000). Vaccination schedules may require modification during canine distemper epidemics, or periods of increased risk of exposure.

**Feline Panleukopenia:** AAZV's Infectious Disease Notebook notes that some small carnivores are susceptible to feline panleukopenia and should be vaccinated and many small carnivores have been vaccinated with a combination product in the past. However, a number of veterinary advisors do not suggest vaccination in their recommendations, including red pandas and black-footed ferrets. Veterinary advisor recommendations should be followed primarily.

Feline panleukopenia has been reported in raccoons and coatis (Bittle 1981). Vaccination with a killed product is recommended. A killed panleukopenia vaccine is available by utilizing the panleukopenia fraction of a multivalent feline vaccine. FPV-1<sup>□</sup>Feline Panleukopenia Vaccine (Biocor Animal Health Inc., 2720 North 84<sup>th</sup> Street, Omaha, NE 68134) is a new non-adjuvanted, killed vaccine. The frequency of vaccination should be at least two vaccines three weeks apart at/after 12 weeks of age. If started before 12 weeks, give a third vaccine, then vaccinate annually. This vaccine has been shown to be safe in pregnant domestic cats.

**Parvovirus:** Parvocine<sup>□</sup>(Biocor Animal Health Inc., 2720 North 84<sup>th</sup> Street, Omaha, NE 68134) is a killed univalent parvovirus vaccine. Dose: 1ml. Route: IM. Frequency: same as listed above for canine distemper.

**Other vaccinations:** In some areas where canine leptospirosis and canine hepatitis are a problem, vaccination may be considered (Carnio 1996). Leptospirosis has been reported in raccoons (Shotts 1981). If canine leptospirosis vaccination is deemed necessary, vaccinate annually with multivalent bacterin (Joslin et al. 1998).

Table 10: Vaccinations for raccoon, coati, and kinkajou (Castro & Heuschele 1992)

Vaccine	Vaccine type	Frequency
Canine distemper	Killed/modified live*	Annual
Feline panleukopenia	Killed/modified live	Annual
Canine adenovirus – 2	Killed/modified live	Annual
Leptospira Bacterin-CI	Killed/modified live	Annual
Rabies	Killed	Annual

\* Vaccine should not be of ferret origin, avian origin is preferred.

Coatis should be vaccinated for the first time at 6, 9, and 12 weeks of age, or until they have received a series of three vaccinations three weeks apart, and vaccinated for rabies at 16 weeks.

- 6 weeks – DHPP (Canine distemper/Parvo) They should not be vaccinated for Lepto or Corona\*.
- 9 weeks – DHPP
- 12 weeks - DHP
- 16 weeks – Imrab rabies

\* Durmune Max 5™ without Lepto, made by Fort Dodge, has been used successfully in the coati (K.Schilling, personal experience).

**Physical Examinations:** It is recommended that all animals have regular routine physical examinations. Young healthy animals can be examined biannually, while clinically healthy but geriatric animals or those with shorter lifespan may be examined more frequently, at the discretion of the attending veterinarian. Additionally any animal that has clinical signs of disease should be evaluated by the attending veterinarian and if indicated, the animal is anesthetized to obtain diagnostic samples and physiologic

parameters. It is ideal to train animals to be able to obtain samples (e.g., blood) and receive vaccinations without anesthesia or darting in order to be able to monitor animals more closely without the need of anesthesia. During the physical examination the following is recommended (see Appendix G for additional recommendations for procyonid physical examinations). The need for each test may vary depending on the geographic location, species, and tests performed at the sending institution.

- Transponders and/or tattoos should be checked and reapplied if they are not readable.
- Baseline physiological parameters, such as weight and body condition scoring, body temperature, heart rate, and respiratory rate, and hydration status should be obtained and recorded.
- Oral exam: including dental chart documentation. Any problems should be noted and addressed if possible. Dental cleaning and polishing should be completed if necessary.
- Ophthalmologic exam; Ear exam: appropriate diagnostics should be completed if there is any indication of problems. Cleaning and treatment should be done if necessary.
- Chest and abdominal auscultation and palpation.
- Assessment of genitalia. Care should be taken to record any changes in the external genitalia, such as vulvar swelling or discharge, testicular enlargement, and mammary gland changes. Contraceptive implants should also be checked to make sure they are in place and not causing any local irritation.
- Skin, feet and nails.
- Anesthesia monitoring sheet.
- Radiographs should be taken and compared to previous ones if possible.
- Hematology and serum biochemistry profile should be performed. For animals that are housed outside in heartworm endemic areas, this can include monitoring for heartworm infection by performing a heartworm ELISA antigen test (will not detect all male infections nor infections with less than three female nematodes). If infection is suspected, POSITIVELY identify the microfilaria as pathogenic before instituting treatment. Treatment is not benign and mortality has been associated with melarsomine dihydrochloride administration to North American river otters and a red panda (Neiffer et al. 2002).
- Serum should be banked whenever possible.
- In some cases urine can be collected from the cage before anesthesia and a urinalysis performed. If any abnormalities are detected, urine should be collected by cystocentesis for a complete urinalysis (may need to include culture and sensitivity).
- Regular fecal examination should be performed to check for internal parasites. The frequency may vary depending on environmental conditions and personnel but should be performed at least annually. Anthelmintics should be administered as needed necessary. Fecal testing should include both a direct smear examination as well as a fecal flotation, and if possible, sedimentation techniques. Baermann fecal examination techniques help identify certain parasites such as lungworms that are otherwise difficult to detect.
- Vaccines should be administered as needed.
- Reports of disease issues, adverse drug reactions, etc. should be reported to the veterinary advisor or AZA TAG on an annual basis, in addition to submission of necropsy reports.
  - NOTE in ovariectomy cases, and necropsies of intact animals, it is strongly recommended that the reproductive tissues be submitted for histopathological examination (even if it is grossly normal) as many diseases may be subclinical and may not affect the individual animal but may have an impact on the reproductive potential of the species.

Perhaps the best way to monitor condition, short of a complete physical examination, is through daily visual inspections combined with the keeper's knowledge of each individual's typical behavior.

**Parasite Control:** It is recommended to diagnose first and treat appropriately. Parasites such as ear mites, fleas, ticks, etc., can be detected during routine physical examination (Petrini 1998). Small carnivores are susceptible to the same parasites as the domestic carnivores, and antiparasite drugs applied to other carnivores (e.g., Piperazine, Telmin, Furacin, Caricide, Yomesan, etc.) have generally proven successful for procyonids as well (Roberts 1997). Species housed out of doors should be routinely administered heartworm preventative in areas where this parasite is endemic (Denver 2003). Fecal examinations should be performed at least annually, but may be more frequent depending on the risk of exposure. The following are recommendations for parasite testing and treatment:

Internal	<ul style="list-style-type: none"> <li>• Annual/ semiannual fecal examination (direct smear, fecal flotation, and sedimentation or Baermann). De-worming should be done as determined by the results of regular fecal exams. As a screening test, samples from the same cage can be pooled. If results are positive, it is possible to perform a separate fecal examination on each animal in order to determine who is positive. However, it is very likely that all animals in the enclosure will need to be treated.</li> <li>• Pre-shipment fecal examinations: direct smear and flotation.</li> <li>• Quarantine fecal examination: 3 negative results of 1/week fecal direct smear and flotation.</li> <li>• Heartworm ELISA antigen tests can be conducted annually in animals exposed to mosquitoes in heartworm endemic areas. Heartworm has been reported in otters (Snyder et al. 1989a; Neiffer et al. 2002; Kiku et al. 2003), ferrets (Sasai 2000), and raccoons (Snyder et al. 1989b).</li> </ul>
External	<ul style="list-style-type: none"> <li>• Animals should be inspected for external parasites, including ear mites, during any physical examination (Petrini 1998).</li> </ul>

## 6.6 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing a procyonid 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.

As most procyonids will sleep in nest boxes, it is relatively simple to periodically capture and weigh even the most intractable and flighty animals by closing them in their nest boxes when they are asleep. Obtaining a weight involves simply weighing the nest box with the animal in it and subtracting the known weight of the nest box and any bedding used. This precludes stressful (to both animal and handler!) capture by net or other potentially injurious means. A little forethought in nest box design can also minimize the potential disturbance of monitoring infants in the nest (Roberts 1997). These species also are good candidates for behavioral training; animals can be conditioned to enter squeeze cages, anesthesia chambers, stand on scales, etc.

Animals being anesthetized should be kept as calm and quiet as possible; voices should be kept low and only those staff members necessary to the procedure should be present during the catch-up and initial anesthesia induction. All animals recovering from anesthesia should be kept in a dark den box, or confined space to facilitate smooth recovery (Fernandez-Moran 2003). It is suggested that the recovery area be kept warm since animals coming out of anesthesia have more difficulty regulating their body temperature. Also, a decrease in body temperature will increase the time needed to fully recover from the anesthesia and may prove detrimental to the overall health of the animal.

Many procyonids are of a size that lends itself well to gas chamber induction. This is a safe method and recoveries are generally quick. Because of its relative safety and low cost, intramuscular (IM) ketamine has been the immobilizing agent of choice for most carnivores including procyonids. However, ketamine alone can produce a number of adverse effects such as excessive salivation, tonic clonic convulsions, hyperthermia, muscular rigidity, and apnea. (Maran & Robinson 1996; Blomqvist & Rudbäck 2001). Therefore the use of ketamine alone is not recommended in carnivores. These side effects can be controlled by the concurrent administration of sedatives such as diazepam (Valium) midazolam, xylazine or medetomidine. It should also be noted that the IM absorption of midazolam is more reliable than that of diazepam.

Combinations of ketamine, an alpha-two agonist (medetomidine or xylazine) and opioid (butorphanol) provide reliable and smooth anesthesia. The opioid and the alpha-two agonist can be antagonized (naloxone and atipamezole resp.) to recover the animal more quickly or to alleviate any cardio respiratory problems the animal may encounter. If used to alleviate cardio respiratory, problems place the animal on a gas anesthesia (Isoflurane). It is not recommended to antagonize the opioid and the alpha-two agonist until at least 30-45 minutes after the administration of ketamine, to avoid the effects of ketamine alone. Combinations of ketamine and alpha-two agonist have produced hypertension in other carnivores (Larsen et al. 2002), therefore it is important to monitor blood pressure. Tiletamine/zolazepam is a combination of

a dissociative and a sedative similar to midazolam or diazepam. It is only available as a combination. Anesthesia is reliable and safe, but recoveries tend to be prolonged.

Table 11: Drugs & dosages used for procyonid species (from Denver 2003)

Drug	Dosage
Ketamine <sup>1</sup>	10-30mg/kg
Ketamine/diazepam	10mg/kg; 0.5mg/kg
Ketamine/midazolam <sup>2</sup>	10mg/kg; 0.25-0.5mg/kg
Ketamine/xylazine <sup>3</sup>	10mg/kg; 1-2mg/kg
Ketamine/medetomidine <sup>4</sup>	2.5-5mg/kg; 25-50µg/kg
ketamine/ medetomidine/ butorphanol	4 mg/kg; 0.04mg/kg; 0.4mg.kg
Tiletamine/zolazepam <sup>5</sup>	3-5mg/kg
Telazol <sup>7</sup>	6-10mg/kg
Isoflurane <sup>6</sup>	In chamber, as needed

<sup>1</sup> Ketamine alone is suitable only for short, minor procedures and may induce significant prolonged hyperthermia.

<sup>2</sup> Ketamine/midazolam and medetomidine/ketamine should have the least respiratory depressant effects.

<sup>3</sup> Ketamine/xylazine may result in significant prolonged hypoxemia.

<sup>4</sup> Medetomidine/ketamine has the advantage of medetomidine being easily reversible using atipamezole (100µg/kg)

<sup>5</sup> The tiletamine/zolazepam combination is very safe, with a prolonged recovery

<sup>6</sup> Isoflurane chamber induction can be used; it also should be used as a supplement, or for maintenance, during long procedures.

<sup>7</sup>Booth-Binczik, personal communication. Used for hundreds of coati immobilizations in the wild, and it worked beautifully, with no muscular rigidity or respiratory depression.

**Coati:** Butorphanol, using a small cat dosage of 0.4mg/kg SQ, has been used successfully as analgesia for coati (S.Grant, personal communication). Ketamine/Rompun (3:1 ratio) at a dose of 3mg/kg IM is a successful anesthesia for coatis (S.Grant, personal communication). Booth-Binczik (2001) effectively used Telazol at a dosage of 6-10mg/kg for hundreds of coati immobilizations in the wild, with no muscular rigidity or respiratory depression seen.

More extensive details on adequate anesthesia protocols can be found in Kollias and Abu-Madi, 2007.

## 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. Staff 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 when their health becomes compromised (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department. Hospital facilities should have x-ray equipment or access to x-ray services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short and long term medical treatments and control for zoonotic disease transmission.

AZA-accredited institutions must have a clear process for identifying and addressing 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

(2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms 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 evaluate illnesses nor prescribe treatment.

### AZA Accreditation Standard

(2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

### AZA Accreditation Standard

(1.5.8) The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

As care givers for the animals residing in our zoos and aquariums, it is vital that we provide the best care possible for them until the time their health deteriorates to a point where euthanasia is the most humane treatment, or the animal dies on its own. Necropsies should be conducted on deceased procyonids to determine their cause of death and the subsequent disposal of the body must be done in accordance with any local, state, or federal laws (AZA Accreditation Standard 2.5.1). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination.

**AZA Accreditation Standard**

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

Diseases that are out of the ordinary or if multiple cases of a certain disease occur, as well as cases of reproductive diseases and contraception problems should also be reported to the veterinary advisor.

**AZA SCTAG Recommendations:** The following table (Table 12) provides a list of diseases and associated clinical signs observed/reported in procyonids; it is not intended as a comprehensive table. For proper treatment and management the reader is referred to more extensive medicine texts. The last column lists the procyonid species in which the disease has been reported; other species may also be susceptible.

Table 12: Diseases that affect procyonids (created by A.Moresco 2003).

<b>Disease</b>	<b>Clinical description</b>
<u>Rabies</u>	
Transmission	Contact of infected saliva with mucosal surface or open wound.
Clinical signs	Considered in any animal with outdoor access with neurologic signs.
Diagnosis	Can only be diagnosed definitively post mortem. Histopath on brain.
Susceptible species	All mammals are susceptible.
<u>Canine Distemper</u>	
Transmission	Aerosol exposure or direct contact with conjunctiva, nasal exudates, urine, or feces. Vaccine (modified live) induced transmission has been reported in red panda.
Clinical signs	Anorexia, vomiting, diarrhea, weight loss, hyperemia of face & ears, hyperkeratosis of nasal planum & footpads, oculonasal discharge, neurologic signs.
Diagnosis	Immunofluorescent antibody test or PCR of conjunctival swab. Histopath exam of affected tissue. May be found with other concurrent diseases.
Susceptible species	Many, including Red panda (Bush et al. 1976; Bush & Roberts 1977; Qin et al. 2007) and raccoon (Wojcinski & Barker 1986; Hamir et al. 1998; Lemberger et al. 2005); MLV vaccine induced in kinkajou and red panda (Bush et al. 1976; Kazacos et al. 1981).
<u>Parvovirus</u>	
Transmission	Direct contact
Clinical signs	Diarrhea, gastroenteritis.
Diagnosis	IFA test on feces. PCR (Elia et al. 2007).
Susceptible species	Raccoon (Martin & Zeidner 1992), red panda (Qin et al. 2007).
<u>Feline panleukopenia</u>	
Transmission	Direct contact with infected animals or via fomite transmission of excreta, in utero from infected mother.
Clinical signs	Vomiting, diarrhea, lethargy, fever, depression, eventually dehydration, leucopenia, abortion. Can be fatal, especially in younger animals.
Diagnosis	Quantitative PCR on blood; Antigen detection in feces.
Susceptible species	Raccoon, Coati (Barker & Parrish 2001; Denver 2003).

<b>Disease</b>	<b>Clinical description</b>
<u>Tyzzler's disease (<i>Clostridium piliforme</i>)</u>	
Transmission	Mainly through fecal-oral route. Can be transplacental.
Clinical signs	Anorexia, depression, diarrhea.
Diagnosis	Serology, histopathology (necropsy), PCR on fecal samples.
Susceptible species	Raccoon, red panda (Wojcinski & Barker 1986; Langan et al. 2000).
<u>Toxoplasmosis</u>	
Transmission	Exposure to sporulated oocysts, ingestion of intermediate host or ingestion of uncooked infected meat.
Clinical signs	Anorexia, lethargy, fever, lymphadenitis, splenomegaly, corneal edema, myocarditis, hepatitis, pneumonitis, neurologic signs.
Diagnosis	Serology, PCR.
Susceptible species	All species (Denver 2003), but frequently reported in wild raccoons (Lindsay et al. 2001).
<u>Neospora</u>	
Transmission	Ingestion of infected tissues or feces.
Clinical signs	Exposure in wild raccoons is minimal, but has been reported. Can occur as a co-infection with other disease.
Diagnosis	Serology, PCR.
Susceptible species	Raccoons (Lindsay et al. 2001; Lemberger et al. 2005)
<u>Dermatophytosis (<i>Microsporium gypsum</i>)</u>	
Transmission	Direct contact or fomite transmission. Exposure to cats.
Clinical signs	Lesions resemble those seen in other species. Young animals most at risk. Skin is thickened, itchy and scaly.
Diagnosis	Definitive diagnosis is done by culture.
Susceptible species	Most species, juvenile red pandas are very susceptible (Montali et al. 1984; Kearns et al. 1999).
<u>GI parasites</u>	
Transmission	Similar to domestic dogs and cats, often fecal-oral route.
Clinical signs	Similar to domestic dogs and cats. <i>Baylisascaris procyonis</i> (roundworm of raccoons) is zoonotic, causing cerebral nematodiasis in other species.
Diagnosis	Fecal exam (float, sedimentation, direct).
Susceptible species	All species.
<u>Lungworm</u>	
Transmission	Depending on the species of lungworm involved, transmission can be direct, by ingestion of L1 from feces or sputum of infected animals, or indirect by ingestion of the intermediate host.
Clinical signs	Can present as coughing, dyspnea, hyperpnea, nasal discharge, or neurological signs.
Diagnosis	First stage infective larva in fecal exam.
Susceptible species	Red pandas usually without clinical disease (Montali et al. 1984).
<u>Heartworm</u>	
Transmission	Bite from infected mosquito.
Clinical signs	Respiratory and cardiac signs. Not all microfilaria infections develop into clinical disease. Often no clinical signs are seen.
Diagnosis	Antigen detection in blood (ELISA), microfilaria in blood (Knott's test/ blood smear), necropsy findings.

<b>Disease</b>	<b>Clinical description</b>
Susceptible species	Raccoon (Snyder et al. 1989b); no patent infections have been described.
<u>Other hemoparasites</u> ( <i>Babesia lotori</i> , <i>Trypanozoma</i> , <i>Dirofilaria tenuis</i> , <i>Mansonella lewellyni</i> )	
Transmission	Bite from infected arthropods.
Clinical signs	<i>Babesia</i> most common of these four hemoparasites in raccoons.
Diagnosis	Blood smear, microscopy..
Susceptible species	Free ranging raccoons in Florida (Telford & Forrester 1991).
<u>Sarcoptic mange</u>	
Transmission	Exposure to infected animals.
Clinical signs	Scabs around head and neck, tail, feet.
Diagnosis	Finding the mites in skin scrapings or biopsy.
Susceptible species	Many
<u>Fleas</u>	
Transmission	Can transfer from other animals, although tend to prefer specific host.
Clinical signs	Signs may vary from asymptomatic to fleabite allergy. Pruritus, inflammation, or anemia can also occur, especially in young or sick animals with heavy infestation.
Diagnosis	Finding fleas or flea dirt in the coat.
Susceptible species	Many
<u>Ticks</u>	
Transmission	Similar to transmission in other mammals
Clinical signs	Itching. May transmit other diseases.
Diagnosis	Finding ticks on animals. Others in group may be affected.
Susceptible species	Many
<b>Non-infectious disease</b>	
<u>Dental disease</u>	
Risk factor	---
Clinical Signs	Decreased appetite, weight loss.
Diagnosis	Physical exam, radiographs.
Species reported	Red pandas are prone to it (Denver 2003).
<u>Hyperthyroidism</u>	
Risk factor	---
Clinical Signs	---
Diagnosis	Physical exam, serum chemistry.
Species reported	Raccoon (Denver 2003).
<u>Hepatic disease</u>	
Risk factor	Diet change.
Clinical Signs	Increased ATL.
Diagnosis	Blood chemistry, biopsy.
Species reported	Red panda (Montali et al. 1989).
<u>Renal disease</u> ( <i>interstitial nephritis</i> )	
Risk factor	Some cases in wild raccoons due to leptospirosis, others unknown cause.
Clinical Signs	Similar to other mammals with renal disease. Dependent on stage of disease.

<b>Disease</b>	<b>Clinical description</b>
Diagnosis	Histopathology
Species reported	Free ranging raccoons (Hamir et al. 2001).
<u>Cardiac disease</u> (CHF and cardiomegaly)	
Risk factor	---
Clinical Signs	As in other mammals
Diagnosis	Physical exam, radiographs, ultrasound.
Species reported	Red pandas
<u>Uterine neoplasia</u>	
Risk factor	Possibly MGA implants.
Clinical Signs	Purulent vaginal discharge
Diagnosis	Physical exam, histopathology.
Species reported	Coati (Chittick et al. 2001)

**Useful Veterinary References:** (This list is not exhaustive, but a sampling of medical references not cited.)

- Fournier, P., Fournier-Chambrillon, C., Vie, J.C. (1998). Immobilization of wild kinkajous (*Potos flavus*) with medetomidine-ketamine and reversal by atipamezole. *Journal of Zoo and Wildlife Medicine* 29(2):190-194.
- Hanson, W.L., Boggs, D.F., Kay, J.M., Hofmeister, S.E., Okada, O., Wagner, Jr. W.W. (2000). Pulmonary vascular response of the coati to chronic hypoxia. *Journal of Applied Physiology* 88(3): 981-986.

## 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.

Procyonids have relatively small litters (usually 1-4 young per litter and most often 2-3) of altricial young that remain nest bound for at least 45 days. The temperate species (raccoon and ringtail) tend to be seasonal breeders and the approximate timing of parturition can be predicted with some confidence. (Ringtails' estrus lasts one to two days, generally occurring in April or May.) The tropically distributed species (e.g., kinkajou, olingo, and some raccoon species) are not seasonal, and should be monitored much more closely for evidence of pending parturition.

