ASSOCIATION OF ZOOS & AQUARIUMS

MUSTELID
(*Mustelidae*)
CARE MANUAL

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

Mustelid (Mustelidae) Care Manual

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Introduction

Preamble

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

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

Taxonomic Classification

Table 1: Taxonomic classification for Mustelidae

Classification	Taxonomy	Additional information
Kingdom	Animalia	
Phylum	Chordata	
Class	Mammalia	
Order	Carnivora	
Suborder	Caniformia	
Family	Mustelidae	Some experts place skunks in the family Mephitidae (Ledje & Árnason 1996a & b)
Subfamily	Mustelinae & Mephitinae	

Genus, Species, and Status

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

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
Mustela	*negripes*	Black-footed ferret	Endangered	Endangered	SSP (separate ACM)
Martes	*pennant*	Fisher	Not listed	Least Concern	PMP
Gulo	*gulo*	Wolverine