Table 13: Selected Procyonidae reproduction/development parameters (from: Denver 2003; Reed-Smith et al. 2003, Appendix K)

Parameter**	Raccoon ( <i>Procyon lotor</i> )	Brown/white nosed coati ( <i>Nasua</i> )	Kinkajou ( <i>Potos flavus</i> )	Ringtail ( <i>B. astutus</i> )	Cacomistle ( <i>B. sumichrasti</i> )
Breeding season	Mid-Dec to early August	Feb-Apr in Panama; Non-seasonal in zoos	Nonseasonal	Feb-May	Year-round, peaks in late winter
Estrous freq.	Typically monestrous	1-3 times per year	Polyestrous	Monestrous	---
Estrus duration	9 days	10 days	Estrus lasts 4-6 days every 60 days or so	24-36 hours	24 hour conception period
Courtship	Elaborate movement patterns	Lek-like mating system	Non-ritualized.	Increased, localized urine depositing and scattering of feces	Submissive chirps, crouches, and "coy" behavior
Copulation	May last as long as an hour	23-60 minutes, repeatedly over the course of 10 days	Several times over several days	Several times per hour for a few minutes	Several times per hour for a few minutes at a time
Gestation (days)	60-75	70-77	112-118	51-54	63-64
No. of offspring	1-7, usually 3-4	2-7, usually 3-5	1, rarely 2	1-5, usually 2-4	1-5
Birth weight (g)	60-75	100-180	150-200	28	Ave. 28
Eyes open (days)	18-23	~10-11	7-19	21-34	31-34
First solid food	~7-8 weeks	8-10 weeks	7-8 weeks	~4 weeks	~4 weeks
Weaned	7-16 weeks	By 4 months	~4 months	3-4 months	~4 months
Sexual maturity*	Females at 9-10 months; males at ~2 years	~2 years for males & females	Males at 1½ years and females at 2¼ years.	~9-10 months	Some say ~10 months, others 1.9 years

\* Capable of breeding but may not be successful until older

\*\* Poglayen-Neuwall 1995; Gompper & Decker 1998; Stanley et al. 1999; Haas & Roback 2000; B.Snyder, unpublished information.

It has been speculated that ringtail and cacomistle (*Bassariscus spp.*) may mate permanently or semi-permanently in the wild but there is no evidence of direct male parental care, and females even endeavor to keep males away from the nest containing infants. Most female procyonids reproduce in their second year and males become sexually mature somewhat later; all have reproductive life spans in

excess of 10 years. Females may be seasonally polyestrous (although some, like *Bassariscus*, are monestrous) and adult females not reproducing in the spring may cycle again within four months with the result that a second birthing season may occur unusually late in the year. While breeding is seasonal in many species in the wild, this appears to be a resource-based effect, with reproductive seasons tending to decay and even disappear in zoos or aquariums. Increasing winter photoperiod plays an important role in initiating reproduction for seasonal breeders. Some of the procyonids do show marked behavioral differences seasonally. Typically these changes are observed during the breeding season or when a female is in estrus, for example when male coatis join the female troop during breeding season. Also, typically solitary animals, such as the raccoon, olingo, ringtail, and cacomistle, may spend more time with an exhibit mate (Roberts 1997). Hormonal tracking of a male or female's reproductive status is possible using fecal or urine hormonal metabolite testing. If this is required, the AZA SCTAG Chair should be contacted for the current Reproductive Advisor's name and contact information.

Gestations tend to scale with body size and most range between 60 days (ringtail and cacomistle) and 72-77 days (coati). A gestation of 113-117 days is on record for the kinkajou (B.Snyder, unpublished information, 2003). The onset of the breeding season is marked by increased activity and agonism, especially among males; mating itself is prolonged and vigorous. This is especially the case for raccoons where males have a very long, re-curved baculum, which presumably has evolved as a result of intersexual competition among males. Most species are solitary and females should be isolated from all conspecifics during the birth and rearing period. While coatis are gregarious during the non-breeding period, females leave the band to give birth and typically do not rejoin the group until some weeks after parturition. Therefore, provision should be made to isolate expectant females in this species as well (Roberts 1997).

In ringtail and cacomistle females there is a clear swelling of the vulva 7-10 days before peak estrus; females of these species are receptive only for about 24 hours (Partridge 1992). Successful breeding in the ringtail often can be marked by observing the female whose vulva has sealed shut with a layer of dried vaginal fluid covering it. This is normal and no attempts should be made to clear this up unless there is evidence of another underlying condition that mandates intervention.

Coati: Female coatis should be housed as a group, neutered/young males can be housed with the females, but the breeding male should be introduced only when a female shows signs of estrus. Groups of females with young are the typical social structure of the coati species. Male coatis should be introduced to females once they begin to show behavioral signs of estrus. It is suggested that the breeding pair be introduced to one another in a neutral space, or one familiar to the female. Off-exhibit holding areas are ideal for this if they are large enough (V.Walkosak, unpublished information 2003). The male and female should also be introduced to one another away from the group; if excessive aggression occurs the pair should be separated and reintroduced several hours to a day later (V.Walkosak, unpublished information 2003). Due to the generally solitary nature of coati males, provisions should be made to allow for isolation of males if required (Standley 1992). Typically males only join female groups for mating. Outside of the breeding season the females and juveniles drive the males away. In zoos and aquariums, females are particularly intolerant of males following parturition (Standley 1992).

Male coatis can remain apart from female groups except during the breeding season, but coatis have a flexible social organization, and in some locations males associate with female groups at all times of year (Booth-Binczik 2001; Hirsch 2007). When female groups are very large, male coatis exhibit lek-like mating behaviors (Booth-Binczik et al. 2004, personal communication); during the breeding season males display to attract females. Such displays include fighting with other males, which frequently results in serious injury and, occasionally death of the opponent.

Young males should be removed from coati groups before they reach sexual maturity at about two years of age (Campbell 2001). Neutered males can be maintained in all-female groups (V.Walkosak, unpublished information 2003).

Ringtail and cacomistle: Typically, male ringtails and cacomistles play no role in the rearing of young (Partridge 1992). Some experts believe the female will allow the male to rejoin the family group when the young are roughly three weeks of age (Poglayen-Neuwall & Toweill 1988). Others believe the young are still vulnerable to infanticide at that age and that the male should not be reintroduced until much later (K.Schilling, personal experience).

Ringtail and cacomistle females housed in trios should be separated from the other female as they are likely to interfere with one another's litters resulting in infanticide (Partridge 1992). Pregnant females

also will become hostile to the male, who should also be removed. Sometimes this expected aggression does not occur, usually when pairs are housed together. In these cases, the male may be driven from the communal nest box, and so alternate sleeping boxes should be provided for him shortly before parturition (Partridge 1992).

The rate of cannibalism is extremely high in *ex situ* populations of ringtails (K.Schilling, personal experience). Females should feel safe and secure when raising a litter. Removal of the male is highly advisable to prevent one or both of the ringtails from cannibalizing the kits (K.Schilling, personal experience).

**Kinkajou:** Kinkajou trios can be left together at all times during breeding. Some trios may be kept together through parturition with one female even helping care for the other's young. In other cases the pregnant female may need to be moved to other quarters. Close monitoring by keepers will determine the appropriate course of action for a particular trio (Kays & Gittleman 2001). See Appendix K for more detailed information.

**Facilities for Reproduction:** Proper nest and maternal management is essential if successful reproduction is a primary goal of *ex situ* population maintenance. Prior to parturition, females will locate a suitable nest site and will prepare it by adding nest material. Straw, hay, grasses, leaves, twigs, and sticks will be used if available. Some procyonids routinely move infants during the nest bound phase of development so alternative nest areas should be provided to accommodate for this behavior. While some species (e.g., raccoon) are fairly adaptable to zoos and aquariums and will rear young in almost any nest area provided, other species (e.g., ringtail and cacomistle) are much less flexible, and care should be taken to provide appropriate and secure nest areas. Often, the provision of a number of nest areas prior to birth allowing the expectant mother to choose an acceptable one is all that is necessary (Roberts 1997).

Pregnant females should be provided with a nest box located away from the group (coatis) or male (kinkajou, ringtail, cacomistle, and olingo). If the exhibit is large enough to allow a parturient female to isolate herself, it is acceptable to leave her with the group. This size may vary from female to female, in general it should be interpreted as large enough to allow the female complete separation from the sounds and smells of conspecifics. Typically, a parturient female should be moved to a quiet, secure location, which she has previously been familiarized with (Campbell 2001; Reed-Smith et al. 2003). See Section 7.3 for additional species-specific information.

## 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.

AI is not a technique currently used in procyonids.

## 7.3 Pregnancy and Parturition

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

**Coati:** In the wild, female coatis will leave the band to give birth, and will not rejoin it until the young are roughly six weeks of age (Standley 1992). Parturient females should be separated from the group or other exhibit mates; females are known to vigorously defend their nests, which could lead to animal injury or neglect of the young (Standley 1992).

Female coatis left with the group to give birth have exhibited aggression towards the male (Campbell 2001), and if there is insufficient cage space 'kidnapping' of the young among the mothers has been reported (Grzimek 1990). Walkosak (unpublished information 2003) states the separation of a parturient female coati into an adjacent suite, which includes nest box, climbing structures, food, water, etc. has been key to the successful rearing of young; this should be an area the female is familiar with. Some managers recommend the male should be removed from the females after breeding season and not held within scent/visual range when the female gives birth. Booth-Binczik (personal communication) offers this observation from the wild: "...females interact amicably with males throughout pregnancy and nesting - they just don't allow them to actually go to the nest. They generally don't allow other females to go to the nest either...females sharing a nest was observed on a couple of occasions." It may not be necessary to remove the male from scent/visual range, something that should be evaluated in each situation, and closely bonded females pregnant simultaneously may be able to be left together in some situations. Management choices should be evaluated based on physical size/layout of the exhibit and individual animals involved (Booth-Binczik, personal communication).

Female coatis should be provided with their own nest box that should be approximately 61 cm x 46 cm x 61 cm (2 ft long x 1.5 ft wide x 2 ft high) (Standley 1992; Campbell 2001), as well as an alternate nesting site where she can move her young if she becomes nervous (Standley 1992; V. Walkosak, unpublished information 2003). Female coatis should be separated from the group just prior to giving birth (V. Walkosak, unpublished information 2003). The female should be left alone without human interference, unless required, or the mother can become too stressed (Haas & Roback 2000).

The well-bedded nest boxes should be provided in quiet, private areas easily accessed by the keeper staff, once the female has settled down, for cleaning and monitoring of young development.

**Kinkajou:** Kinkajou pairs can be left together for parturition but should be monitored for aggression or excessive interference by the male with the young (B. Snyder, unpublished information 2003). Some trios can be left together but should be closely monitored, especially the first time one of the females gives birth (Kays & Gittleman 2001). See Appendix K for more detailed information.

**Ringtail and Cacomistle:** There is a high rate of cannibalism of ringtail babies in *ex situ* populations, often as the result of improper husbandry. This is a highly sensitive species that should be given ample time (several weeks) to become accustomed to new surroundings before giving birth. Schilling recommends isolating female ringtails in familiar surroundings and that unfamiliar/loud noises should be kept to a minimum (K. Schilling, personal experience). Females should be given quiet and privacy as well as nest box choices. Females of both species should be separated from exhibit mates. Primiparous ringtail females should be monitored to ensure they are caring for their young and have not abandoned or eaten them. Poglayen-Neuwall (1980b) reports for the ringtail:

"The annual breeding season extends from Feb. into May, with the majority of matings taking place in April. The female is receptive during a 24 hour period only, which coincides with the peak of the estrous swelling of her vulva. If conception has occurred, vulval swelling commences again a few days after the termination of the estrous cycle and shows another peak at the time of parturition. Recurring vulval swelling is an indication of pregnancy in addition to mammary development and increased abdominal girth. The gestation period in this species varies from 51 days and 8 hours to 53 days and 14 hours, and parturition may last from 85-126 min. This is the shortest gestation period among Procyonidae. No post-partum estrus with copulations was observed even after the loss of neonate young."

In another article (original articles in German, this information is taken from English summaries), Poglayen-Neuwall, I. (1980a) states:

"Young ringtails frequently ingest saliva from the mother's mouth during the nutritional weaning stage, when the mother's mammary glands begin to dry up. Spontaneously, or more often after prodding by the young, the mother facilitates the saliva licking by opening her mouth and bending her head toward the young. When the young are essentially weaned, fully mobile and capable of following the mother on extended foraging excursions, the mother will deny the young access to her mouth and the interest of the young in this source of fluid will wane rapidly. This behavior may contribute to the survival of young ringtails under conditions of aridity and excessive heat by minimizing the danger of dehydration."

See Table 13 for estrus, courtship, copulation, gestation, and kit development information.

## 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.” See below for summary information about birthing facilities, however Section 7.1 and 7.3 also should be consulted for management considerations.

**Coati:** Female coatis should be provided with their own nest box that should be approximately 61cm x 46cm x 61cm (2 ft long x 1.5 ft wide x 2 ft high) (Standley 1992, Campbell 2001), as well as an alternate nesting site where she can move her young if she becomes nervous (Standley 1992; V.Walkosak, unpublished information 2003). Female coatis should be separated from the group just prior to giving birth (V.Walkosak, unpublished information 2003). The female should be left alone without human interference, unless required, or the mother can become too stressed (Haas & Roback 2000).

The well-bedded nest boxes should be provided in quiet, private areas easily accessed by the keeper staff, once the female has settled down, for cleaning and monitoring of young development.

**Kinkajou:** No information is available on recommended nest box size for this species. The female should be provided with at least two nest box choices; boxes should be large enough for her to turn around in and to accommodate the presence of young. Boxes should be provided with dry nesting material. Females should not be disturbed immediately after parturition unless trouble is suspected. Normal routines should be maintained but noise kept to a minimum.

**Ringtail and Cacomistle:** There is a high rate of cannibalism of ringtail babies in *ex situ* populations, often as the result of improper husbandry. This is a highly sensitive species that should be given ample time (several weeks) to become accustomed to new surroundings before giving birth. Schilling recommends isolating female ringtails in familiar surroundings and that unfamiliar/loud noises should be kept to a minimum (K. Schilling, personal experience). Females should be given quiet and privacy as well as nest box choices. Females of both species should be separated from exhibit mates. Primiparous ringtail females should be monitored to ensure they are caring for their young and have not abandoned or eaten them.

## 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.

**Hand-rearing:** Hand rearing may be necessary for a variety of reasons – rejection by the parents, ill health of the mother, or weakness of the offspring. Careful consideration should be given as hand rearing requires a great deal of time and commitment (Muir 2003).

Before the decision to hand rear is made, the potential for undesirable behavioral problems in a hand-reared adult should be carefully weighed (aggression towards humans, inappropriate species-specific behavior, etc.), and plans made to minimize deleterious effects on the development of natural behaviors as far as possible. This may require extensive time commitment on the part of staff, plans for fostering, relocation of the young, exposure to species-specific sounds, etc. Once the decision has been made and the young have been abandoned by the mother, or are consistently getting weaker/losing weight, it is best to remove the infants as soon as possible.

If young have been abandoned by their mother it is best to remove them to prevent infanticide. If the offspring are being cared for but receiving no milk they will be restless, possibly calling continuously, or conversely they may be hypothermic and scattered around the enclosure. Another indicator of trouble would be the female moving around the exhibit continuously while carrying the young; this could mean she is not comfortable with the denning provided, or there is something wrong with her or the young (Muir 2003).

If it is necessary to remove offspring because of an exceptionally large litter, it is best to remove two of the largest infants. The temptation is often to take the smallest, but they stand the best chance if raised by their mother. Hand-rearing of singletons is more likely to lead to severe imprinting than if they have a conspecific to play with (Muir 2003).

**Physical care:** Incubators are the best source of warmth; heat lamps are too intense and can be dehydrating or cause serious burns. Hot water bottles can be used in a pinch and hypothermic babies can be warmed slowly by placing them next to your body (Muir 2003). Most babies will feel more secure if wrapped in layers of towels; this also aids in keeping them warm (Muir 2003). Ringtails and cacomistles should be placed in an incubator with a floor temperature of ~38°C (100°F) (Partridge 1992).

**Feeding Protocols:** Young mammals require a specific number of kcal/day for optimum development and growth. If the formula being offered is nutritionally dense, fewer feedings will be necessary than with formulas that are more dilute or low in fat or protein. Following is a method for calculating the volume of food to be offered daily, the volume that should be offered at each feeding and the number of feedings per day (adapted from Grant 2004).

The Basal Metabolic Rate (BMR) or Basal Energy Requirement (BER) is the amount of energy (kcal) an animal needs for basic metabolic function at rest in a thermoneutral zone. In other words, the amount of calories it needs to stay alive, without having to use energy to maintain normal body temperatures. The formula to determine the BER/BMR is:  $70 \times \text{body wt (in kg)}^{0.75}$  (Kleiber 1947). For a 30g infant the BER would be:  $70 \times 0.03^{0.75} = 5.0$  kcal/day. For a 90g infant the BER would be:  $70 \times 0.09^{0.75} = 11.5$  kcal/day. For this formula, 0.75 is an exponent that is multiplied by the body weight to put mammals of different sizes on the same playing field when assessing metabolism. As body weight increases, metabolism decreases, so a larger animal will not have the same caloric requirement as a much smaller animal (e.g., mice consume a much higher percentage of their body weight than an elephant does). In order to complete the calculations, you will need a scientific calculator that does exponents other than squares. Follow steps 1-3 below to calculate the BER. Add step 4 if you want to calculate the Maintenance Energy Requirement. Table 14 provides some pre-calculated MER values.

1. Key in the body weight (in kg) into the calculator
2. Press the exponent key (on Texas Instrument calculators the button is marked by the symbol  $x^y$  representing x with the exponent y) and type in 0.75
3. Press the equals sign, and then multiply that by 70 to get the BER.
4. To calculate the MER, multiply this value by the MER factor (i.e., 2, 3 or 4) to get the kcal required for that particular animal. .

Once the BER is established, the Maintenance Energy Requirement (MER) can be calculated. This measurement determines the amount of calories the animal needs to function in a normal capacity at its life stage. For adults in a maintenance life stage, the BER is multiplied by 2. For infants that have a higher metabolism and are developing and growing, the BER is multiplied by 3 or 4 (Evans 1987), depending on the species and other factors.

The stomach capacity for most placental mammals is 5-7% of the total body weight (Meehan 1994). Convert the body weight into grams to find the stomach volume in ml/cc. To calculate the stomach capacity in ounces, convert body weight into grams (30g ~ 1oz). It is important that units are the same for body weight and stomach volume. The stomach capacity is the amount of formula an infant can comfortably consume at one feeding. Offering much more than this value may lead to overfilling, stomach distension and bloat. It also prevents complete emptying of the stomach before the next feeding and promotes the overgrowth of potentially pathogenic bacteria, diarrhea, and enteritis (Evans 1987).

The following calculations will determine the total volume and kcal to feed/day, as well as the amount of formula for each feeding and the total number of feedings daily (see Table 14 for sample calculated kcal/day and stomach capacity for various body weights).

1. Calculate Maintenance Energy Requirement (MER):  $70 \times \text{body wt (kg)}^{0.75} \times 3$  or 4.
2. Determine stomach capacity (amount that can be fed at each meal):  $\text{Body weight (in grams or ounces)} \times 0.05$ .
3. Divide MER (number of calories required per day) by the number of kcal/ml in the formula to determine the volume to be consumed per day. This value can be converted into ounces, by dividing it by 30.
4. Divide ml of formula per day by volume to be consumed at each meal (stomach capacity). This gives the number of meals to be offered per day.
5. Divide 24 hours by the number of feedings/day to find the time interval between feedings.

Table 14: Chart for determining kcal/day and stomach capacity for various body weights (Grant 2004)

Weight (grams)	MER (kcal/day) [70 x bw (kg) <sup>0.75</sup> x 3]	MER (kcal/day) [70 x bw (kg) <sup>0.75</sup> x 4]	Stomach capacity (ml/feeding)
5.0	3.95	5.25	0.25
6.0	4.5	6.0	0.30
7.0	5.1	6.8	0.35
8.0	5.6	7.5	0.40
9.0	6.1	8.2	0.45
10.0	6.6	8.9	0.50
11.0	7.1	9.5	0.55
12.0	7.6	10.2	0.60
13.0	8.1	10.8	0.65
14.0	8.5	11.4	0.70
15.0	9.0	12.0	0.75
16.0	9.4	12.6	0.80
17.0	9.9	13.2	0.85
18.0	10.3	13.8	0.90
19.0	10.7	14.3	0.95
20.0	11.2	14.9	1.0
25.0	13.2	17.6	1.25
30.0	15.1	20.2	1.50
35.0	17.0	22.7	1.75
40.0	18.8	25.0	2.0
45.0	20.5	27.4	2.25
50.0	22.2	29.6	2.5
55.0	23.9	31.8	2.75
60.0	25.5	33.9	3.0
65.0	27.0	36.0	3.25
70.0	28.6	38.1	3.5
75.0	30.1	40.1	3.75
80.0	31.6	42.1	4.0
85.0	33.1	44.0	4.25
90.0	34.5	46.0	4.5
95.0	35.9	47.9	4.75
100	37.3	49.8	5.0
125	44.1	58.9	6.25
150	50.6	67.5	7.5
175	56.8	75.8	8.75
200	62.8	83.7	10.0
250	74.2	---	12.5
300	85.1	---	15.0
350	95.6	---	17.5
400	105.6	---	20.0

Initially the animal should receive only an electrolyte solution for the first 2-3 feedings, depending on how compromised it is. This is to rehydrate the animal and clear the stomach of the maternal milk. Then the artificial formula is started at a diluted concentration, generally at a 1:4 ratio (mixed formula: water) for another two to three feedings. It generally takes 48-72 hours to get the animal on full-strength formula by gradually offering higher concentrations. Depending on the species, three to four feedings of each concentration level (1:3, 1:2, 1:1, full-strength) are recommended to allow for adaptation and to minimize the onset of digestive problems, particularly diarrhea. During the initial phase, weight loss is to be expected but the animal should quickly begin to maintain weight and then start gaining as the formula concentration increases. It's important that the infants not be given full strength formula too soon (in less than 48 hours after pulling for hand-rearing) because the likelihood of diarrhea occurring is extremely high. Diarrhea is of particular concern with neonates less than one week of age because they have very little or no immunity to infections.

The stomach capacity of most eutherian mammals is 5% body weight (bw). This is the volume of formula that should be offered at each feeding (Grant 2004). The total volume offered per day will depend

on how nutrient dense the formula is. The optimal amount would be the number of kcal calculated from the infant's body weight (see Table 14).

As a general rule, animals should not have an overnight break between feedings that are longer than twice the time period between daytime feedings (equivalent to missing one feeding). For example, if you are feeding every three hours during the day, they can go six hours at night without food. When they are eating every four hours, they can go eight hours at night. It is not advisable to go more than eight hours between feedings with species that typically nurse throughout the day when mother-raised. Intervals between feeding also will depend on how healthy or strong the infants are. Very weak neonates will probably need feedings every few hours even through the night; typically this is necessary for only a few days to a week.

Feed only if the infant is hungry and suckling vigorously. Weak infants may be hypothermic, dehydrated and/or hypoglycemic. It is recommended to not offer anything by mouth until the body temperature is within the normal range for its age. Offer oral electrolytes if it will suckle, or give subcutaneously if it is weak or dehydrated. Offer 2.5-5% dextrose to raise glucose level, if necessary. Babies will not die from being slightly underfed, but overfeeding may result in gastrointestinal disease that is potentially fatal. Young animals will be hungry at some feedings, less at others, but this is quite normal (Muir 2003).

It is important to keep in mind that neonates are obligate nose breathers and incapable of breathing through their mouths and nursing at the same time. For this reason, respiratory infections can be life threatening because they may interfere with breathing and make nursing difficult or impossible (Meier 1985). Aspirated formula is frequently a contributing factor to neonatal respiratory infections; to avoid this be sure to select the appropriate nipple. The nipple's hole should suit the neonate's sucking reflex. Also, if a nipple is too stiff, the pup may tire and refuse to nurse.

Hold the pup in the correct nursing position; ventrally or sternally recumbent (tummy down, not on its back), with the head up. Place the hand holding the bottle in such a way that it provides a surface for the pup to push against with its front feet. If milk comes through their nose the nipple hole may be too large or the pup may be trying to eat too quickly.

If an animal aspirates fluids the recommended protocol is to hold the infant with head and chest lower than the hind end. A rubber bulb syringe should be used to suck out as much fluid from the nostrils and the back of the throat as possible. If aspiration is suspected, or if fluid is heard in the lungs, contact the veterinarian immediately; do not administer drugs without the veterinarian's involvement. Monitor body temperature closely for the occurrence of a fever and a decline in the animal's appetite and general attitude. Depending on the condition and age of the animal, diagnostic procedures may include radiographs, CBC, chemistry. It is possible to start a course of antibiotics while results from the blood work are pending, and the attending veterinarian can prescribe an appropriate antibiotic course.

Digestive upset is a common issue with hand-reared neonates, and may be associated with several factors (Meier 1985): a) inappropriate milk formula, b) feeding frequency, c) overfilling the stomach, d) rapid changes in the diet, and e) improper storage of formula (spoilage). Unused formula requires refrigeration, and is safe to use for 24-36 hours after preparation and refrigeration. Refer to the label guidelines of the formula manufacturer. When digestive upset, characterized by diarrhea, bloating, inappetence, and/or extreme fuzziness occurs, it is recommended that one factor is analyzed and/or changed at a time. Lactose intolerance also should be considered, particularly for the coati (D.Bressler, personal communication).

**Ringtail and cacomistle:** The formula of choice is Esbilac<sup>®</sup> (Pet Ag<sup>®</sup> manufacture KMR<sup>®</sup>, Esbilac<sup>®</sup>, Multi-Milk<sup>®</sup> and the Zoologic Milk Matrix<sup>®</sup> line; contact details: 261 Keyes Ave., Hampshire, IL. 60140, 1-800-323-0877/ 1-800-323-6878 www.petag.com), which should be offered 9 times per day for the first 14 days. Total intake per day should be about 6ml per 24 hours for this period. On days 15-30, 18ml should be offered, daily, in 7 feedings (Partridge 1992). Total food amounts should be based on the infant's weight. KMR<sup>®</sup> should not be used for ringtail; they appear to respond initially but then can go downhill quickly, often dying.

Kittens should be stimulated to urinate and defecate for the first three weeks. Solid food should be introduced into the diet on approximately day 35 at which time the Esbilac can be increased up to ~43ml per day and the number of feedings reduced to five. By day 60, Esbilac should be reduced to one feeding of ~30ml and can be eliminated entirely by day 80. The amount of solids offered should be gradually

increased to ~140grams by day 90. Artificial heating can be discontinued when the kittens are about five weeks of age as long as the ambient temperature stays between 24-30°C (75-86°F) (Partridge 1992).

**Raccoons:** The formula of choice for these species is KMR<sup>®</sup> or Milk Matrix<sup>®</sup> 42/25 (Pet Ag<sup>®</sup>). Mix one part powder to two parts water by volume for either product after first ensuring that the kit is well hydrated. The kit should be offered 3:1 rehydrating solution to formula, then half and half before being fed 100% formula. The weaning diet should be comprised of soaked puppy chow, Gerber<sup>®</sup> high-protein baby cereal, and KMR powder with enough water to make up an oatmeal-like consistency. Kits with their eyes still closed may need to be tube feed (DeGhetto et al. 2002).

**Coati:** The formula of choice is Esbilac<sup>®</sup>/water mixed at a 1:2 ratio. Day one pups should start with a hydrating formula solution, progressing gradually over several days to a 1:1 formula/water mix then to straight formula. Formula should be kept at 35-37.8°C (95-100°F) or the baby coati will refuse it. All nipples should be the same size, color, and texture or they might refuse the bottle. Pups should be fed every 2 hours until two weeks of age, and every 3 hours until three weeks of age; at this stage rice cereal should be added to the formula (just enough to thicken it). At 3 weeks, the pups should be fed every 4 hours with a mixture of 1 part formula, 2 parts water, 1 part cereal, 1 part baby peaches (jarred) until five weeks of age. At five weeks of age, pups can go 6 hours overnight without feeding them (D. Bressler, personal communication). Since coatis are lactose intolerant, Lactaid<sup>®</sup> pills should now be added to mixture (2 crushed pills for every 12 scoops of formula) (D. Bressler, personal communication).

Final weaning should not occur before 16 weeks of age (weaning age in the wild). However, weaning may begin at 8 weeks of age with the addition of foods, such as mashed bananas, soaked puppy food, dry puppy food, and scrambled eggs. At this time, the pup should be offered formula in a bottle 4 times a day. Pups should be stimulated to urinate until they are three to four weeks of age. The amount of formula offered should be based on the pups age and weight (see Table 14) (D. Bressler, personal communication).

## 7.6 Contraception

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

In addition to reversible contraception, reproduction can be prevented by separating the sexes or by permanent sterilization. In general, reversible contraception is preferable because it allows natural social groups to be maintained while managing the genetic health of the population. Permanent sterilization may be considered for individuals that are genetically well-represented or for whom reproduction would pose health risks. The contraceptive methods most suitable for procyonids are outlined below. More details on products, application, and ordering information can be found on the AZA Wildlife Contraception Center (WCC) webpage: [www.stlzoo.org/contraception](http://www.stlzoo.org/contraception).

The progestin-based melengestrol acetate (MGA) implant, previously the most widely used contraceptive in zoos, has been associated with uterine and mammary pathology in felids and suspected in other carnivore species (Harrentstein et al 1996, Munson et al 2002, Munson 2006). Other progestins (e.g., Depo-Provera<sup>®</sup>, Ovaban<sup>®</sup>) are likely to have the same deleterious effects (e.g., Chittick et al. 2001; Munson et al. 2002). For carnivores, the AZA Wildlife Contraception Center now recommends GnRH agonists, e.g., Suprelorin<sup>®</sup> (deslorelin) implants or Lupron Depot<sup>®</sup> (leuprolide acetate) as safer alternatives. Although it appears safe and effective, dosages and duration of efficacy have not been systematically evaluated for all species. GnRH agonists can be used in either females or males, and side effects are generally those associated with gonadectomy, especially weight gain, which should be managed through diet. Suprelorin<sup>®</sup> was developed for domestic dogs, but has been tested in very few procyonids (e.g., coati).

**Gonadotropin Releasing Hormone (GnRH) Agonists:** GnRH agonists (Suprelorin<sup>®</sup> implants, or Lupron Depot<sup>®</sup>) achieve contraception by reversibly suppressing the reproductive endocrine system and preventing production of pituitary (FSH and LH) and gonadal hormones (estradiol and progesterone in females and testosterone in males) (Munson et al. 2001). The observed effects are similar to those following either ovariectomy in females or castration in males, but are reversible. GnRH agonists first stimulate the reproductive system, which can result in estrus and ovulation in females or temporary enhancement of testosterone and semen production in males. Then, down-regulation follows the initial stimulation. The stimulatory phase can be prevented in females by daily Ovaban administration for one week before and one week after implant placement (Wright et al. 2001).

GnRH agonists should not be used during pregnancy, since they may cause spontaneous abortion or prevent mammary development necessary for lactation. They may prevent initiation of lactation by inhibiting progesterone secretion, but effects on established lactation are less likely. New data from domestic cats have shown no effect on subsequent reproduction when treatment began before puberty; no research in prepubertal procyonids has been conducted (Bertschinger et al. 2001).

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

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

If used in males, disappearance of sperm from the ejaculate following down-regulation of testosterone may take an additional 6 weeks, as with vasectomy. It should be easier to suppress the onset of spermatogenesis in seasonally breeding species, but that process begins at least 2 months before the first typical appearance of sperm. Thus, treatment should be initiated at least 2 months before the anticipated onset of breeding.

**Progestins:** If progestins (Melengestrol acetate (MGA) implants, Depo-Provera<sup>®</sup> injections, Ovaban<sup>®</sup> pills) have to be used, they should be administered for no more than 2 years, and then discontinued to allow for a pregnancy. Discontinuing progestin contraception and allowing non-pregnant cycles does not substitute for a pregnancy. Use of progestins for more than a total of 4 years is not recommended. MGA implants last at least 2 years, and clearance of the hormone from the system occurs rapidly after implant removal. Progestins are considered safe to use during lactation.

**Vaccines:** The porcine zona pellucida (PZP) vaccine has not been tested in procyonids but may cause permanent sterility in many carnivore species after only one or two treatments. This method is not recommended.

**Ovariectomy or Ovariohysterectomy:** Removal of ovaries is a safe and effective method to prevent reproduction for animals that are eligible for permanent sterilization. In general, ovariectomy is sufficient in young females, whereas, removal of the uterus as well as ovaries is preferable in older females, due to the increased likelihood of uterine pathology with age.

**Coati:** In consultation with the AZA Small Carnivore TAG, ovariohistorectomies may be performed at ~6 months of age and are performed as other spay procedures on mammals: 2-0 PDS or Maxon is recommended for ligating the pedicles and muscle layer; SQ and intra-dermal sutures are very important. The skin can be closed with a small amount of surgical glue (e.g., Nexaband) (S. Grant, personal communication).

**Vasectomy:** Vasectomy of males will not prevent potential adverse effects to females that can result from prolonged, cyclic exposure to the endogenous progesterone associated with the pseudo-pregnancy that follows ovulation. This method is not recommended for procyonids.

## 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.

**AZA SCTAG Recommendations:** As far as possible, all procyonids should routinely shift into a holding area and readily separate into specific holding areas on cue. It is recommended that all animals should be trained to do the following:

**Shift and station:** The animal should come when called by the keeper for daily, visual health checks; this is most often accomplished with fencing or a mesh barrier between keeper and animal.

**Remain calm:** The animal should be calm and not aggressive during visual health checks, and during all training interactions.

**Crate:** The animal should enter a crate on cue (e.g., Wooster 1998).

**Station and scale:** The animal should stand on a scale for routine weighing.

Clicker and target training have proven to be extremely successful with procyonid and very useful when training routine and unusual husbandry procedures. These species respond very well to positive reinforcement. Procyonids are good candidates for desensitizing or training for non-routine procedures such as blood draws, hair clipping for identification, mouth checks, etc. See Appendix H for examples provided by the AAZK Animal Training Committee. See Table 15 for a list of behaviors commonly trained with *ex situ* populations of procyonids.

Table 15: Commonly trained behaviors in procyonids

Raccoons	Ringtails	Kinkajou	Coati
Show paws/feet	Show paws/feet	Target	Show paws/feet
Separations	Target	Blood draw	Show belly
Station	Station	Injection	Target
Target	Show side/torso	Stethoscope	Stations
Stand up	Show belly	Otoscope	Separations
Lie parallel	Stethoscope	Ophthalmoscope	Shift
Climb	Stand on a scale	Leash on/off	Climb
Carry an object	Shift	Move from A to B	Stand on a scale
Enter squeeze cage or crate	Climb	Enter squeeze cage or crate	Enter squeeze cage or crate
Nail trim	Injections		
Take oral medications			
Out (go on exhibit)			
Shape discrimination			

Keepers should avoid use of aversive stimuli in the daily management of procyonids. Profound aversive stimuli such as squirting with hoses, loud noises, harsh words, and long-term withholding of food

are inappropriate unless serious injury of keeper or animal is imminent (e.g., serious fight). Many of the procyonids respond to profound aversive stimuli with fear and/or aggression. It is best to maintain all keeper/animal interactions positive and pleasant. Assessing the animal's motivation (why should it "want" to come in? Why does it "want" to stay outside?) is a useful exercise when training problems occur. Patience and planning are keys to success (Wooster 1998). See Appendix H for examples of commonly trained behaviors (AAZK Animal Training Committee). The following table (Table 16) provides descriptions of behavioral cues and criteria for trained behaviors used with procyonids.

Table 16: Sample trained behaviors, cues, and reinforcement criteria\*

Species	Behavior	Verbal cue**	Visual cue**	Criteria for reinforcement
Coati	Stationing	Station	----	Standing in assigned spot
Coati	Target on item	Target	Tennis ball on a stick	Standing with nose on target
Coati	Scale	Scale	Point to scale	Standing calmly on scale
Kinkajou	Go into crate	Crate	Point to crate	Animal enters and allows door to be closed
Kinkajou	Collar with leash	Collar	Show collar	Animal has collar & leash put on while staying calm
Raccoon	Target	Target	Target stick presented	Stands with nose on target
Raccoon	Up	Up	Arm extended with hand flat against mesh of cage	Stands on hind feet while front feet rest on wire mesh
Raccoon	Follow	Follow	Right index finger points at animal	Animal follows trainer
Raccoon	Crate in	Crate	Right index finger points at animal & then at crate	Animal enters crate and waits
Raccoon	Crate out	Out	Right index finger points at animal & then away from crate	Animal leaves crate
Raccoon	Scale	Scale	Animal is targeted to scale	Animal stands calmly on scale
Raccoon	Paw present	Touch	Touch apparatus is moved to front of cage	Animal holds bar until bridged

\* Information from: B.Stark, Institution H; A.Varsik, Institution I; C.Shultz, Institution J; A.Dosch, Institution K; J.Gramieri, Institution L

\*\* Verbal and visual cues may differ between facilities; the above table is intended to illustrate examples of cues used successfully.

**Animal Management and Exhibit Design:** In general, procyonid species can be trained in protected-contact (i.e., keeper and animal should be separated by a mesh barrier) or free contact situations; these decisions should be made by the institution's management staff, taking the species and individual animal into consideration. It is advised that all facilities have holding areas in order to shift animals into/out of their primary enclosure. Husbandry training may occur anywhere the individual animal seems to feel comfortable and where the keeper can safely access them through a mesh screen. Care should be given not to encroach upon the animal's flight distance. Managers and caretakers should decide if food rewards can be hand fed through/under mesh screen or if a meat stick should be used to deliver the food.

## 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 animals 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.

It is recommended that an enrichment program be based on current information in biology, and should include the following elements: goal-setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. Environmental

enrichment programs should ensure that all environmental enrichment devices (EEDs) are safe and are presented on a variable schedule to prevent habituation. AZA-accredited institutions must have a formal written enrichment program that promotes species-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1).

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).

**AZA SCTAG Recommendations:** Development of enrichment ideas should be goal-oriented, proactive, based upon the animal's natural history, individual history, and exhibit constraints, and should be integrated into all aspects of their *ex situ* population management. Successful enrichment techniques include variation of exhibit schedule or exhibit mates (where appropriate only), re-arranging of exhibit furniture/features, change of furniture (some of the old should always be retained to maintain the animal's scent and an element of the familiar), scents, sounds, toys (natural and artificial; care should be taken they cannot be eaten, broken, or become stuck in the animal's mouth), herbs, spices, different substrates for digging/rolling, food items, and novel presentation of food items. It is important that enrichment items are not merely thrown in an exhibit and allowed to stay for extended periods – an enrichment program is only successful and useful if actively managed and constantly reviewed. The American Association of Zoo Keepers (AAZK) Enrichment committee provides the following general guidelines about enrichment:

“The goal of enrichment should be to maximize the benefit while minimizing unacceptable risks. All enrichment should be evaluated on three levels: 1) whether the enrichment item itself poses an unacceptable risk to the animals, 2) what benefit the animals will derive from the enrichment, and 3) whether the manner of enrichment delivery is apt to lead to problems.

A written plan of action that eliminates the most dangerous risk factors while maintaining the benefits of a challenging and complex environment can help animal managers develop a safe and successful enrichment program. Keepers should evaluate new and creative enrichment ideas with their managers and staff from other departments (curatorial, janitorial, maintenance, veterinary, nutritional, etc.) to decrease the frequency of abnormal and stereotypic behaviors or low activity levels, and to fine-tune enrichment ideas. For enrichment to be safely provided, it is strongly recommended that each institution establish enrichment procedures, protocols, and a chain of command that keepers can follow.” (AAZK Enrichment Committee)

The AAZK Enrichment Committee also provides an excellent cautionary list for the various types of enrichment on their web page accessed through [www.aazk.org](http://www.aazk.org). This list includes key questions that should be answered for all enrichment items or programs to assess potential hazards. For example:

1. Can the animals get caught in it or become trapped by it?
2. Can it be used as a weapon?
3. Can an animal be cut or otherwise injured by it?
4. Can it fall on an animal?
5. Can the animal ingest the object or piece of it? Is any part of it toxic, including paint or epoxy?
6. Can it be choked on or cause asphyxiation or strangulation?
7. Can it become lodged in the digestive system and cause gut impaction or linear obstruction?
8. In a multi-species exhibit or other social grouping, could a larger or smaller animal become stuck or injured by the object or get hung up on it (particularly a young animal)?
9. Can it destroy an exhibit?
10. If fecal material is used for enrichment, has it been determined to be free from harmful parasites?
11. Is food enrichment included as part of the animals' regular diet in a manner that will reduce the risk of obesity?
12. When introducing animals to conspecifics or in a multi-species exhibit, are there sufficient areas for them to escape undesirable interactions?

#### AZA Accreditation Standard

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

#### AZA Accreditation Standard

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

13. Can the manner of enrichment presentation (i.e., one item or items placed in a small area) promote aggression or harmful competition?
14. Has browse been determined to be non-toxic?
15. Do the animals show signs of allergies to new items (food, browse, substrates, etc.)?
16. Does the enrichment cause abnormally high stress levels?
17. Does the enrichment cause stimulation at a high level for extended periods of time that do not allow the animal natural down time in the species' normal repertoire (e.g., constant activity for public enjoyment when the animal would normally be inactive in its native habitat)?

#### **AAZK Enrichment Committee, Enrichment Caution List**

##### **Dietary Enrichment**

- Food enrichment, if uncontrolled, can lead to obesity and tooth decay; deviation from the normal diet can cause nutritional problems. Keepers can consult with the nutritionist or commissary staff to determine the best method of introducing novel food items.
- New food items introduced without analysis may cause colic, rumenitis or metabolic acidosis in ungulates.
- Food items can spoil and cause animal illness if left in the exhibit for extended periods of time. Enrichment food items should be removed within a reasonable amount of time to prevent spoilage.
- Animals can have adverse reactions to toxic plants and chemicals. Keepers should be able to correctly discern between toxic and browse plants, ensure that browse is free of fertilizers and herbicides, and wash plants to remove free ranging bird and animal feces and debris.
- Foraging or social feedings may give rise to aggression and possible injuries within the animal population.
- Competition for enrichment items may lead to social displacement of subordinate animals. These concerns can be minimized by providing enough enrichment to occupy all of the animals within the population.
- Carcass feedings for omnivores and carnivores may be hazardous if the source of the carcass is not determined and appropriate precautions taken. Diseased animals, chemically euthanized animals or those with an unknown cause of death are not appropriate for an enrichment program. Freezing the carcasses of animals that are determined to be safe to feed to exhibit animals can help minimize the risk of parasitism and disease. Providing enough carcasses in group feedings can minimize competition and aggression within an exhibit.
- Carefully introducing a group of animals to the idea of social feedings can be done by moving carcass pieces closer together at each feeding until the animals are sharing one carcass. This can allow social carnivores to exhibit normal dominance posturing while minimizing the possibility of aggression. During live feedings, prey animals may fight back. Care should be taken to ensure such prey can only inflict superficial wounds on zoo animals.
- Cage furniture may interrupt flight paths or entangle horns and hooves if poorly placed. Careful planning can prevent this.
- If unsecured, some items may fall on an animal or be used as a weapon and cause injuries.
- If position is not thoughtfully considered, limbs and apparatus may provide avenues for escape or may block access into exhibit safety zones, leaving subordinate animals feeling trapped and vulnerable.
- Animals that crib or chew wood should be provided with non-toxic limbs and untreated wood furniture.
- Water features should be tailored to the inhabitants to prevent drowning and ensure that animals such as box turtles can right themselves if they flip over on their backs.
- Animals can be injured in filtration systems if water intake areas are not protected.
- Substrates should provide adequate traction and not cause an intestinal impaction if ingested.
- Caution should be exercised when ropes, cables, or chains are used to hang or secure articles to prevent animals from becoming entangled. Generally, the shortest length possible is recommended. Chain can be covered with a sheath such as PVC pipe; swivels can be used to connect the chain to the enrichment item to minimize kinking.

**Olfactory Enrichment**

- Scents from different animals or species can lead to aggression if there is an assertion of dominant animals or subordinate animals attempting to use enrichment to advance their status in the hierarchy.
- Animal feces used for olfactory enrichment should be determined to be parasite free through fecal testing and as with other animal by-products such as feathers, sheds, wool and hair, come from only healthy animals. Many of these items can be autoclaved for sterilization.
- Perfumes can be overwhelming to some animals (and keepers) and are therefore best used in open, ventilated areas.
- Some spices may be too strong or toxic to some animals.

**Auditory Enrichment**

- When provided with audio enrichment, animals may be less threatened by deflected sounds rather than those directed at the animals.
- Some animals may have adverse reactions to recordings of predator calls and should be closely observed when this type of enrichment is provided.
- Providing the animals with an option for escape or the means to mobilize for confrontation when predator calls are played can lessen the stress of this type of enrichment and allow the animals to investigate the sounds and their environment over a period of time.

**Manipulable Enrichment**

- Individual parts or enrichment devices may be swallowed resulting in choking or asphyxiation.
- If ingested, indigestible enrichment items may cause a gut impaction or linear obstruction.
- Broken items may have sharp edges that can cut an animal. Only items that are appropriate for the species should be provided. For example, some devices will hold up to the play of a fox but not a wolf
- When building or designing enrichment items from wood, it may be wise to use dovetail cuts and glue rather than screws and nails. Rounded corners and sanded edges can prevent the animals from getting splinters.
- Many paints and other chemicals are toxic if eaten. When providing enrichment involving paint or other chemicals, only non-toxic items should be used.
- If used, destructible items such as cardboard boxes and paper bags should be free of staples, tape, wax, strings or plastic liners.

Factors that should be considered when determining how often behavioral or environmental enrichment is offered include the species and individual(s) involved as well as the physical characteristics of the exhibit. Large, complex exhibits may offer ample opportunities for animals to exercise natural behaviors with infrequent enrichment (2-3 times weekly). Other exhibits or individuals may require more frequent enrichment (daily or multiple times per day). Husbandry staff should monitor all individuals in an exhibit and structure an enrichment schedule for the needs of those animals, providing them opportunities several times a day to interact positively with their environment. Enrichment should never be offered on a regular schedule, instead times, items, and delivery methods should be rotated so there is always an element of novelty associated with each item or activity.

Many of the procyonid species have acute olfactory senses, enrichment designed to stimulate these senses and encourage foraging should be well-received and stimulate species-appropriate behaviors (Campbell 2001). Additionally, some species are very tactile oriented (e.g., raccoons and coatis), and will benefit from rotating new and unusual tactile stimuli. This is particularly useful for education animals generally housed in smaller enclosures. All enrichment items should be approved by an institution's management team, including the veterinarian and horticulturist.

More information on enrichment initiatives, resources, and references can be found in the following appendices: Appendix I (enrichment and training resources), Appendix J (sample enrichment ideas and techniques).

**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. See Section 8.1 for exhibit design tips to facilitate exhibit design.

Animal management staff should be encouraged to form a trusting relationship with the animals in their care. This, however, does not mean one in which the animals are made pets. All animals should be treated with respect; keeper staff should learn the behavioral profiles of each individual animal and structure their working routines to maximize the animal's comfort. Behavioral management in the form of training for husbandry procedures, both routine and non-routine, is encouraged. Interactions with procyonid species while the public is present should be primarily for educational purposes; interactions with procyonid species for medical emergency or routine husbandry purposes while the public is present should be limited. If these activities have to be carried out while the public is present, it is suggested that an interpreter be present to explain what is happening and why.

Each zoo should have written standard operating guidelines that address the safety of both the animal and the keeper. Keepers should avoid entering the enclosure with the animals present if possible. Where this is not possible, the animals should be given time to get to know the standard husbandry routine and be allowed to separate themselves from the keepers (Roberts 1997).

Keepers should take care to keep outside the flight distance of the individuals involved. This will minimize stress to the animal and the keeper (Roberts 1997). Coatis and kinkajous can become very accustomed to people; sudden movements and excessive interaction with the animals should be avoided.

**Coati and Raccoons:** Keepers should wear protective gear on their hands when working with raccoons that have not been treated for parasites. Both coatis and raccoons show a propensity towards "object claiming". Keepers who have direct contact with these species should keep this in mind. The wearing of jewelry while working with these animals should be restricted. Even animals that are not acclimated to direct human contact will behave with great curiosity and approach to get a better view of items such as watches, earrings, bracelets, and necklaces. Additionally, curious animals also may vehemently search keepers' pockets, so care should be taken to keep pocket contents to a minimum. Bolder animals will make daring attempts to remove or claim such items.

Both raccoons and coatis can behave very aggressively when defending an object they have claimed as their own. This does not apply only to items claimed off of humans, but also objects within their enclosures. Both coatis and raccoons will demonstrate overt aggression when they feel their prize is being threatened. Their claims may be on a particular stick in the enclosure, an edible treat, or a toy placed there for enrichment. In general, if the animal is presently preoccupied with an object, greater caution should be exercised around the animal to prevent defensive attacks on the keeper (K.Schilling, personal experience).

Maintaining eye contact, not turning your back, and keeping your head above the coatis and raccoons whenever possible will help the keeper staff hold a dominant position to the animals (D.Bressler, personal experience; K. Schilling, personal experience). Some coatis and raccoons display aggression as the result of certain sounds. The same sounds may induce playful behaviors in other individuals. Keepers should be aware of this and familiarize themselves with individual animals that demonstrate such behavior and the triggers that may solicit it. Some of the typical sounds that elicit these responses include: jingling keys, squeaky toys, or bells (K.S chilling, personal experience).

## 8.4 Staff Skills and Training

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

The following technical skills and competencies are recommended for all animal care staff working with small carnivores.

- Keepers and managers should have an in-depth understanding of the species natural history and the individual's history.
- Keepers and managers should have an in-depth understanding of the individual animal's behaviors, an understanding of the function of those behaviors, and the ability to describe those behaviors orally and in writing.
- Keepers should be able to recognize signs of illness and injury in the procyonid species they are working with and to communicate those signs orally or in writing to managers and veterinarians.

- Keepers should be able to accurately assess the appropriate level of cleanliness and safety of the animal's exhibit, holding area, and food-prep area.
- Keepers should have the skills to safely capture or restrain the procyonid species in question.
- Keepers should have some understanding of the species natural diet and foraging style.
- Keepers and managers should have an understanding of enrichment concepts and have a commitment to consistently enhance the environments of the species in their care.
- Keepers should understand the concepts of animal learning and training, be able to use a variety of techniques (e.g., habituation, operant conditioning) to train the animals under their care, and to create a training plan (identifying training steps, cues, and criteria). See [www.animaltraining.org](http://www.animaltraining.org) for additional details.
- Managers should understand the concepts of animal learning and training, be able to coach keepers in all aspects of training, review their training plans, look for consistency among keepers in their training techniques, and help their teams prioritize training, enrichment, and other husbandry goals.

## 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 D) 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.

- A kinkajou female that participates in education programs at one institution (Kirkendall, personal communication) is housed indoors at a temperature range of 20° to 22.2° C (68° to 72°F) year-round. Her cage is 121.9 cm x 152.4 cm x 187.9 cm (48 in wide x 60 in deep x 74 in tall). She does not have access to an unsupervised weathering yard, but she is taken out on leash often for programs and physical activity. During exercise periods she is allowed to climb into a small orange tree and run around the lawn area while on her leash.

#### AZA Accreditation Standard

**(1.5.4)** A written policy on the use of live animals in programs should 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 animal collection, 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.

### 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 which have designated program animals are required to develop their own Institutional Program Animal Policy that articulates and evaluates the program benefits (see Appendix E 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

#### AZA Accreditation Standard

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

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 Standards 10.3.3;1.5.2).

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).

### Conservation Education Messages

**Coati:** "There is still debate as to whether or not the Cozumel coati (*N. nelson*) is truly a separate species or a subspecies introduced to Cozumel by the Maya (Bixler, unpublished data). Coatis are highly adaptable animals. They are essentially diurnal in their activities and can be both terrestrial and arboreal. They are also very variable in their social groupings, being either solitary or living in groups of up to 30 individuals; the females live in groups while the adult males are solitary. The term coatimundi, which is often used in the literature to refer to the coati, actually refers to a solitary adult male coati. Coatis are omnivorous, feeding on fruit, invertebrates, and small animals. They will search for fruit high in the forest canopy or forage on the forest floor for animal prey, poking their long noses into crevices, pushing over rocks, or ripping apart dead logs with their claws. When they are alarmed, they seek refuge in trees and at night sleep at the tops of trees....the prime threat to coatis is habitat loss due to deforestation." (Glatston 1994)

- **White-nosed coati:** "White-nosed coatis are classified as an endangered species in New Mexico and they are given total legal protection there. However, in Arizona, where most of the coatis in the United States live, they are subject to year round hunting. Coatis are listed in Appendix III of CITES by Honduras. Elsewhere in their range they do not appear to be afforded any official protection. Coatis are threatened by large scale habitat loss and in some areas hunting. In addition, the coati population in the United States is suspected to be gradually becoming genetically isolated from populations further south as a result of the situation in Mexico. This could lead to local extirpation of the coati in the United States. Coatis are hunted throughout their range either for their skin or for food. In the United States they are occasionally caught in traps set for other species, killed by hunters ostensibly looking for other species, or they fall victim to "predator" control campaigns. They apparently disappeared from the Burro Mountains in New Mexico at about the same time as a coyote poisoning campaign (Kaufmann et al., 1976). In addition, coatis are susceptible to canine distemper and rabies (Kaufmann et al. 1976) (Samudjo et al. 2008)."

**Kinkajou:** "Little is known about the natural history of the kinkajou. It is highly arboreal, as indicated by its prehensile tail. It is the only carnivore, with the exception of the binturong (*Artictis binturong*), to possess

#### 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 collection 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 Accreditation Standard

**(1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

#### 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.

such an appendage. Its diet consists essentially of fruit supplemented by insects (Bisbal 1987). Charles-Dominique et al. (1981) states that kinkajous play an important role in dispersing the seeds of some plant species. Their social behavior has been little studied. Apart from observations of females with their young, kinkajous are normally seen singly, although several may feed together in fruiting trees (Ewer 1973). They have been observed with olingos, and the two species can be confused by some observers. As this is a highly arboreal species, even though we have no evidence that it is becoming threatened, it must be presumed that its numbers decrease with extensive human disturbance (Glatston 1994)."

Threats include extensive human disturbance, deforestation, and the pet trade (Glatston 1994, IUCN Red List 2009)

**Ringtail:** "Of the two species (cacomistle and ringtail), the ringtail has been studied in some detail (Trapp 1972; 1978). This species is known to be nocturnal and solitary in its habits. It inhabits a variety of habitats including rocky or cliff areas, areas of dense riparian or evergreen forest, scrub, and desert. It is restricted to altitudes of less than 2,800 m. Its diet consists of small vertebrates, fruits, and insects. Much of the food is succulent and ringtails are able to produce highly concentrated urine (Richards 1976), and so can live in fairly arid habitats (Kaufmann 1982). The cacomistle is much less well-known than the ringtail but the information available indicates that it inhabits wetter forests than the ringtail and that it is highly arboreal and nocturnal. It is solitary outside of the breeding season (Poglayen-Neuwall & Towell 1988). It forages alone and emits a high-pitched long call which apparently serves as a spacing function (Coates-Estrada & Estrada 1986). However, it is not yet certain whether its behavior and ecology are similar to those of the ringtail. Threats to the ringtail include automobiles and trappers. Threats to the cacomistle include habitat disturbance, deforestation, and fragmentation of populations (Glatston 1994)."

**Raccoon:** There is dispute over how many species of raccoon should be recognized. The common raccoon and crab-eating raccoon have the widest distribution while all other raccoon species, or subspecies, are confined to islands. Some confusion arises from what is thought to be the relatively recent arrival of the island raccoons due to rafting or human introduction. The IUCN Red List recognizes only one of the island raccoons as a separate species, the Cozumel or pygmy raccoon (*P. pygmaeus*), which is listed as Critically Endangered with a decreasing population. The common raccoon should be used to educate the visiting public about raccoons, their natural history, and the threats to the pygmy raccoon and other island raccoons.

"The crab-eating raccoon is naturally rare in some areas of its range and it does not seem as adaptable to human activity as the common raccoon, although it is probably stable throughout South America where viable areas exist. Threats to this species include overhunting for pelts, use for target practice, the pet trade, and, in some areas, habitat destruction (being a rain forest species). Little is known of any of the island forms of raccoon in regards to distribution or natural history. However, they have probably never been very numerous, given the small size of their island ranges and the undoubted negative influence of tourism. Their habitats are probably diminishing and one form, the Barbados raccoon *P. gloveralleni*, is probably extinct. The last sighting occurred in the early 1960s. The status of the rest is indeterminate at present (Glatston 1994)."

The IUCN Procyonid and Ailurid Action Plan (Glatston 1994) has this to say about the cultural significance of the procyonid species:

There does not appear to be any appreciable folklore associated with any species, although it is possible that there may be some references to these species in the folklore of current Amerindians or in those of past cultures such as the Toltecs, Aztecs, Incas, or Mayas. For example, the coati is thought to have been a fertility symbol for the Maya and was also used as a pet and a source of food (possibly eaten only by the women) (Hamblin 1984). Indeed, Bixler (unpublished) speculates that the Cozumel coati may have been brought to that island by the Maya, as Cozumel was an important center for the worship of Ix Chel, the goddess of fertility. Other indications of the interest that some procyonid species may have held for the indigenous people of the Americas are to be found in their local names. The name cacomistle is derived from the Mexican Nahuatl Indian word, "Tlacomiztli", meaning "half mountain lion"; coati is derived from the name "Kuat-l" used by the indigenous Guarani Indians, while raccoon comes from the word "Aroughcoune," used by the Algonquin Indians of Virginia to mean "he scratches with his hands." Further information regarding what, if anything, these animals meant to the tribes

concerned is unknown. On the subject of names, the cacomistle (or ringtail) has also been known as the “miner’s cat,” a name earned because ringtails were placed in frontier mines to control rodents as they were supposed to be better mousers than cats (Poglayen-Neuwall & Towell 1988; Whitaker 1988). Otherwise, cultural interest in procyonids only involves their use as companion animals or as sport. Some procyonid species, notably coatis and kinkajous, are kept as pets in various countries throughout Central and South America today. Some species, again notably the kinkajou and coati, are also hunted for their meat by the indigenous peoples of Mexico and Central America. However, this kind of hunting activity is strictly limited.

### **9.3 Program Evaluation**

AZA-accredited institutions which have an Institutional Program Animal Plan are required to evaluate the efficacy of the plan routinely (see Appendix E 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. The AZA SCTAG has no specific recommendations regarding program evaluation format.

## Chapter 10. Research

### 10.1 Known Methodologies

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

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.

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 or Species Survival Plan® Programs.

The following covers a variety of the types of studies that have been conducted on procyonids to date. This list is not exhaustive and those interested in conducting research should perform a thorough literature review prior to beginning.

#### Behavioral

- Kays, R.W., Gittleman, J.L. (2001). The social organization of the kinkajou *Potos flavus* (Procyonidae). *Journal of Zoology* (London) 253(4):491-504.
- Blount, J.D., Taylor, N.J. (2000). The relative effectiveness of manipulable feeders and olfactory enrichment for Kinkajous *Potos flavus*: A preliminary study of Newquay Zoo. *International Zoo Yearbook*. 37:381-394.
- Weldon, P.J., Cranmore, C.F., Chatfield, J.A. (2006). Prey-rolling behavior of coatis (*Nasua spp.*) is elicited by benzoquinones from millipedes. *Naturwissenschaften* 93(1):14-16.
- Booth-Binczik, S.D., Binczik, G.A., Labisky, R.F. (2004). Lek-like mating in white-nosed coatis (*Nasua narica*): Socio-ecological correlates of intraspecific variability in mating systems. *Journal of Zoology* (London) 262(2):179-185.
- Hass, C.C. (2002). Home-range dynamics of white-nosed coatis in southeastern Arizona. *Journal of Mammalogy* 83(4):943-946.
- Hass, C.C., Jason, F. (2000). Copulatory behavior of white-nosed coatis. *Southwestern Naturalist*. 45(3):329-331.

#### AZA Accreditation Standard

(5.3) Institutions should maximize the generation of scientific knowledge gained from the animal collection. 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 Accreditation Standard

(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.

#### AZA Accreditation Standard

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

**Ex situ Population Management**

- Pernalet, J.M. (1997). Management and reproduction of the Kinkajou *Potos flavus* at Institution M. *International Zoo Yearbook* 35(0):287-289.

**Dietary**

- Kays, R.W. (1999). Food preferences of kinkajous (*Potos flavus*): A frugivorous carnivore. *Journal of Mammalogy* 80(2):589-599.
- Julien-Laferrier, D. (1999). Foraging strategies and food partitioning in the neotropical frugivorous mammals *Caluromys philander* and *Potos flavus*. *Journal of Zoology* (London) 247(1):71-80.

**Field studies**

- Ackerson, B.K., Harveson, L.A. (2006) looked at (1) habitat selection, (2) home range, (3) denning characteristics, and (4) food habits of a population of ringtail in Texas.
- Barja, I. (2006) Reported on fecal marking behaviour in ringtails (*Bassariscus astutus*) during the non-breeding period focusing on spatial characteristics of latrines and single feces.
- Nava-Vargas, V., Tejero-Diez, J.D., Chavez-Tapia, C.B. (1999) Studies the food habits of the ringtail *Bassariscus astutus* (Carnivora: Procyonidae) in a xerophitic bush in Hidalgo, Mexico.
- Hass, C.C., Valenzuela, D. (2002). Anti-predator benefits of group living in white-nosed coatis (*Nasua narica*). *Behavioral Ecology & Sociobiology* 51(6):570-578.

**Physiological**

- Poglayen-Neuwall, I., Shively, J.N. (1991). Testicular cycles of the ringtail *Bassariscus astutus*. (Poglayen-Neuwall has studied the ringtail extensively, including gestation and parturition; see References for other citations.)
- Urashima, T., Yamamoto, M., Nakamura, T., Arai, I., Saito, T., Namiki, M., Yamaoka, K., Kawahara, K. (1999). Chemical characterization of the oligosaccharides in a sample of milk of a white-nosed coati, *Nasua narica* (Procyonidae: Carnivora). *Comparative Biochemistry & Physiology Part A: Molecular & Integrative Physiology* 123(2):187-193.
- McClearn, D. (1992). Locomotion posture and feeding behavior of kinkajous, coatis, and raccoons. *Journal of Mammalogy* 73(2):245-261.

**Vocalizations**

- Compton, L.A., Clarke, J.A., Seidensticker, J., Ingrisano, D.R. (2001). Acoustic characteristics of white-nosed coati vocalizations: A test of motivation-structural rules. *Journal of Mammalogy* 82(4):1054-1058.
- Maurello, M.A., Clarke, J.A., Ackley, R.S. (2000). Signature characteristics in contact calls of the white-nosed coati. *Journal of Mammalogy* 81(2):415-421.

**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.

**Specific Areas of Ex situ Population Research Needed by Manual Heading:****Chapter 1: Ambient Environment**

Section 1.4. Sound and Vibration: Little is known about sound or vibration sensitivity in these species and should be investigated in the future.

**Chapter 3: Transport**

Section 3.2. Protocols: There is no definitive information available at this time as to whether there should be a maximum duration of transport for procyonids. Information from the pre- and post-transport examinations of procyonid species, after transports of differing durations, may provide key information that can be used to determine the need for duration requirements.

## Chapter 4: Social Environment

Section 4.1. Group Structure and Size: There is no information available on the occurrence of cohort groups in procyonid species. Field and *ex-situ* population research is needed to investigate whether this is a common phenomenon for these species.

Section 4.1. Group Structure and Size: There are currently no specific standards of care detailing optimal or minimum group sizes for procyonid species. Additional research is needed to determine the effect that different group sizes and structures have on the welfare of individuals within current AZA institutions. Trends and patterns seen should be reported.

Section 4.2. Influence of Others and Conspecifics: No recommendations are available for the placement of procyonid enclosures with respect to enclosures housing conspecifics or heterospecifics, as there is no information available on the influence that other groups or species can have on individual animals (e.g., from a visual, auditory, or olfactory perspective). Assessing behavioral and physiological indicators of stress in animals housed adjacent to conspecifics or potential predators will provide useful data to explore these non-physical social interactions.

Along similar lines, additional research on the best approaches to take when individuals from social species need to be separated for prolonged medical procedures/treatment (e.g., quarantine, hospitalization) is recommended. Questions that need to be answered include: what are the behavioral or physical indicators that suggest procyonids are not coping with enforced social isolation? What are the mechanisms that can be used to avoid the need for separation (e.g., the 'buddy' system; visual, auditory, or olfactory contact; increased enrichment; etc.). Examples of how medical separation has been addressed for procyonid species at AZA institutions should be shared, identifying the most successful strategies.

## Chapter 5: Nutrition

Section 5.1. Nutritional Requirements: There is little information available on the changing nutritional requirements of procyonids during periods of reproductive activity (e.g., during gestation or periods of lactation). Additional nutritional research is needed in this area.

## Chapter 6: Veterinary Care

Section 6.1. Veterinary Services: For the continuing evaluation of procyonid health issues and treatments, there is always a need for access to stored blood/tissue samples. Future research will benefit significantly from the appropriate banking of blood/serum and tissue samples from procyonids, and the AZA Small Carnivore TAG requests this where possible. See Appendix G and Appendix M for additional information.

Section 6.7. Management of Diseases, Disorders, Injuries and/or Isolation: The presence of hereditary diseases in procyonid species should be investigated further, especially in terms of how this relates to population management.

Section 6.7. Management of Diseases, Disorders, Injuries and/or Isolation: Further research is needed to establish the medical requirements for these classes. Research should focus on the timing and frequency of physical examinations, the schedule of vaccinations (neonates), common diseases and disorders for these age classes, and their treatments, and veterinary procedures that should be considered as specifically important for these groups.

## Chapter 7: Reproduction

Section 7.6. Contraception: Research on the effects that GnRH agonists have on future reproductive abilities when provided to prepubertal procyonids is needed, as current research is based on studies using domestic cats.

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## References

- AAFCO (Association of American Feed Control Officials) 1999. Nutrient Guidelines for Dogs. Pet Food Regulations. AAFCO, Inc., Atlanta.
- Ackerson, B.K., Harveson, L.A. (2006). Characteristics of a ringtail (*Bassariscus astutus*) population in Trans Pecos, Texas. *Texas Journal of Science* 58(2):169-184.
- Andrews, P. (2001). Introducing adult males and females. In: Mellen J, Wildt D. (eds.), Husbandry manual for small felids. Lake Buena Vista, FL: Disney's Animal Kingdom. (available on Felid TAG web site: [www.csew.com/felidtag/](http://www.csew.com/felidtag/))
- Anon. (1981). Outdoor Air Requirements for Ventilation (ASHRAE Standard 62-1981) 3.1 Commercial Facilities (Offices, Stores, Shops, Hotels, Sports Facilities, etc.). American Society of Heating, Refrigeration, Air Conditioning Engineers: 74-85.
- AWR (Animal Welfare Regulations) 2005. Animal Welfare Act, 7 U.S.C. Animal Welfare Regulations, 9 CFR Chapter 1, Subchapter A, Parts 1-4.
- Ayars, G.H., Altman L.C., Frazier C.E., Chi E.Y. (1989). The toxicity of constituents of cedar and pine woods to pulmonary epithelium. *Journal of Allergy and Clinical Immunology* 83: 610-618.
- AZA (Association of Zoos and Aquariums) 2008. Accreditation Standards and Related policies. Association of Zoos and Aquariums, Silver Spring, MD.
- AZA SCTAG 2008. Otter Care Manual. Association of Zoos and Aquariums, Silver Spring, MD. p.119.
- Barker, I.K., Parrish C.R. (2001). Parvovirus infections. In: Williams ES, Barker IK (eds.), *Infectious Diseases of Wild Mammals*, 3rd Ed., Iowa State University Press, Ames, IA. pp.131-146.
- Barja, I. (2006). Faecal marking behaviour in ringtails (*Bassariscus astutus*) during the non-breeding period: spatial characteristics of latrines and single faeces. *Chemoecology* 16(4):219-222.
- Bertschinger, H.J., Asa, C.S., Calle, P.P., Long, J.A., Bauman, K., DeMatteo, K., Jochle, W., Trigg, T.E., Human A. (2001). Control of reproduction and sex related behaviour in exotic wild carnivores with the GnRH analogue deslorelin: preliminary observations. *Journal of Reproduction and Fertility*, Supplement 57: 275-283.
- Bisbal, F.L. (1987). *The carnivores of Venezuela: their distribution and the ways they have been affected by human activities*. Unpublished PhD Thesis, Univ. of Florida
- Bitgood, S., Patterson, D., Benefield, A. (1986). Understanding your visitors: ten factors that influence visitor behavior. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 726-743.
- Bitgood, S., Patterson, D., Benefield, A. (1988). Exhibit design and visitor behavior. *Environment and Behavior* 20(4): 474-491.
- Bittle, J.L.(1981) Feline panleukopenia. In: Davis JW, Karstad LH, Trainer DO. (eds), *Infectious Diseases of Wild Mammals*, 2nd ed. Ames, IA; Iowa State University Press: pp.97-101.
- Blomqvist, L., Rudbäck, E. (2001). Management & Medical Care. In: Management of Captive Wolverines, *Gulo gulo*, in Europe: Studbook, & Guidelines o Husbandry, Vol. 2. EAZA, Swedish Zoo Association and The Nordic Ark Foundation.
- Booth-Binczik, S.D. (2001). *Ecology of coati social behavior in Tikal National Park, Guatemala*. Ph.D. dissertation, University of Florida, Gainesville, FL.
- Booth-Binczik, S., Binczik, G.A., Labisky, R.F. (2004). Lek-like mating in white nose coati (*Nasua narica*) Socio-ecological correlates of intra-specific variability in mating systems. *Journal Zoological Society* (London)262: 179-185.
- Burkhart, C.A, Robinson, J.L. (1978). High rat pup mortality attributed to the use of cedar wood shavings as bedding. *Laboratory Animals* 12: 221-222.
- Bush, M., Roberts, M. (1977). Distemper in captive red pandas. *International Zoo Yearbook* 17: 194-196.
- Bush, M., Montali, R.J., Brownstein O., James E., Appel MJG. 1976. Vaccine-induced canine distemper in a lesser panda. *Journal of the American Veterinary Medical Association* 169: 959-960.
- Campbell, H. (2001). Brown-nosed Coati (*Nasua nasua*) & White-nosed Coati (*Nasua narica*) *North American Regional Studbook*, 1st Edition. Detroit Zoological Institute, Detroit, MI.
- Carnio, J. (1996). Minimum Husbandry Guidelines for Mammals: Viverrids and Mongooses. Metropolitan Toronto Zoo, AZA Mammal Standards Task Force 1996.

- Carpenter, J.W., Appel, M.J., Erickson, R.C., Novilla, M.N. (1976). Fatal vaccine-induced canine distemper virus infection in black-footed ferrets. *Journal of the American Veterinary Medical Association* 169: 961-964.
- Castro, A.E., Heuschele, W.P. (1992). *Veterinary Diagnostic Virology: A Practitioner's Guide*. Mosby Year Book, Inc., St. Louis and Baltimore, U.S.A.
- Charles-Dominique, P., Atramentowicz M., Charles-Dominique M., Gerard H., Hladik A., Hladik C.M., Prevost M.F. (1981). Les mammifères frugivores aborigènes nocturnes d'une forêt gutaïse: Interrelations plantes-animaux. *Revue d'Ecologie: La Terre et la Vie* 35:341-435.
- Chittick, E., Rotstein, D., Brown, T., Wolfe, B. (2001). Pyometra and uterine adenocarcinoma in a melengestrol acetate-implanted captive coati (*Nasua nasua*). *Journal of Zoo and Wildlife Medicine* 32: 245-251.
- Churchman, D. (1985). How and what do recreational visitors learn at zoos? *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 160-167.
- Coke, R.L., Backues, K.A., Hoover, J.P., Saliki, J.T., Ritchey, J.W., West, G.D. (2005). Serologic responses after vaccination of fennec foxes (*Vulpes zerda*) and meerkats (*Suricata suricatta*) with a live, canarypox-vectored canine distemper virus vaccine. *Journal of Zoo and Wildlife Medicine* 36: 326-330.
- Conway, W. (1995). Wild and zoo animal interactive management and habitat conservation. *Biodiversity and Conservation* 4: 573-594.
- Corbet, G.B., Hill, J.E. (1991). *A World List of Mammalian Species*. Oxford University Press, Natural History Museum Publications, Oxford, England.
- Davison, V.M., McMahon, L., Skinner, T.L., Horton, C.M., Parks, B.J. (1993). Animals as actors: take 2. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 150-155.
- Deem, S.L., Spelman, L.H., Yates, R.A., Montali, R.J. (2000). Canine distemper in terrestrial carnivores: a review. *Journal of Zoo and Wildlife Medicine* 31: 441-451.
- DeGhetto, D., Papageorgiou, S., Convy, J. (2002). Raccoons. Chapter 25, In: Gage LJ (ed.), *Hand-Rearing Wild and Domestic Animals*. Iowa State Press, Ames, Iowa. pp.191-202.
- Denver, M. 2003. Procyonidae and Viverridae. In: Fowler ME, Miller RE. (eds.), *Zoo and Wild Animal Medicine*, 5th Ed., Saunders, St. Louis, Missouri. pp.516-523.
- Elia, G., Cavalli, A., Desario, C., Lorusso, E., Lucente, M.S., Decaro, N., Martella, V., Buonavoglia, C. (2007). Detection of infectious canine parvovirus type 2 by mRNA real-time RT-PCR. *Journal of Virological Methods* 146: 202-208.
- Evans, R.H. (1987). *Rearing orphaned wild mammals*. In: *Vet Clinics of North America* 17(3). W.B. Saunders, Philadelphia, PA. pp.754-784.
- Ewer, R.E. (1973). *The Carnivores*. Wiedenfeld & Nicolson, London
- Fernandez-Moran, J. (2003). Mustelidae. In: *Zoo and Wild Animal Medicine* 5th Edition. M. Fowler & R. Miller Editors. Saunders, St. Louis, Missouri. Pp 501-515.
- Ford, L., Hoffmann, R. (1988). *Potos flavus*. American Society of Mammalogists Species Sheets # 321. pp.1-9.
- Glatston, A.R. (1994). The Red Panda, Olingos, Coatis, Raccoons, and their Relatives: Status Survey and Conservation Action Plan for Procyonids and Ailurids. IUCN/SSC Mustelid, Viverrid, and Procyonid Specialist Group. IUCN, Gland, Switzerland. ISBN 2-8317-0046-9
- Gompper, M.E. (1994). *The importance of ecology, behavior, and genetics in the maintenance of coati (Nasua narica) social structure*. Ph.D. dissertation, University of Tennessee, Knoxville, TN.
- Gompper, M. (1995). *Nasua narica*. American Society of Mammalogists Species Sheets #487. pp.1-10.
- Gompper, M., Decker, D. (1998). *Nasua nasua*. American Society of Mammalogists Species Sheets # 580. pp.1-9.
- Grant, K. (2004). *Erethizon dorsatum*. AZA Porcupine Husbandry Manual. [www.glenoakzoo.org/Rodent%20TAG.htm](http://www.glenoakzoo.org/Rodent%20TAG.htm).
- Grzimek, B. (1972). *Grzimek's Animal Life Encyclopedia*. New York, NY. Van Nostrand Reinhold Company. pp.90-95.
- Grzimek, B. (1990). *Grzimek's Encyclopedia of Mammals*. Vol. 3. McGraw-Hill Publishers, New York, New York. pp.461-464.
- Haas, C.C. (2002). Home-range dynamics of white-nosed coatis in southeastern Arizona. *Journal of Mammalogy* 83(4):943-946.
- Haas, C., Roback, J. (2000). Copulatory Behavior of the White Nosed Coatis. *Western Naturalist* 45(3).

- Hamir, A.N., Summers, B.A., Rupprecht, C.E. (1998). Concurrent rabies and canine distemper encephalitis in a raccoon (*Procyon lotor*). *Journal of Veterinary Diagnostic Investigation* 10: 194-196.
- Hamir, A.N., Hanlon, C.A., Niezgodna, M., Rupprecht, C.E. (2001). The prevalence of interstitial nephritis and leptospirosis in 283 raccoons (*Procyon lotor*) from 5 different sites in the United States. *The Canadian Veterinary Journal*. 42: 869-871.
- Harrenstien, L.A., Munson, L., Group, U.S. (1996). Seal And American Zoo And Aquarium Association Mammary Cancer Study Mammary cancer in captive wild felids and risk factors for its development: A retrospective study of the clinical behavior of 31 cases *Journal of Zoo and Wildlife Medicine* 27 (4): 468-476.
- Hirsch, B.T. (2007). *Within-group spatial position in ring-tailed coatis (Nasua nasua); balancing predation, feeding success, and social competition*. Ph.D. dissertation, Stony Brook University, Stony Brook, NY.
- IATA (International Air Transport Association) 2009. IATA Live Animal Requirements, 36th edition. International Air Transport Association, Montreal-Geneva (ISBN978-92-9229-058-0). Pp.345-346.
- IUCN. 1995. The world conservation unit. Raccoons and Their Relatives: 8317-0051-5.
- IUCN Red List of Threatened Species. 2009. Version 2009.1, [www.iucnredlist.org/search](http://www.iucnredlist.org/search). Downloaded June 9, 2009.
- Johnston, R.J. (1998). Exogenous factors and visitor behavior: a regression analysis of exhibit viewing time. *Environment and Behavior* 30(3): 322-347.
- Joslin, J.O., Amand, W., Cook, R., Hinshaw, K., McBain, J., Oosterhuis, J. (1998). Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals ([www.aazv.org/Webaddit.pdf](http://www.aazv.org/Webaddit.pdf)).
- Kaufmann, J.H. (1962). *Ecology and social behavior of the coati, Nasua narica on Barro Colorado Island Panama*. University of California Publications in Zoology 60: 95-222.
- Kays, R.W., Gittleman, J.L. (2001). The Social Organization of the Kinkajou *Potos flavus* (Procyonidae). *Journal of Zoology* 253: 491-504.
- Kazacos, K.R., Thacker, H.L., Shivaprasad, H.L., Burger, P.P. (1981). Vaccination-induced distemper in kinkajous. *Journal of the American Veterinary Medical Association* 179: 1166-1169.
- Kearns, K.S., Pollock, C., Ramsay, E.C. (1999). Dermatophytosis in red pandas (*Ailurus fulgens fulgens*): a review of 14 cases. *Journal of Zoo and Wildlife Medicine* 30: 561-562.
- Kiku, M., Byeong-Kirl, B., Chae-Woong, L. (2003). Eurasian otter (*Lutra lutra*), a definitive host for *Dirofilaria immitis*. *Journal of Zoo and Wildlife Medicine* 34: 200-201.
- Kleiber, M. (1947). Body size and metabolic rate. *Physiological Review* 27: 511-541.
- Kollias, G. V. and N. Abu-Madi. (2007). Procyonids and mustelids. In: West, G., D. Heard, and N. Caulkett (eds.). *Zoo Animal and Wildlife Anesthesia and Immobilization*, 1st Ed., Blackwell Publishing, Ames, IA. Pp. 417 - 428.
- Langan, J., Bemis, D., Harbo, S., Pollock, C., Schumacher, J. (2000). Tyzzer's disease in a red panda (*Ailurus fulgens*). *Journal of Zoo and Wildlife Medicine* 31: 558-562.
- Larsen, R.S., Loomis, M.R., Kelly, B.T., Sladky, K.K., Stoskopf, M.K., Horne, W.A. (2002). Cardiorespiratory effects of medetomidine-butorphanol, medetomidine-butorphanol-diazepam, and medetomidine-butorphanol-ketamine in captive red wolves (*Canis rufus*). *Journal of Zoo and Wildlife Medicine* 33(2):101-7.
- Legrand-Defretin, V., Munday, H. (1993). Feeding Dogs and Cats for Life. In: Burger IH. (ed.), *The Waltham Book of Companion Animal Nutrition*. Pergamon Press, New York, NY, pp.57-68.
- Lemberger, K.Y., Gndim, .L.F.P., Pessier, A.P., McAllister, M.M., Kinsel, M.J. (2005). Neospora caninum infection in a free-ranging raccoon (*Procyon lotor*) with concurrent canine distemper virus infection. *Journal of Parasitology* 91: 960-961.
- Lindsay, D.S., Spencer, J.A., Rupprecht, C.E., Blagburn, B.L. (2001). Prevalence of agglutinating antibodies to Neospora caninum in raccoons, *Procyon lotor*. *Journal of Parasitology* 87: 1197-1198.
- MacMillen, O. (1994). Zoomobile effectiveness: sixth graders learning vertebrate classification. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 181-183.
- Manharth, A., Shellebarger, W. (2003). Small Carnivore Medical Management Guidelines. ([aazv.org/displaycommon.cfm?an=1&subarticlenbr=272](http://aazv.org/displaycommon.cfm?an=1&subarticlenbr=272))
- Maran, T., Robinson, P. (1996). European Mink, *Mustela lutreola*, Captive Breeding and Husbandry Protocol. Tallinn Zoological Gardens, Estonia.

- Martin, H.D., Zeidner, N.S. (1992). Concomittant cryptosporidia, coronavirus, and parvovirus infection in a raccoon (*Procyon lotor*). *Journal of Wildlife Diseases* 28: 113-115.
- McNab, B.K. (1989). Basal Rate of Metabolism, Body Size, and Food Habits in the Order Carnivora. In: Gittleman, J.L. (ed.), *Carnivore Behavior, Ecology, and Evolution*. Vol 1, pp.335-354.
- Mead, J.L., Van Devender, T.R. (1981). Late Holocene Diet of *Bassariscus astutus* in the Grand Canyon, Arizona. *Journal of Mammalogy* 62: 439-442.
- Meehan, T. (1994). Hand-rearing Felids. In: AZA Infant Diet Notebook. American Zoo and Aquarium Assoc. Silver Springs, MD.
- Meier, J.E. (1985). Hand Rearing Techniques for Neonatal Exotic Animals. In: Meehan T, Allen ME. (eds.), *Proceedings of the Fourth and Fifth Dr. Scholl Conferences on the Nutrition of Captive Wild Animals*. Dec. 7 & 8, 1984; Dec. 13 & 14, 1985 Lincoln Park Zoological Gardens, Chicago, IL. Pp.36-48.
- Montali, R.J., Roberts, M., Freeman, R.A., Bush, M. (1984). Pathology survey of the red panda (*Ailurus fulgens*). In: Ryder OA, Byrd ML. (eds.), *One Medicine*, Springer-Verlag, Berlin. Pp.128-140.
- Montali, R.J., Wallace, R., Phillips, L.G. Jr., Bush, M., Roberts, M., Crissey, S.D., Warnell, K.J., Oftedal, O.T., Edwards, M., Rabin, L. (1989). Hepatopathy and hypercholesterolemia in red pandas associated with a diet change. In: Glatston AJ. (ed.), *Red Panda Biology*. SPB Academic Publishing, The Hague, The Netherlands. Pp.31-40.
- Moore, D. (1997). Zoo Standards for Keeping Mustelids in Captivity. Central Park Zoo, New York. Pp.1-6.
- Morgan, J.M., Hodgkinson, M. (1999). The motivation and social orientation of visitors attending a contemporary zoological park. *Environment and Behavior* 31(2): 227-239.
- Muir, S. (2003). Hand-rearing guidelines for small carnivores. Shaldon Wildlife Trust, UK.
- Muñoz-García, A., Williams, J.B. (2005). Basal Metabolic Rate in carnivores is associated with diet after controlling for phylogeny. *Physiological & Biochemical Zoology*. 78(6): 1039-1056.
- Munson, L. (2006). Contraception in felids. *Theriogenology* 66: 126-34.
- Munson, L., Bauman, J.E., Asa, C.S., Jochle, W., Trigg, T.E. (2001). Efficacy of the GnRH analogue deslorelin for suppression of oestrus cycle in cats. *Journal of Reproduction and Fertility*, Supplement 57: 269-273.
- Munson, L., Gardner, A., Mason, R.J., Chassy, L.M., Seal, U.S. (2002). Endometrial hyperplasia and mineralization in zoo felids treated with melengestrol acetate contraceptives. *Veterinary Pathology* 39(4): 419-27.
- Nava-Vargas, V., Tejero-Diez, J.D., Chavez-Tapia, C.B. (1999). Food habits of the ringtail *Bassariscus astutus* (Carnivora: Procyonidae) in a xerophitic bush in Hidalgo, Mexico. *Anales del Instituto de Biología Universidad nacional Autónoma de México Serie Zoología* 70(1):51-63.
- Neiffer, D.L., Klein, E.C., Calle, P.P., Terrell, S.P., Walker, R.L., Todd, D., Vice, C.C., Marks, S.K. (2002). Mortality associated with melarsomine dihydrochloride administration in two North American river otters (*Lontra canadensis*) and a red panda (*Ailurus fulgens fulgens*). *Journal of Zoo & Wildlife Medicine* 33(3): 242-248.
- Nowak, R. (1999). *Walker's Mammals of the World*, 6th Ed., Vol 1. The Johns Hopkins University Press, Baltimore, MD. pp.1097-1104.
- NRC (National Research Council) 2006. Nutrient Requirements of Dogs. National Academy Press, Washington, DC.
- NRC (National Research Council) 1982. Nutrient Requirements of Mink and Fox. National Academy Press, Washington, DC.
- Ott Joslin, J., Collins, D. (1999). Chapter 5: Designing an Ideal Animal Shipment. In: Fowler M, Miller R. (eds.), *Zoo and Wild Animal Medicine*, current therapy 4. W.B. Saunders Co., Philadelphia and London. Pp.17-26.
- Partridge, J. (1992). Husbandry notes on the maintenance of cacomistles and ringtails. In: *Management Guidelines for Bears and Raccoons*. J. Partridge editor. Association of British Wild Animal Keepers (ABWAK), Bristol, England. Pp.149-151.
- Pearson, G.L. (1977). Vaccine-induced canine distemper virus in black-footed ferrets. *Journal of the American Veterinary Medical Association* 170: 103, 106, 109.
- Petrini, K. (1998). Health Care Section. In: Asian small-clawed Otter Husbandry Manual. Asian small-clawed Otter SSP, Columbus Zoological Park
- Poglayen-Neuwall, I. (1973). Preliminary notes on maintenance and behaviour of the Central American cacomistle, *Bassariscus sumichrasti* at Louisville Zoo. *International Zoo Yearbook*, 13: 207-11.

- Poglayen-Neuwall, I. (1980a). Gestation period and parturition of the ringtail *Bassariscus astutus*. *Zeitschrift fuer Saeugetierkunde* 45(2):73-81.
- Poglayen-Neuwall, I. (1980b). Saliva licking a possible adaptation enhancing the survival of young ringtails, *Bassariscus astutus*. *Zoologische Beitrage* 26(2):319-328.
- Poglayen-Neuwall, I. (1990). Procyonids. In: Grzimek B. (ed.), *Encyclopedia of Mammals*. Vol 3, pp.450-468.
- Poglayen-Neuwall, I. (1995). Observation on ethology of the Central American cacomistle, *Bassariscus sumichrasti*. *Ecology Zoological Garten N.F.* 65: 11-49.
- Poglayen-Neuwall, I., Towell, D.E. (1988). *Bassariscus astutus*. Mammalian Species Account Number 327, pp.8.
- Poglayen-Neuwall, I., Shively, J.N. (1991). Testicular cycles of the ringtail *Bassariscus astutus* (Carnivora: Procyonidae). *Zeitschrift fuer Saeugetierkunde* 56(2):72-80.
- Povey, K.D. (2002). Close encounters: the benefits of using education program animals. *Annual Proceedings of the Association of Zoos and Aquariums*.
- Povey, K.D., Rios, J. (2002). Using interpretive animals to deliver affective messages in zoos. *Journal of Interpretation Research* 7: 19-28.
- Qin, Q., Wei, F., Li, M., Dubovi, E., Loeffler, I.K. (2007). Serosurvey of infectious disease agents of carnivores in captive red pandas (*Ailurus fulgens*) in China. *Journal of Zoo and Wildlife Medicine* 38: 42-50.
- Reed-Smith, J., Wagner, D., Riger, P., Bernier, D. (2003). AAZK Biological Information on Selected Mammal Species CD, American Association of Zoo Keepers (AAZK) Topeka, KA.
- Robbins, C. (1993). *Wildlife Feeding and Nutrition*. Academic Press, Inc. New York, NY.
- Roberts, M. (1997). General Husbandry Requirements for Procyonidae. AZA Minimum Husbandry Standards.
- Rodriguez-Bolanos, A., Cadena, A., Sanchez, P. (2000). Trophic characteristics in social groups of the mountain coati, *Nasuella olivacea* (Carnivora: Procyonidae). *Small Carnivore Conservation* 23, October 2000:1-6.
- Samudio, R., Kays, R., Cuarón, A.D., Pino, J.L., Helgen, K. (2008). *Nasua narica*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. [www.iucnredlist.org](http://www.iucnredlist.org). Downloaded on 26 August 2009.
- Sasai, H., Kato, K., Sasaki, T., Koyama, S., Kotani, T., Fukata, T. (2000). Echocardiographic diagnosis of dirofilariasis in a ferret. *Journal of Small Animal Practice* 41: 172-174.
- Sherwood, K.P., Rallis, S.F., Stone, J. (1989). Effects of live animals vs. preserved specimens on student learning. *Zoo Biology* 8: 99-104.
- Shotts, E.B. (1981). Leptospirosis. In: Davis JW, Karstad LH, Trainer DO. (eds), *Infectious Diseases of Wild Animals*, 2nd ed. Ames, IA; Iowa State University Press: pp.323-331.
- Snyder, D.E., Hamir, A.N., Nettles, V.G., Rupprecht, C.E. (1989a). *Dirofilaria immitis* in a river otter (*Lutra canadensis*) from Louisiana. *Journal of Wildlife Diseases* 25: 629.
- Snyder, D.E., Hamir, A.N., Hanlon, C.A., Rupprecht, C.E. (1989b). *Dirofilaria immitis* in a raccoon (*Procyon lotor*). *Journal of Wildlife Diseases* 25: 130-131.
- Standley, S. (1992). The ring tailed coati. In: Partridge J. (ed.), *Management Guidelines for Bears and Raccoons*. ABWAK, Bristol, England. Pp.143-148.
- Stanley, D., Fritzell, G., Fritzell, E. (1999). Behavior aspects of the raccoon mating system: determinant of consortship success. *Animal Behavior* 7: 593-601.
- Stephens, C.E., Hume, I.D. (1995). *Comparative Physiology of the Vertebrate Digestive System*. 2nd Ed. Cambridge University Press. New York, NY.
- Telford, S.R., Forrester, D.J. (1991). Hemoparasites of raccoons (*Procyon lotor*) in Florida. *Journal of Wildlife Diseases* 27: 486-490.
- Thompson, D. (2003). North American Regional Studbook Ringtail/Cacomistle, 1st Edition March 2003. Little Rock Zoo, Little Rock, AR. ([dthompson@littlerock.state.ar.us](mailto:dthompson@littlerock.state.ar.us)).
- Trapp, G.R. (1972). Some anatomical and behavioral adaptations of ringtails, *Bassariscus astutus*. *Journal of Mammalogy* 53: 549-57.
- Trapp, G.R. (1978). Comparative behavioural ecology of the ringtail and the Gray Fox in Southwest Utah. *Carnivore*, 1. Pp. 3-31.
- USDA 2003. USDA Guidelines for the care and use of laboratory animals. [www.nap.edu/readingroom/books/labrats/chaps.html](http://www.nap.edu/readingroom/books/labrats/chaps.html)

- Valenzuela, D. (1998). Natural history of the white nose coati, *Nasua nasua* in the tropical dry forests of Western Mexico. *Revista Mexicana de Mastozoología*, 3: 26-44.
- Vesell, E.S. (1967). Induction of drug-metabolizing enzymes in liver microsomes of mice and rats by softwood bedding. *Science* 157: 1057-1058.
- Wilson, D.E., Reeder, D.M. (1992). *Mammal Species of the World, A Taxonomic and Geographic Reference*, 2nd Edition. Smithsonian Institution Press, Washington D.C.
- Wojcinski, Z.W., Barker, I.K. (1986). Tyzzer's disease as a complication of canine distemper in a raccoon (*Procyon lotor*). *Journal of Wildlife Diseases* 22: 55-59.
- Wolf, R.L., Tymitz, B.L. (1981). Studying visitor perceptions of zoo environments: a naturalistic view. In: Olney P.J.S. (Ed.), *International Zoo Yearbook*. Dorchester: The Zoological Society of London. pp.49-53.
- Wooster, D. (1998). Role of the Keeper in Management of Small Cats. In: Mellen J, Wildt D. (eds.), *Husbandry Manual for Small Felids*. AZA & Disney Wild Animal Kingdom. Chapter 10.
- Wright, K. and M. Edwards. 2009. Considerations for Kinkajou Captive Diets. *The Veterinary Clinics of North America Exotic Animal Practice* 12: 171-185.
- Wright, P.J., Verstegen, J.P., Onclin, K., Jochle, W., Armour, A.F., Martin, G.B., Trigg, T.E. (2001). Suppression of the oestrous responses of bitches to the GnRH analogue deslorelin by progesterin. *Journal of Reproduction and Fertility*, Supplement 57: 263-268.
- Yerke, R., Burns, A. (1991). Measuring the impact of animal shows on visitor attitudes. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 532-534.
- Yerke, R., Burns, A. (1993). Evaluation of the educational effectiveness of an animal show outreach program for schools. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 366-368.

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- Booth-Binczik, S. Dallas Zoo, [Sue.boothbinczik@dallaszoo.com](mailto:Sue.boothbinczik@dallaszoo.com)
- Moresco, A. U.C. Davis. AZA SCTAG Vet Advisor. [amoresco@ucdavis.edu](mailto:amoresco@ucdavis.edu).
- Bressler, D.: Logan & Abby's Fund (coati rescue organization). [Coatiowner3S@aol.com](mailto:Coatiowner3S@aol.com).
- Carter, S: Curator of Mammals, Detroit Zoological Park.
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- Dulaney, M: Cincinnati Zoo & Botanical Garden, Cincinnati, OH 45220.
- Granat, G.: Brookfield Zoo, Brookfield, IL. Unpublished information, 2003.
- Grant, S.: Veterinary specialist dealing with coatimundi.
- Kimble, K.: Santa Barbara Zoo. [kkimble@sbzoo.org](mailto:kkimble@sbzoo.org).
- Kirkendall, L. Sacramento Zoo, [lkirkendall@cityofsacramento.org](mailto:lkirkendall@cityofsacramento.org)
- Montali, R.: Smithsonian Institute, National Zoo.
- Schilling, K.: 2005. Animals for Awareness. [Paloszoo@aol.com](mailto:Paloszoo@aol.com)
- Snyder B.: John Ball Zoo, Grand Rapids, Michigan. Unpublished information, 2003.
- Walkosak, V.: Arizona Sonora Desert Museum. Unpublished information, 2003.

#### **Useful References:**

- Ford L, Hoffmann RS. 1988. *Potos flavus*. *Mammalian Species*, 321, pp.9.
- Fowler ME. 1986. Restraint. In: Fowler ME. (ed.), *Zoo and Wild Animal Medicine*. W.B. Saunders and Co., Philadelphia. Pp.37-50.
- Kaufmann JH. 1982. Raccoons and allies. In: Chapman A, Feldhamer GA. (eds.), *Wild Mammals of North America*, Journal The Johns Hopkins University Press, Baltimore. . pp.567-585.
- McClearn D. 1992. Locomotion, posture, and feeding behavior of kinkajous, coatis and raccoons. *Journal of Mammalogy*, 73: 245-261.
- Mehren KG. 1986. Procyonidae. In: Fowler ME. (ed.), *Zoo and Wild Animal Medicine*. W.B. Saunders and Co., Philadelphia. pp.816-820.
- Wozencraft WC. 1989. The phylogeny of the recent Carnivora. In: Gittleman J. (ed.), *Carnivore Behavior, Ecology and Evolution*. Cornell University Press. pp.495-535.

## Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to procyonids are taken from the AZA Accreditation Standards and Related Policies (AZA 2010) 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 wildlife laws and regulations. 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 animal collection must be protected from weather detrimental to their health.

**(10.2.1)** Critical life-support systems for the animal collection, 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 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.

**(1.5.9)** The institution must have a regular program of monitoring water quality for collections of 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

**(1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

**(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.

**(11.3.3)** Special attention must be given to free-ranging animals so that no undue threat is posed to the animal collection, 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.

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

**(11.3.6)** Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

**(11.2.3)** 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. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

**(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).

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

**(11.2.5)** 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 (sharks, whales, tigers, bears, 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.

### 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 local, state, and federal laws must be adhered to.

### Chapter 5

**(2.6.2)** A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

**(2.6.3)** Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

**(2.6.1)** Animal food preparations must meet all local, state/provincial, and federal regulations.

**(2.6.4)** 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. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

**(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 animal collection.

**(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 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 in the animal collection.

**(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 or guidelines adopted by the AZA.

**(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 testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

**(2.5.1)** Deceased animals should be necropsied to determine the cause of death. 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 collection 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 symptoms 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 evaluate illnesses nor prescribe treatment.
- (2.3.2)** Hospital facilities should have x-ray equipment or have access to x-ray services.
- (1.5.8)** The institution must develop a clear process for identifying and addressing animal welfare concerns within the institution.

#### **Chapter 8**

- (1.6.1)** The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.
- (1.6.2)** The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

#### **Chapter 9**

- (5.3)** A written policy on the use of live animals in programs should 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 animal collection, 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 a part of the institution's programs, an education and conservation message must be an integral component.

#### **Chapter 10**

- (5.3)** Institutions should maximize the generation of scientific knowledge gained from the animal collection. 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, education 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<sup>®</sup>.
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 an AZA PMP, institutions should consult with the AZA 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 captive 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 an AZA PMP, institutions should consult with the AZA 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: 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 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 -94°F (-70°C) frost-free freezer or a -4°F (-20°C) 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 Procyonid:

*Procyonid:*

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 D: 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:
  - i. Public access outside the exhibit/enclosure. Public may interact with animals from outside the exhibit/enclosure (e.g., giraffe feeding, touch tanks).
  - ii. 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:
  - i. 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”).
  - ii. 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).
  - iii. 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:
  - i. 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 and 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 and Benefield, 1986, 1988; Wolf and 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 and 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.

## Acknowledgements

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## References

- Bitgood, S., Patterson, D., & Benefield, A. (1986). Understanding your visitors: ten factors that influence visitor behavior. *Annual Proceedings of the American Association of Zoological Parks and Aquariums*, 726-743.
- Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior. *Environment and Behavior*, 20 (4), 474-491.

- Churchman, D. (1985). How and what do recreational visitors learn at zoos? Annual Proceedings of the American Association of Zoological Parks and Aquariums, 160-167.
- Davison, V.M., McMahon, L., Skinner, T.L., Horton, C.M., & Parks, B.J. (1993). Animals as actors: take 2. Annual Proceedings of the American Association of Zoological Parks and Aquariums, 150-155.
- Johnston, R.J. (1998). Exogenous factors and visitor behavior: a regression analysis of exhibit viewing time. *Environment and Behavior*, 30 (3), 322-347.
- MacMillen, Ollie. (1994). Zoomobile effectiveness: sixth graders learning vertebrate classification. Annual Proceedings of the American Association of Zoological Parks and Aquariums, 181-183.
- Morgan, J.M. & Hodgkinson, M. (1999). The motivation and social orientation of visitors attending a contemporary zoological park. *Environment and Behavior*, 31 (2), 227-239.
- Povey, K.D. (2002). Close encounters: the benefits of using education program animals. Annual Proceedings of the Association of Zoos and Aquariums, in press.
- Povey, K.D. & Rios, J. (2002). Using interpretive animals to deliver affective messages in zoos. *Journal of Interpretation Research*, in press.
- Sherwood, K. P., Rallis, S. F. & Stone, J. (1989). Effects of live animals vs. preserved specimens on student learning. *Zoo Biology* 8: 99-104.
- Wolf, R.L. & Tymitz, B.L. (1981). Studying visitor perceptions of zoo environments: a naturalistic view. In Olney, P.J.S. (Ed.), *International Zoo Yearbook* (pp.49-53). Dorchester: The Zoological Society of London.
- Yerke, R. & Burns, A. (1991). Measuring the impact of animal shows on visitor attitudes. Annual Proceedings of the American Association of Zoological Parks and Aquariums, 532-534.
- Yerke, R. & Burns, A. (1993). Evaluation of the educational effectiveness of an animal show outreach program for schools. Annual Proceedings of the American Association of Zoological Parks and Aquariums, 366-368.

## Appendix E: 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:

- I. On-site programming
  - A. Informal and non-registrants:
    1. On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
    2. Children's zoos and contact yards
    3. Behind-the-scenes open houses
    4. Shows
    5. Touch pools
  - B. Formal (registration involved) and controlled settings
    1. School group programs
    2. Summer Camps
    3. Overnights
    4. Birthday Parties
    5. Animal rides
    6. Public animal feeding programs
- II. Offsite and Outreach
  1. PR events (TV, radio)
  2. Fundraising events
  3. Field programs involving the public
  4. School visits
  5. Library visits
  6. Nursing Home visits (therapy)
  7. Hospital visits
  8. Senior Centers
  9. 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

All 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:
  - Temperament and suitability for program use
  - Husbandry requirements
  - Husbandry expertise
  - Veterinary issues and concerns
  - Ease and means of acquisition / disposition according to the AZA code of ethics
  - Educational value and intended conservation message
  - Conservation Status
  - 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., handwashing 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 numbers 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 F: Description of Nutrients (U.S. National Library of Medicine)

**Protein:** Protein is the main building blocks of animal structure on a fat-free basis. In addition to being an important constituent of animal cell walls, protein is one of the nutrients responsible for making enzymes, hormones, lipoproteins, and other crucial elements needed for proper bodily functions. Protein also is essential for building and repairing body tissue, as well as protecting the animal from harmful bacteria and viruses. Furthermore, protein aids in the transportation of nutrients throughout the body and facilitates muscle contractions. The requirements for crude protein are effectively requirements for dietary amino acids. The requirements are based on the needs of the animal, the quality of the protein, the source of the protein, and the digestibility of the protein available.

**Fat:** Dietary fat plays an important role in the manufacture of certain hormones. It also plays a crucial role in a wide variety of chemical bodily functions. Also, fat functions as a concentrated energy source, serves as a carrier for fat-soluble vitamins (Vitamins A, D, E, and K), and provides essential fatty acids. The requirements for fat are effectively requirements for dietary fatty acids.

**Vitamin A:** Vitamin A is a fat-soluble vitamin essential for maintaining good vision and healthy mucous membranes. It contributes to the differentiation and growth of skin tissue and bone formation (including teeth), as well as bone remodeling in growing animals, and glycoprotein synthesis. Vitamin A can improve skin and hair/fur conditions, help to increase resistance to certain infections, and improve fertility in both genders. In many cases, a vitamin A requirement is effectively a requirement for carotenoids (precursors to vitamin A).

**Vitamin C (Ascorbic Acid):** Vitamin C is a water-soluble antioxidant, which plays an important role in biochemical oxidation-reduction reactions, as well as in the formation of collagen, an important protein needed for the formation of skin, scar tissue, tendons, ligaments, and blood vessels. Because of this, Vitamin C is crucial to an animal's ability to heal wounds and repair and or maintain cartilage, teeth, and bones. It also may reduce infection by increasing immunity.

**Vitamin D:** Vitamin D is a fat-soluble vitamin necessary for active calcium absorption, calcium metabolism and resorption from bone. Requirements for vitamin D can be totally or partially met by exposure to sunlight or artificial UV light (vitamin D is biosynthesized in the skin of animals or in some plant cells upon exposure to the appropriate wavelength of UV light; 285-315nm).

**Vitamin E:** Vitamin E is a fat-soluble antioxidant that helps to maintain the structure of cellular and subcellular membranes by preventing oxidation of unsaturated fatty acids. It also protects tissues from free radicals, which are substances known to harm cells, tissues, and organs. Vitamin E is essential in the formation of red blood cells and aids the body in Vitamin K utilization.

**Thiamine (B-1):** Thiamine is a water-soluble vitamin, which functions as a necessary coenzyme in carbohydrate metabolism (converting carbohydrates into energy) and is hypothesized to play a role in nerve or neuromuscular impulse transmission. Thiamine also is important in the proper functioning of the heart, muscles, and the nervous system.

**Riboflavin (B-2):** Riboflavin is a water-soluble vitamin. It functions in two coenzymes: Flavin adenine dinucleotide or "FAD" and flavin mononucleotide. Riboflavin is important for growth and the production of red blood cells. It also helps the body to release energy from carbohydrates. Microbial synthesis of riboflavin occurs in the gastrointestinal tract of some animals, but synthesis appears to be dependent on the type of animal and the source of dietary carbohydrate.

**Niacin (Nicotinic Acid):** Similar to Riboflavin, niacin is a water-soluble vitamin which functions in two coenzymes: Nicotinamide adenine dinucleotide or "NAD" and nicotinamide adenine dinucleotide phosphate or "NADP". Niacin plays a crucial role in assisting the normal functioning of the digestive, skin, and nerve systems. Like riboflavin, niacin helps the body to convert energy from food. The niacin requirement of many animals theoretically could be satisfied by synthesis of the vitamin from the amino acid tryptophan. However, removal rate of an intermediate in the pathway to create niacin is often so rapid that virtually none is produced.

**Pyridoxine (B-6):** Pyridoxine also known as B-6 is a water-soluble vitamin, which aids the body in the synthesis of antibodies by the immune system. It also plays a role in the formation of red blood cells and helps to promote healthy nerve functions. Pyridoxine is required to produce the chemical activity necessary for protein digestion.

**Choline:** Choline is an essential nutrient, which contributes to the function of nerve cells. It is a component (helps to form phosphatidylcholine, the primary phospholipid of cell membranes) of the phospholipid lecithin (found in cells throughout the body) and is critical to normal membrane structure and formation. It also functions as a “methyl donor”, but this role can be completely replaced by excess amounts of the amino acid methionine in the diet.

**Folacin (Folate, Folic Acid, B-9, Pteroylglutamic Acid):** Folacin, or folate, is a water-soluble vitamin, which assists the body in the formation of red blood cells. It also plays a major role in the formation of genetic material (synthesis of DNA, the hereditary and functioning blueprint of all cells) within all living cells. Folacin functions as a coenzyme, which is important at the cellular and subcellular levels in decarboxylation, oxidation-reduction, transamination, deamination, phosphorylation, and isomerization reactions. Working in conjunction with Vitamin C and B-12, Folacin assists in digestion and protein utilization and synthesis. This vitamin may be used to increase appetite and stimulate healthy digestive acids.

**Vitamin B-12:** Vitamin B-12 is a water-soluble vitamin, which functions as a coenzyme in single carbon and carbohydrate metabolism. In addition to playing a role in metabolism, B-12 assists in the formation of red blood cells and aids in the maintenance of the central nervous system.

**Pantothenic Acid:** Pantothenic acid is a water-soluble vitamin and part of the B vitamin complex. It is needed to break down and use (metabolize) food. Pantothenic acid also is needed for the synthesis of both hormones and cholesterol.

**Calcium:** The mineral calcium (in association with phosphorus) is a major component of the body and is largely associated with skeletal formation. It is important in blood clotting, nerve function, acid-base balance, enzyme activation, muscle contraction, and eggshell, tooth, and bone formation and maintenance. It is one of the most important minerals required for growth, maintenance, and reproduction of vertebrates.

**Phosphorus:** In addition to acting as a major component of the body and being largely associated with skeletal and tooth formation (in conjunction with calcium), phosphorus is involved in almost every aspect of metabolism (energy metabolism, muscle contractions, nerve function, metabolite transport, nucleic acid structure, and carbohydrate, fat, and amino acid metabolism). Phosphorus is needed to produce ATP, which is a molecule the body uses to store energy. Working with the B vitamins, this mineral also assists the kidneys in proper functioning and helps to maintain regularity in heartbeat.

**Magnesium:** Magnesium is a mineral, which serves several important metabolic functions. It plays a role in the production and transport of energy. It also is important for the contraction and relaxation of muscles. Magnesium is involved in the synthesis of protein, and it assists in the functioning of certain enzymes in the body.

**Potassium:** Potassium is a mineral that is involved in both electrical and cellular functions in the body. (In the body it is classified as an electrolyte.) It has various roles in metabolism and body functions. Potassium assists in the regulation of the acid-base balance and water balance in blood and the body tissues. It also assists in protein synthesis from amino acids and in carbohydrate metabolism. Potassium is necessary for the building of muscle and for normal body growth, as well as proper functioning of nerve cells, in the brain and throughout the body.

**Sodium (salt):** Sodium is an element, which the body uses to regulate blood pressure and blood volume. Sodium also is critical for the functioning of muscles and nerves.

**Iron:** Iron is a trace element and is the main component of hemoglobin (oxygen carrier in the blood), myoglobin in muscles (oxygen carrier with a higher affinity for oxygen than hemoglobin), and many proteins and enzymes within the body. It also functions in immune defenses against infection.

**Zinc:** Zinc also is a trace element that is second only to iron in terms of concentration within the body. Zinc plays an important role in the proper functioning of the immune system in the body. It is required for the enzyme activities necessary for cell division, cell growth, and wound healing. It plays a role in the acuity of the senses of smell and taste. Zinc also is involved in the metabolism of carbohydrates. Zinc is essential for synthesis of DNA, RNA, and proteins, and it is a component or cofactor of many enzyme systems.

**Manganese:** Manganese is essential for carbohydrate and lipid metabolism, for synthesis of one of the precursors to cartilage formation, and for proper bone formation. Manganese plays a key role in the growth and maintenance of tissues and cartilage, specifically proper bone development. It particularly aids in development at the ends of bones where new bone formation takes place. This therefore helps to reduce the risk of osteoporosis. Manganese also helps to produce certain hormones, metabolizes fat, and is part of superoxide dismutase (SOD) an antioxidant. Studies on humans have shown that manganese also may lower the frequency of epileptic seizures and enhance immune functioning.

**Copper:** Copper is an essential trace mineral present in all body tissues. Copper, along with iron, helps in the formation of red blood cells. It also helps in keeping the blood vessels, bones, and nervous and immune systems healthy.

**Selenium:** Selenium is an essential trace element. It is an integral part of enzymes, which are critical for the control of the numerous chemical reactions involved in brain and body functions. Selenium has a variety of functions. The main one is its role as an antioxidant in the enzyme selenium-glutathione-peroxidase. This enzyme neutralizes hydrogen peroxide, which is produced by some cell processes and would otherwise damage cell membranes. Selenium also seems to stimulate antibody formation in response to vaccines. It also may provide protection from the toxic effects of heavy metals and other substances. Selenium may assist in the synthesis of protein, in growth and development. In humans, selenium has been shown to improve the production of sperm and sperm motility.

**Iodine:** Iodine is a trace mineral and an essential nutrient. Iodine is essential for the normal metabolism of cells. It is a necessary nutrient for the production of thyroid hormones and normal thyroid function.

## Appendix G: Small Carnivore Medical Management Guidelines

Ann Manharth, DVM, and Wynona Shellabarger, DVM. 2003. (American Association of Zoo Veterinarians)

**Introduction:** The classification “small carnivore” encompasses an extensive variety of animals. The following recommendations include those for *Procyonidae*, *Viverridae*, and *Mustelidae*. A number of individual species may already have medical programs thoroughly outlined by veterinary advisors and these should be reviewed and followed when they vary from the general guidelines below. Species with individual programs include North American river otters (*Lontra canadensis*), Asian small-clawed otters (*Aonyx cinerea*), black-footed ferrets (*Mustela nigripes*), and red pandas (*Ailurus fulgens*). A list of veterinary advisors may be found at [www.aazv.org](http://www.aazv.org).

**Pre-shipment:** The goals of pre-shipment planning and examination are to ascertain the animal’s health before, during, and after shipment and to protect the animal collection at the receiving institution. In order to do this, communication between sending and receiving institutions is critical. Ideally, this communication should occur directly between veterinary staffs at the two institutions to minimize confusion or delays. It is recommended that:

- Records on the animal being shipped should be forwarded to the receiving institution in advance of the pre-shipment examination.
- The receiving institution should promptly advise the sending institution of any specific testing and health requirements after review of the records.
- After the pre-shipment examination has been completed, the sending institution should discuss any concerns with the receiving institution and forward copies of the examination and test results.
- Any problems that may compromise an animal, such as parasitic or bacterial infections, should be addressed and resolved prior to shipment.
- The pre-shipment examination should ideally occur within 60 days of the shipment unless interstate shipping requirements or receiving institution requests differ.
- The sending institution should check with the state veterinary office of the receiving institution’s state for any testing requirements that may be additional/different than the institutional requirements ([www.usda.aphis.gov](http://www.usda.aphis.gov)).
- A current diet sheet for the animal should be forwarded so that dietary items may be obtained in advance of the animal’s arrival.

**Records:** It is recommended that a standardized, typed (not hand-written) form of record keeping be used. MedARKS (International Species Information Systems (ISIS), 12101 Johnny Cake Ridge Rd., Apple Valley, MN 55124-8151) is used by a majority of institutions and enables a more consistent transfer of data. When transferring data, both hard copies and disk should be provided to the receiving institution if MedARKS is available. Medical records should be as complete as possible, including:

1. Medical history
2. Identification (current ARKS record, transponder numbers, tattoos, etc.)
3. Clinical notes (including exam findings, diagnoses, vaccination history, etc.)
4. Parasitology
5. Anesthesia
6. Clinical pathology
7. Treatments (current medications, recent treatments, etc.)
8. Pathology
9. Reproductive status (contracepted, cycle details or abnormalities, etc.)
10. Nutritional information (nutritional deficiencies, supplements, allergies, etc.)
11. Behavioral/social group notes (social traumas, aggression, training for medical procedures, etc.)

12. Any pertinent group history should be included as well, especially if there is a history of infectious disease within the group or exhibit.
13. As small carnivores are prone to dental disease, a thorough history of dental problems and, preferably, a dental chart noting extractions, root canals, problems, etc. is recommended.

**Identification:** All individuals should be permanently identified prior to shipment. Transponder chips are recommended as a primary method, tattooing may be done in addition (males should be tattooed on the inner right thigh and females on the inner left). Two main brands of transponders are used and recommended: 1) Trovan<sup>®</sup> (InfoPet Inc., 415 W. Travelers Trail, Burnsville, MN 55337-2548); and 2) AVID<sup>®</sup> (Avid, 3179 Hamner Ave., Norco, CA 91760). Chip type and implantation site may be specifically recommended based on the species (e.g., bridge of nose for otters) or even sex (e.g., AVID behind right ear for male black-footed ferrets), otherwise the general standard of over the back between the scapulae to the left of the midline should be applied.

**Genetic materials banking:** Prior to shipping, it is recommended that genetic materials be banked. This may provide positive identification should there ever be any question regarding an animal's identity (e.g. transponder loss or breakage). In addition, the materials may serve as a future resource for research. Methods are detailed at the end of this Appendix.

**Examination:** Ideally, the pre-shipment examination should occur at least two weeks prior to shipment. This enables the animal to fully recover from anesthesia and respond to any vaccinations or treatments given. There is also time for test results to be forwarded to the receiving institution. With most small carnivores, crating does not require the use of an anesthetic, so this guideline should not be a hardship with appropriate planning. A complete pre-shipment examination should include the following, and results should be documented in the record (photo documentation of specific problems may be valuable):

1. Physical exam
  - a. Body weight and body condition scoring (assessment scaled 1-5 or 1-10)
  - b. Heart rate, respiratory rate, body temperature, hydration status
  - c. Oral exam: including dental chart documentation. Any problems should be noted and addressed if possible. Dental cleaning and polishing should be completed if necessary.
  - d. Ophthalmologic exam
  - e. Ear exam: appropriate diagnostics should be completed if there is any indication of problems. Cleaning and treatment should be done if necessary.
  - f. Auscultation
  - g. Abdominal palpation
  - h. Assessment of genitalia, including rectal palpation in both sexes if of a size to permit safely
  - i. Skin/coat assessment: any problems should be worked up with appropriate diagnostics.
  - j. Feet/nails
2. Verification of transponder or tattoo (placement/replacement if necessary)
3. Sample Collection
  - a. Blood
    - CBC
    - Serum chemistry panel
    - Heartworm antigen: recommended if housed outside as many small carnivores are susceptible to heartworm
    - Serum banking (receiving institution may request serum as well)
    - Genetic materials banking
    - Research requests, if any
  - b. Urine
    - For standard urinalysis, via cystocentesis
    - If there are current/historical urinary tract problems, cultures should be submitted
  - c. Fecal
    - Two negative fecals, one week apart, should be obtained prior to shipment
    - Fresh direct and float or sedimentation should be completed

- Acid fast staining – if there is a history/indication of cryptosporidiosis
- Culture should be submitted if requested or if there is any history or indication of infectious bacterial disease (e.g. salmonellosis)
- d. Genetic materials
  - Blood
  - Skin
  - Hair
- 4. Radiographs
  - a. Chest and abdominal survey radiographs should be completed
  - b. Any problems (e.g., previous fractures, renal calculi, etc.) should be documented
  - c. Ideally, a duplicate set of radiographs should be made to go with the animal to the new institution. This is especially important if there is a problem that is going to need follow-up. A duplicate set can be made by placing two layers of film in the cassette prior to exposing, though this does not provide as good quality films as having copies made. Alternatively, digital images of the radiographs can be made though quality is not always optimum for interpretation.

Vaccinations: Vaccinations should be current or updated before the animal is shipped. Once again, if there is a veterinary advisor or husbandry manual available for the specific species, review this information in the references or contact the advisor if there are questions. Specifics regarding type/lot of vaccine and site of injection should be recorded in the animal's record. Most recommendations are not based on scientific studies done on the specific species.

1. Canine Distemper
  - a. PUREVAX<sup>®</sup> Ferret Distemper Vaccine (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) is a monovalent recombinant canary pox vectored vaccine. It has been used in a number of small carnivores with minimal adverse effects and development of titers, which appear to be protective (see [www.aazv.org](http://www.aazv.org) for recommendations based on Dr. Montali's study). A 1ml (IM) dose should be given at the following frequency:
    - Vaccinated adults: annually
    - Unvaccinated adults: two vaccinations 3-4 weeks apart, then annually
    - Juveniles: three vaccinations, every three to four weeks from 8 to 16 weeks of age (e.g. 8, 12 and 16 weeks)
2. Parvovirus
  - a. Parvocine<sup>®</sup> (Biocor Animal Health Inc., 2720 North 84<sup>th</sup> Street, Omaha, NE 68134) is a killed univalent parvovirus vaccine. A 1ml (IM) dose should be given at the same frequency listed for canine distemper
3. Leptospirosis
  - a. If leptospirosis has been diagnosed or is endemic in the area, a killed bacterin could be used, though most of these are currently in combination vaccines.
4. Rabies
  - a. Only a killed rabies vaccine product should be used. Though it is recommended, use of rabies vaccines in these species will be extra-label and will not be considered protective in the event of a bite.
  - b. Imrab<sup>®</sup>3 (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) is a killed rabies vaccine that has been used extensively in small carnivores without apparent adverse effects. A 1ml (IM) dose should be given once at 16 weeks of age, and then annually.
  - c. PUREVAX<sup>®</sup> Feline Rabies (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) is a live canarypox vectored, nonadjuvanted recombinant rabies vaccine that is currently being used at some institutions for small carnivores. A 1ml (IM) dose should be given once at 8 weeks (or older), and then annually.
5. Feline Panleukopenia
  - a. AAZV's Infectious Disease Notebook notes that some small carnivores are susceptible to feline panleukopenia and should be vaccinated and many small carnivores have been vaccinated with a combination product in the past. However, a number of veterinary advisors do not recommend vaccination for red pandas and black-footed ferrets. Veterinary advisor recommendations should be followed primarily.

- b. If there is significant risk of exposure to feline panleukopenia (e.g., feral cat population), vaccination should be considered.
  - c. FPV-1<sup>®</sup> Feline Panleukopenia Vaccine (Biocor Animal Health Inc., 2720 North 84<sup>th</sup> Street, Omaha, NE 68134) is a new non-adjuvanted, killed vaccine. This vaccine has been shown to be safe in pregnant domestic cats. A 1ml (SQ) dose should be given at the following frequency:
    - At least two vaccines three weeks apart at/after 12 weeks of age. If started before 12 weeks, give a third vaccine – then annually.
6. Titer Evaluations
- a. Distemper, parvovirus, and leptospiral titers can be evaluated by submitting serum to: Cornell Diagnostic Laboratory, College of Veterinary Medicine, Cornell University, Upper Tower Road, Ithaca, NY 14851-0786, Ph: 607-253-3900

**Transport:** With the wide variety of species included within “small carnivore”, only general recommendations will be provided.

1. Crates should be designed so that the animal can assume normal postures, including turning around. IATA recommendations should be followed. Crates should be of impervious materials as many small carnivores are diggers or chewers and this will allow for proper disinfection as well. Some small carnivores are considered “injurious species” (e.g., meerkats) and are required to be double crated for shipment.
2. Animals should be crated individually to avoid aggression.
3. Animals should only be shipped when the weather is appropriate at all points along the shipping route. Unplanned delays and errors should be considered as possibilities and risky shipments (e.g., too hot at site of layover) should be rescheduled. This may be true even for counter-to-counter shipments.
4. Appropriate temperature ranges will vary by species, but a “safe” window would be between 10-21°C (50-75°F) for most small carnivores.
5. Methods of providing visual access and water to the animal should be addressed. The crate should otherwise be secure from tampering.
6. Most small carnivores will not require anesthesia for crating. In the event that anesthesia is required, the animal should be fully recovered (standing and stable) prior to shipping. Ideally, an inhalant or reversible anesthetic should be used in these cases.

**Quarantine:** Quarantine is the next step in assuring the health of the new arrival and the protection of the animals already in the collection. General quarantine guidelines have been outlined by AAZV and AZA. It is critical that protocols be developed and followed.

1. Length – minimum of 30 days for small carnivores
2. Examination
  - a. Visual exam should be performed upon arrival, preferably at uncrating. A body weight can easily be obtained at this time as well (in the crate).
  - b. Ideally, a physical exam should be completed during the third week of the quarantine. This allows the animal to adjust to the environment and dietary changes and allows test results to come back before the end of quarantine.
    - Physical exam, verification of ID, sample collection, and radiographs should be completed as detailed for pre-shipment.
    - Repeating this work will provide a baseline for the animal at the new institution (especially for radiographs), allow any problems to be rechecked, and potentially reveal new problems that may have developed during the stress of shipment and quarantine.
    - Vaccinations should have been given during pre-shipment if needed, but, if not, should be given during quarantine before exposure to a new environment.
3. Fecals
  - a. A minimum of three (3) consecutive negative fecals (fresh direct and float or sedimentation), each one week apart, should be obtained before clearing from quarantine.
  - b. Appropriate treatment for any parasites should be administered while in quarantine and three negative fecals should be obtained post-treatment.

- c. Cultures and special stains should be repeated during this time if there has been a history of infectious disease in this animal or its previous group. In the event of an infectious bacterial intestinal disease (e.g., salmonellosis), it is recommended that repeated cultures be submitted (three per week) in order to identify or document the condition.
4. Nutrition
  - a. Most diets are not going to be identical from one institution to the next. It is recommended that the sending institutions diet be obtained in advance of the animal's arrival. This enables the receiving institution to provide a familiar diet to the animal upon arrival and for the first week of quarantine. The sending institution may want to send some of the regular diet with the animal.
  - b. After the first week of quarantine, if the animal is doing well, the new diet should slowly be introduced. If this is done at a rate of approximately 25% of new diet exchanged for old per week, the animal should be converted to the new diet by the end of quarantine and should avoid any problems associated with dietary change.

Preventive Health: In order to appropriately ensure the health of small carnivores, it is recommended that a physical examination take place on a routine basis. The following is recommended for a routine exam:

1. Physical exam: as detailed in pre-shipment
2. Verification of identification
3. Sample collection
  - a. Blood
    - CBC/chem. panel
    - HW antigen
    - Serum banking
    - Research requests
    - Viral titers: as there is little information about vaccine titer levels in many of these species, it is suggested that titers be run opportunistically and documented as to time from vaccination(s), route, vaccine product and titer level. See above for information on obtaining titers.
  - b. Urine: as detailed in pre-shipment
  - c. Fecals: should be submitted at a minimum of annually; twice annually is recommended
  - d. Genetic materials should only need to be collected once if preserved properly.
4. Radiographs: chest and abdomen minimally (this is especially important for monitoring renal calculi in otters)
5. Vaccination: as detailed above

Miscellaneous: Ideally, weights should be recorded monthly (accomplished with the aid of training). In areas where the animal is housed outside and heartworm is endemic, ivermectin at 0.006mg/kg orally once a month may be used for prevention. This dose has been used safely and effectively in a number of small carnivores. Reports of disease issues, adverse drug reactions, etc. should be reported to the veterinary advisor or TAG on an annual basis, in addition to submission of necropsy reports.

Necropsy: All small carnivores that die should receive a thorough necropsy in a timely manner. This will help establish cause of death, provide valuable insight into the health of the collection, and help protect the other animals in the social grouping by delineating any immediate concerns. A complete report, including histopath and test results, should be submitted to the veterinary advisor on an annual basis.

1. Blood: serum banking
2. Radiographs post-mortem
3. External exam, including weight and description of condition of body
4. Internal exam
  - a. A detailed written report should be completed.
  - b. Cultures should be submitted, if indicated
  - c. Photo documentation, if possible
  - d. Submission of a representative sample of all lesions AND routine tissues:
    - Skin, muscle, sciatic nerve, bone (femur), tongue, salivary gland, eye, brain, pituitary, trachea, thyroid, parathyroid, thymus, esophagus, lymph nodes (thoracic and abdominal), lung, bronchus, heart, aorta, liver, gall bladder, diaphragm, spleen,

- pancreas, stomach, duodenum, jejunum, ileum, ileocolic jxn, colon, adrenal, kidneys, bladder, ureter, urethra, reproductive organs
- It is recommended that a pathologist familiar with non-traditional species be used for histopathology.
- Reproductive organs should be submitted to: Dr. Linda Munson, Dept. of VM-PM1, Haring Hall, School of Veterinary Medicine, University of California, Davis, CA 95616 as a standing request.
- e. Frozen set of tissues: heart, liver, kidney, brain, serum, lesions
- f. Any stones (uroliths, renoliths, etc.) should be submitted for analysis to: Minnesota Urolith Center, Dept. of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Minnesota, 1352 Boyd Avenue, St. Paul, MN 55108

Methods for Banking Genetic Materials: Avoid contamination of genetic samples; wear gloves, clean equipment, etc. The protocols are listed in preferential order:

1. Whole Blood
  - A. Minimum required volume: 0.05ml (1 drop)
  - B. Lysis buffer (all ingredients may be obtained from Sigma)
    - 0.1 M Tris-HCl (pH 8.0) (bring to pH with HCl)
    - 0.1 M EDTA (pH 8.0) (bring to pH with NaOH)
    - 0.1 M NaCl
    - 2% (w/v) SDS (sodium dodecyl sulfate)
  - C. Protocol
    - Draw blood; if anti-coagulant is needed, heparin is preferable, but EDTA is acceptable
    - Mix 1:1 with buffer (a little more buffer is acceptable) in cryovial
    - Label with Animal, ID#, Date, Institution, Sample type (e.g. whole blood with heparin in lysis buffer)
    - Freeze at **-57°C (-70°F)**
2. Tissue Biopsies (skin with dermis or muscle)
  - A. Minimum required volume: at least this “•” big. Maximum required volume: piece(s) should be no larger than 0.4 cm<sup>3</sup>, section if necessary
  - B. Place in cryovial
  - C. Label with Animal, ID#, Date, Institution, Sample type
  - D. Freeze **immediately** at **-57°C (-70°F)**
3. Hair
  - A. Minimum required amount: 1 follicle; 10-20 preferred. Follicles **must** be attached.
  - B. Place follicle ends in a cryovial; with sterile scissors cut follicles into vial. Always use gloves when handling the hairs.
  - C. Label with Animal, ID#, Date, Institution, Sample type
  - D. Freeze **immediately** at **-57°C (-70°F)**

## Appendix H: Commonly Trained Behaviors for Procyonids (AAZK, Inc.)



The following list of behaviors was derived using data from a 2003 survey conducted by the American Association of Zoo Keepers Animal Training Committee (AAZK, ATC). The goal of the survey was to census the existence and depth of training programs for species in AZA facilities. For each species trained, each respondent was asked to list trained behaviors, types of reinforcement and conditioned reinforcers used. Additional information about facility design, training tools, and general comments was also requested. The ATC hopes that this data will aid in the design of training programs for the Mustelid, Procyonid, and Viverrid taxa. Where appropriate, these commonly trained behaviors can greatly enhance the husbandry of species in this group. Not every behavior will work for every animal. The appropriateness of a behavioral goal for an individual will depend on management policy and building design of the facility, as well as the needs and disposition of the animal. For questions or comments about this list or the Trained Behaviors Survey, please contact the AAZK Animal Training Committee at [www.aazk.org](http://www.aazk.org).

Survey results pertaining to the list of behaviors: 219 AZA facilities were surveyed. There were 71 respondents. 31 of these train species within the Procyonid taxonomic group. Because many similarities were found within taxonomic groups, commonly trained behaviors were compiled to serve as a reference for animal training programs. Of the 31 respondents that train within this group, the percentage that trains each behavior is listed next to the behavior.

<b>Raccoons</b>	<b>% Used</b>	<b>Red pandas</b>	<b>% Used</b>	<b>Ringtails</b>	<b>% Used</b>
Paws/feet	25%	Belly	33%	Target	67%
Separations	50%	Paws/feet	67%	Stethoscope	33%
Station	50%	Sides (torso)	33%	Station	67%
Target	75%	Shift	83%	Belly	33%
Oral meds	25%	Station	67%	Paws/feet	67%
Squeeze/crate	75%	Squeeze/crate	83%	Sides (torso)	33%
Climb	50%	Scale	83%	Station	67%
Carry object	25%	Come down	17%	Scale	67%
Stand up	50%	Target	83%	Injection	33%
Nail trim	25%	Tactile desensitization	67%	Climb	67%
Belly	25%	Vaginal swab	17%	Shift	33%
Shifting	75%	Ultrasound	17%		
		Hand injection	17%		
		Oral meds	50%		
		Ears	17%		
<b>Coati</b>	<b>% Used</b>	<b>Kinkajou</b>	<b>% Used</b>		
Belly	40%	Oral meds	33%		
Paws/feet	20%	Blood collection	33%		
Separations	40%	Squeeze/crate	67%		
Shift	80%	Injection	33%		
Station	60%	Ophthalmoscope	33%		
Squeeze/crate	100%	Otoscope	33%		
<b>Coati</b>	<b>% Used</b>	<b>Kinkajou</b>	<b>% Used</b>		
Scale	60%	Stethoscope	33%		
Climb	20%	Climb	33%		
		Leash on/off	33%		
		A to B	33%		

## Appendix I: Resources for Enrichment and Training

Sue Maher, Institution D

### Enrichment

- Coe J. 1992. Plan ahead for behavioral enrichment in environmental kaleidoscope: Research, management, and design. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 120-23.
- du Bois T. 1992. The Los Angeles Zoo environmental enrichment program: We get a lot of help from our friends. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 112-19.
- Goss D. 1999. Creating artificial vines for natural zoo displays. AAZK Forum: 26(11):449-51.
- Grams K, Ziegler G. 1995. Enrichment companies and products. AAZK Forum: 22(6):210.
- Hare V, Worley K. 1995. The shape of enrichment: The first generation. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 180-86.
- Harris A. 1998. Enrichment: Trials, tribulations and magic moments. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 271-74.
- Houts L. 1999. Folsom City Zoo piñatas. AAZK Forum: 26(5): 177-78.
- Houts L. 1999. Utilizing young visitors for behavioral enrichment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 72-3.
- Houts L. 2000. Enhancing animal welfare with limited resources. Proceedings of the AZA Annual Meeting. Wheeling. WV: AZA.
- Houts L, Greaves J. 2000. Enrichment options- Using Graphics to promote enrichment. AAZK Forum: 27(7): 307-08.
- Lacinak CT, Turner TN, Kuczaj SA. 1995. When is environmental enrichment most effective? In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 324-27.
- Lattis R. 2000. Animal welfare and the AZA. Proceedings of the AZA Annual Meeting. Wheeling. WV:AZA.
- Laule G. 1992. Addressing Psychological well being: Training as enrichment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 415-22.
- Laule G, Desmond T. Positive reinforcement training as an enrichment strategy. In: Shepherdson DJ, Mellen JD, Hutchins M, editors. *Second Nature: Environmental enrichment for captive animals*. Washington: Smithsonian Institution Press; 1998. pp. 302-313.
- Lindburg D. Enrichment of captive animals through provisioning. In: Shepherdson DJ, Mellen JD, Hutchins M, editors. *Second Nature: Environmental enrichment for captive animals*. Washington: Smithsonian Institution Press; 1998. pp. 262-301.
- Markowitz H. *Behavioral enrichment in the zoo*. New York: van Nostrand Reinhold Company; 1982.
- Martin S. 1996. Training as enrichment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV: AAZPA. pp 139-41.
- McPhee ME, Foster JS, Sevenich M, Saunders CD. 1996. Public perceptions of behavioral enrichment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. Pp 248-53.
- Mellen J, Shepherdson D, Hutchins M. Epilogue: The future of environmental enrichment. In: Shepherdson, D, Mellen, J, Hutchins, M, editors. *Second nature: Environmental enrichment for captive animals*. Washington, DC: Smithsonian Institution Press; 1998. p. 329-336.
- Mellen J, Sevenich M. 1999. Philosophy of animal enrichment: past, present, and future. In: Proceedings of the PAZAAB Conference. Cape Town: South Africa.
- Moore D. 1997. AZA Minimum Husbandry Guidelines for Mammals: Mustelids. AZA Mammal Standards Task Force, 1997. 7pg.
- Moore D, Reiss D. 2000. A multi-institutional program addressing welfare, enrichment, husbandry training and behavioral research. Proceedings of the AZA Annual Meeting. Wheeling. WV: AZA.
- Myers M. 1999. Feeder designs at the Audubon Park and Zoological Gardens. AAZK Forum: 26(11):369-72.
- Seidensticker J, Forthman D. Evolution, ecology, and enrichment: Basic considerations for wild animals in zoos. In: Shepherdson DJ, Mellen JD, Hutchins M, editors. *Second Nature: Environmental enrichment for captive animals*. Washington: Smithsonian Institution Press; 1998. pp. 15-29.

- Sevenich MacPhee M, Mellen J. 2000a. Framework for planning, documenting, and evaluating enrichment programs (and the Director's, Curator's, and Keeper's roles in the Process). Proceedings of the AZA Annual Meeting. Wheeling. WV:AZA.
- Sevenich MacPhee M, Mellen J. 2000b. Training and enrichment models for avian exhibits. Proceedings of the AZA Annual Meeting. Wheeling. WV:AZA.
- Sheng S. 1992. The ultimate enriched environment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 124-27.
- Shepherdson D. 1992. Environmental enrichment: an overview. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 100-3.
- Shepherdson D. 1997. The animal's perspective: Developing strategies for successful enrichment. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 486-89.
- Shepherdson D. Tracing the path of environmental enrichment in zoos. In: Shepherdson, D, Mellen, J, Hutchins, M, editors. Second nature: Environmental enrichment for captive animals. Washington, DC: Smithsonian Institution Press; 1998. p. 1-14.
- Shepherdson D, Carlstead K. 2000. When did you last forget to feed your tiger? Proceedings of the AZA Annual Meeting. Wheeling. WV:AZA.
- Shepherdson D, Mellen J. 1993. Environmental enrichment: Carrying forth the message. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 216-18.
- Shields J. 1995. Behavioral enrichment for the rest of the zoo. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 456-57.
- Smith C. 1993. An inexpensive simulated thundershower for small enclosures. AAZK Forum: 20(9):322-23.
- Stern S. 1994. Whose life is really being enriched here anyway? Shape of enrichment 3(3).
- Widner K. 1994. Initiation of the zoo-wide enrichment program at the Knoxville Zoo. In: Proceedings of the AAZPA Annual Meeting. Wheeling. WV:AAZPA. pp 51-2.
- Williams L. 1996. Ethological considerations for designing behavioral enrichment. Lab Animal. pp 29-33.
- Whorley KE, Hare VJ. 1995. An overview of the 1995 Environmental Enrichment Conference. The Shape of Enrichment. Vol. 4, No. 4, November.

**There are also many enrichment resources available on-line and in print, including:**

- "Enrichment Options" – A regular column featuring brief descriptions of ideas published monthly in the Animal Keepers' Forum. Published by the American Association of Zoo Keepers, Inc. AAZK Administrative Office, Susan Chan, Editor. 3601 S.W. 29th Street, Suite 133 Topeka, KS 66614. Phone: (785) 273-9149, Fax: (785) 273-1980. Email: [akfeditor@zk.kscoxmail.com](mailto:akfeditor@zk.kscoxmail.com). Website: [www.aazk.org](http://www.aazk.org)
- "The Shape of Enrichment" Newsletter – A newsletter devoted entirely to enrichment of captive wild animals. Published by The Shape of Enrichment, Inc., V. Hare & K. Worley, (eds.). 1650 Minden Drive, San Diego, CA 92111. Phone: (619) 270-4273. Fax: (619) 279-4208. E-mail: [shape@enrichment.org](mailto:shape@enrichment.org). Website: [www.enrichment.org](http://www.enrichment.org)
- The American Association of Zoo Keepers Enrichment Committee [www.aazk.org](http://www.aazk.org)
- Disney Animal Kingdom - [www.animalenrichment.org](http://www.animalenrichment.org)
- AAZK Enrichment Notebook 3rd ed. 2004 ISBN1-929672-11-X, [www.aazk.org/2004enrichnotebookcd.php](http://www.aazk.org/2004enrichnotebookcd.php).
- Fort Worth Zoo's Enrichment Online: [www.enrichmentonline.org/browse/index.asp](http://www.enrichmentonline.org/browse/index.asp)

**Training**

- Baker A. 1991. Training as a management tool: Creating the climate and maintaining the momentum. In: AAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 563-568.
- Blasko D, Doyle C, Laule G, Lehnhardt J. 1996. Training terms list. Principles of Elephant Management School. St. Louis: American Zoo and Aquarium Association, Schools for Zoo and Aquarium Personnel.
- Bloomsmith M, Laule G, Thurston R, Alford P. 1992. Using training to moderate chimpanzee aggression. In: AAZPA Regional Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 719-722.

- Coe J. 1992. Animal training and facility design – a collaborative approach. In: AAZPA/CAZPA Regional Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 411-414.
- Coe J. 1992. Animal training and facility design – a collaborative approach. In: AAZPA/CAZPA Regional Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 411-414.
- Dewsbury D. 1978. Comparative animal behavior. New York: McGraw-Hill.
- Grandin T. 1995. Thinking in pictures. New York: Vintage book. 222 p.
- Hediger H. 1950. Wild animals in captivity. London: Butterworths. 207 p.
- Hediger H. 1969. Man and animal in the zoo. London: Routledge and Kegan Paul. 303 p.
- Kazdin A. 1994. Behavior modification in applied settings. Pacific Grove CA: Brooks/Cole Publishing Company. 508 p.
- Kleiman D, Allen M, Thompson K, Lumpkin S, editors. 1996. Wild mammals in captivity: Principles and techniques.
- Laule G. 1992. Addressing psychological well-being: Training as enrichment. In: AAZPA/CAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 415-422.
- Laule G. 1995. The role of behavioral management in enhancing exhibit design and use. In: AZA Regional Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 83-88.
- Lyons J. 1991. Lyons on horses: John Lyons' proven conditioned-response training program. New York: Doubleday. 228p.
- Mellen J, Ellis S. 1996. Animal learning and husbandry training. In: Kleiman D, Allen M, Thompson K, Lumpkin S, editors. Wild mammals in captivity: Principles and techniques. Chicago: The University of Chicago Press. p. 88-99.
- Mellen J, Sevenich MacPhee M. (2001). Philosophy of environmental enrichment: Past, present, and future. *Zoo Biology* 20: 211-226.
- Pryor K. 1984. Don't shoot the dog! Simon & Schuster: New York.
- Pryor K. 1995. On behavior. North Bend: Sunshine Books, Inc.
- Ramirez K. 1999. Animal training: Successful animal management through positive reinforcement. Chicago: Ken Ramirez and The Shedd Aquarium. 578 p.
- Reichard T, Shellabarger W, Laule G. 1992. Training for husbandry and medical purposes. In: AAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums. p. 396-402.
- Reynolds G. 1975. A primer of operant conditioning. Palo Alto: Scott, Foresman and Co.
- Sevenich MacPhee M, Mellen J. 2000. Framework for planning, documenting, and evaluating enrichment programs (and the director's, curator's, and keeper's roles in the process). In: AAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums.
- Shepherdson DJ. 1998. Tracing the path of environmental enrichment in zoos. In: Shepherdson DJ, Mellen JD, Hutchins, M, editors. Second nature: Environmental enrichment for captive animals. Washington, DC: Smithsonian Institution Press. p. 1-12.
- Shepherdson D, Carlstead K. 2000. When did you last forget to feed your tiger? In: AAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums.
- Stevens B, Groff A, Joseph S, Mellen J, Ogden J, Plasse R. 2000. Evolving a new species of animal care professional: Combining AZA expertise with Disney leadership. In: AAZPA Annual Conference Proceedings. Wheeling, W.Va.: American Association of Zoological Parks and Aquariums.
- Wilkes G. 1994. A behavior sampler. North Bend: Sunshine Books, Inc.

## Appendix J: Sample Procyonid Enrichment Items and Techniques

All items should be evaluated by Animal Care staff for safety and appropriateness. Food items should be accounted for within the individual animal's daily nutritional requirements.

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### COATIS/RACCOONS

#### Sensory: auditory, visual, olfactory, tactile

Spices; catnip  
 Urine/trapping lures  
 Scented lotions  
 Body sprays, colognes  
 Perfume pages  
 Listerine, diluted  
 Extracts  
 Audio tapes  
 Radio  
 Paper, paint, stickers, etc. on outside of glass  
 Sun catcher (presented outside of enclosure)  
 Hair/wool or feathers  
 Snake sheds  
 Bubbles  
 Hooves  
 Broom heads/Astroturf for rubbing & scratching  
  
 Diluted essential oils  
 Hides (see hide protocol)  
 Pinwheels (outside of exhibit)  
 Laser Pointer  
 Disco ball (outside of exhibit)  
 Mirror mobile (outside of exhibit)  
 Lemons\*

#### Manipulative items/toys

Burlap bag (pillows) stuffed with hay or straw  
 Cardboard box/tube  
 Egg carton (without food)  
 Christmas trees\* (unpainted)  
 Pinecones  
 Piñatas (without food)  
 Boomer ball  
 Coconuts  
 Paper bags, sticks  
 Traffic cone  
 Water cooler jugs w/o food  
 Busy box child's toy  
 Fire hose  
 Phone book  
 Pine boughs\*  
 Things to bang together to make noise  
 Durable balls (i.e. basketballs, etc.)\*  
 Frozen Frisbees (water or broth)\*  
 Buckets with holes feeder hung in trees\*  
 Milk crates\*

#### Foods and feeding

Cardboard box/tube  
 Egg carton feeder  
 Peanut butter (in some type of device)  
 Honey (in some type of device)  
 Marshmallows  
 Puzzle feeder  
 Piñatas  
 Jell-O (in some type of device)  
 Frozen fruit pops  
 Insects (crickets, meal/wax worms) in puzzle  
 Crayfish  
 Nuts, berries, dried fruit, cob corn & corn stocks  
 Squash, including pumpkin; melons  
 Chicken gizzards, breast  
 Pile of rocks with diet hidden inside  
 Pinecone feeder  
 Eggs: hard boiled, scrambled or raw  
 Bones or Nylabones  
 Graham crackers  
 Hanging log puzzle feeder  
 Water cooler jugs w/ food items  
 Blue jean feeder\*  
 Acrylic sheet feeder\*  
 Feeder pan\*  
 Acrylic tube feeder in box\*  
 Hanging frozen corn cobs\*  
 Burlap bag feeder\*

#### Physical environment

Sand or sod  
 Straw/hay, blankets  
 Logs, stumps, branches  
 Kiddy pool with sand or leaves  
 Large hanging baskets (for animals to sleep in)

Coke barrel beds

Linen bed sheets

Water tubs & running water

#### Behavioral/Social

Visual access to contra specifics (DAF animals)  
  
 Visual access to animal decoys, piñatas, etc.)  
 Approved Training Programs  
 Window walker

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**CACOMISTLE/RINGTAIL****Sensory: auditory, visual, tactile, olfactory**

Snake skins  
 Scents - cinnamon and allspice  
 Urine/Trapping lures  
 Bath and Body Works body splashes and lotions  
 Perfume pages from magazines  
 Diluted extracts  
 Baby mirrors (unbreakable)  
 Hooves  
 Feathers  
 Non-toxic bubbles  
 Camel hair/wool  
 Herbs  
 Squirrel call  
 Chalk drawings  
 Paper, paint, stickers, etc. on outside of glass  
 Sun catcher (presented outside of enclosure)  
 Diluted essential oils  
 Hides (see Hide Protocol)  
 Disco ball (outside of exhibit)  
 Mirror mobile (outside of exhibit)

**Manipulative items/toys**

Paper bags  
 Paper towels  
 Small boomer ball  
 Ferret ball  
 Piñatas (w/o food)  
 Antlers  
 Pine cones  
 Traffic cones  
 Newspaper  
 Burlap bag pillows  
 Cardboard boxes/tubes  
 Phone books  
 Tennis balls  
 Kong toys  
 Wiggly Giggly Ball  
 Fire hose

**Behavioral/social**

Visual access to contra specifics (DAF animals)  
 Visual access to decoys & stuffed toys  
 Window walker

**Foods and feeding**

Gerbil ball with mealworms inside  
 Plastic ball smeared lightly with peanut butter  
 Crickets, meal/wax worms in puzzle device  
 Bones (if not given on a regular basis)  
 Pine cone feeders  
 Pile of rocks in a framed box to hide food in  
 Cardboard box/tube feeders  
 Buster Food cube  
 Egg carton/paper bag feeders  
 Boomerball puzzle feeder  
 PVC bug feeder  
 Piñatas  
 Sugar free Jell-O (in some type of device)  
 Frozen fruit pops  
 Nyla bones/Healthy edibles  
 Kong toy w/ diet  
 Carved pumpkins w/ diet  
 Burlap bags w/ bugs in it  
 Coconut feeder  
 Live fish in black tub  
 Hanging log puzzle feeder

**Physical environment**

Hanging baskets  
 Varied substrate  
 Shredded paper  
 Approved browse  
 Snow  
 Kiddy pool  
 Logs  
 Stumps  
 Cornstalks  
 Visual barriers  
 Auto misters  
 Excelsior  
 Sod  
 Large hanging baskets for animals to sleep in  
 Linen bed sheets

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Information taken from: Institution N, Institution O's Enrichment Online\*, Institution K

## Appendix K: Reproduction in the Kinkajou (*Potos flavus*)

By: Rain Westgard, Kristen Noble, Erin Bussom; Institution P (2009)

Kinkajou (*Potos flavus*) reproduction has not been well studied or documented, either *in-situ* or *ex-situ*. Information for this document comes from personal observations of the kinkajou breeding and training program at Institution P.

**Reproductive Physiology and Behavior:** Kinkajous reach sexual maturity around 2 years of age for males and 3 years for females. Kinkajous are polyestrous and can have more than one offspring in a single year with a minimum birth interval of 8 months. Estrus is widely variable, even within an individual throughout the year. Estrus cycles average 40 - 60 days with the female in estrus for approximately 3 - 4 days. With such fluctuations, it is important to track estrus cycles of each female by keeping a record of estrus beginning and end as well as behavioral or physical changes and breedings. Swelling of the vulva is typically the only noticeable physical change during estrus. Behaviorally, females may display increased aggression towards staff during estrus. There may be increased marking and territoriality if other females are in range of the estrus individual. Due to the strict nocturnal nature of kinkajous, staff may not even notice behavioral changes.

Copulations between the male and female usually occur at night. The male will approach the female and nip at her mandible and chin, making a soft chirping call. When the female is ready, she will assume a lordosis posture and elevate her tail. The male mounts her from behind. He uses the bony protrusions on his wrists to rub and stroke the abdomen of the female. There may be high pitched squeaks emitted by both. Copulations can last several minutes. Once the male releases the female, the kinkajous will separate and engage in genital grooming. Multiple copulations will occur while the female is in estrus.

Assisted reproduction has not been attempted in kinkajous.

**Pregnancy:** Gestation for a kinkajou is just under 4 months. Physical changes in the female do not become readily evident until the last trimester. Ultrasound is the most reliable diagnostic tool for detecting pregnancy early and has been used successfully. It is not recommended to anesthetize a pregnant female during the last trimester. If the female is to be moved to another enclosure, every attempt should be made to do so prior to the last trimester. This will provide her ample time to adjust to new surroundings. The male may be left in with the female, if she does not object; multiple elevated nest boxes should be available for her to choose a nesting site away from him, however. The nest boxes should be dry without substrate or bedding. An external heat source may be used if needed, but ensure that she can move away from it if she chooses.

During the latter part of the second trimester, a defined bulge will become visible in the female's abdomen. In the last trimester, the female's lower abdomen will become much more pronounced as the baby "drops". Fetal movement will be observable and fetal activity will increase as parturition draws near. The female will clear her two inguinal teats a few days prior to parturition and her mammary glands will swell as milk is letdown. During the entire last trimester, the female's appetite and caloric needs also will increase significantly and her diet should be increased at this time. Typically, the diet should be increased ~35 - 40% (for 2 adults housed together); all dietary items are increased equally. However, there may be an actual decrease in diet consumption just prior to parturition. The female may experience some physical discomfort as the fetus grows and occupies more space in her body, so increased stretching and restlessness may be observed, especially in the last trimester.

**Parturition:** Behaviorally, the female may exhibit some anxiety and agitation as her pregnancy progresses. She will drive the male away from her proximity at some point shortly before parturition, often just a few hours, but occasionally a few days before giving birth. He will stay away from the female and offspring until the female allows him to return to her nest. This reacceptance can take a couple of days or a couple of weeks. The female almost always gives birth overnight or during very early morning hours. She will chew off the umbilicus and consume all membranes and the placenta once it has passed.

Institution P had one kinkajou that occasionally experienced a uterine prolapse following parturition; however, this does not appear to be a common occurrence. If a prolapse occurs, immediate veterinary intervention is advised. Every attempt should be made to keep the offspring with the dam for as long as possible prior to repair of the prolapse and reintroductions should be attempted as soon as the dam has recovered from anesthesia. The offspring will require supplemental care while the dam is in surgery.

Following parturition, efforts should be made to keep the environment quiet and stable for at least two weeks, allowing the female to bond with the offspring. Females will aggressively defend the nest if they feel threatened, so only staff familiar to the kinkajou should work in the area if possible. Husbandry efforts should be kept to a minimum while maintaining good sanitation. This should continue until the female is comfortable and relaxed around staff. If the male is present in the enclosure, he will have no active part in rearing the offspring, but also will defend the nest if the female is threatened.

**Kinkajou Young:** The newborn kinkajou is altricial and should begin to nurse within a few hours of birth. Typical birth weights range between 150 and 180 grams. It is not unusual to see the newborn lying away from the mother in the same nest box for extended periods, especially in hot weather. It will lie next to or on top of the dam and nurse frequently throughout the day and night and will sometimes favor one teat over the other. If the diet of the female has not yet been increased, it must be increased to maintain lactation and provide proper nutrition for the infant. The diet increase should range between 35 and 40% of the female's maintenance diet; all dietary items should be increased equally. If the female loses an infant, she typically will have an estrus cycle within a few days.

Young kinkajous' eyes begin opening at about 1 week of age. Weight should increase steadily reaching ~200 – 270g at 1 week, 600 – 800g at 6 weeks, and 1.3 – 1.7kg at 6 months when they are roughly 75% adult size. The young become independently mobile at about 5 to 6 weeks and will begin showing an interest in solid food being eaten by their mother around 8 weeks of age. At about 10 to 12 weeks of age they will begin to consume solid foods taken from their mother and are typically weaned by 14 to 16 weeks. A young kinkajou will continue nursing as long as the mother allows, even after they have begun consuming the majority of their calories from solid foods. Food amounts offered should be increased to accommodate weanlings.

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## Appendix M: AZA Small Carnivore TAG Necropsy Protocol and Forms

### AZA Small Carnivore TAG Necropsy Protocol

- I. Recommended Fixed tissues. In addition collect a sample of any lesion. Fix in 10 parts 10% neutral buffered formalin to 1 part tissues, samples should be no thicker than 1 cm, and should be fixed for at least 72hrs to ensure adequate fixation.
  1. Trachea
  2. Lung (several sections including a large airway) Skin
  3. Pulmonary/Hilar lymph node
  4. Heart (left and right ventricle, septum & atrium)
  5. Aorta
  6. Thymus (if present)
  7. Esophagus (2 cm long cross section)
  8. Stomach (2 cm long portion of cardia, fundus, and pylorus)
  9. Duodenum, jejunum, & ileum (2 cm long cross section)
  10. Cecum
  11. Colon (2 cm long cross section)
  12. Rectum
  13. Liver
  14. Spleen
  15. Mesenteric lymph node
  16. Kidneys (cortex and medulla in section)
  17. Adrenal (cross section with cortex and medulla)
  18. Urinary bladder
  19. Prostate
  20. Testes (with epididymis)
  21. Female reproductive tract (fix whole - leave ovaries attached to uterus, longitudinal incisions in horns)
  22. Skeletal muscle (hindlimb)
  23. Tongue (cross section including both mucosal surfaces)
  24. Salivary gland
  25. Peripheral lymph node (popliteal or prescapular)
  26. Bone marrow (2 cm of opened rib or femur – **with marrow exposed**)
  27. Thyroids/parathyroids
  28. Brain (if possible whole)
  29. Pituitary
  30. Both eyes

For neonates also collect placenta and fetal membranes and umbilicus/umbilical area

For aborted fetuses and still births, freeze stomach contents and placenta

Necropsy Exam:

1. Estimate stage of gestation.
2. Measure the Crown to Rump Length: from the highest point on the skull (external occipital protuberance) to the base of the tail.
3. Note gross appearance of placenta and if it's complete.
4. Examine for congenital abnormalities: limb deformities, cleft palate, hernias, hydrocephalus, etc.
5. Check if lungs were inflated: pink or dark red color; sink or float in formalin.
6. Observe if the ductus arteriosus is contracted and if the foramen ovale is closed.
7. Determine if suckling has occurred: check stomach for milk curds; and note amount, viscosity and color of upper and lower GI tract contents.

### III. Shipping & Contact Information

Histopathology for the species managed under small carnivores should be submitted to the service the institution regularly uses (in-house, Northwest ZooPath, etc)



## **II. Gross Necropsy Examination**

Under appropriate sections, use “NE” for not examined or WNL if no abnormalities are present.

1. External & General Exam (postmortem condition, nutritional status, muscling, subcutaneous fat, skin, eyes, ears, nose, body orifices).
  
2. Musculoskeletal Systems (bones, joints, muscling, bone marrow).
  
3. Body Cavities (thoracic/abdominal cavities, amount of adipose, presence of fluids/exudates, negative pressure in chest).
  
4. Respiratory System (pharynx, larynx, nasal passages, trachea, bronchi, lungs, hilar lymph nodes).
  
5. Hemic-Lymphatic System (spleen, lymph nodes, thymus)
  
6. Cardiovascular System (pericardium, heart: valves & chambers, aorta, large vessels)
  
7. Digestive System (Mouth, teeth, esophagus, stomach, intestines, liver, pancreas, mesenteric lymph nodes). **Neonates:** is milk present in the stomach?).
  
8. Urinary System (kidneys, ureters, bladder, urethra)
  
9. Reproductive System (ovaries, oviducts, uterus, cervix, vagina, mammary glands, placenta/fetuses, testes, penis, accessory sex glands).
  
10. Endocrine System (thyroids, parathyroids, adrenals, pituitary, pineal gland-if found)
  
11. Nervous System (brain, meninges/dura mater, spinal cord, peripheral nerves)

### **III. Summary Gross Diagnoses**

### **IV. Ancillary Laboratory Test Results**

(cytology, urinalysis, fluid/serum analysis, microbiology, parasitology, serology, toxicology, virology, or others; attach reports as necessary).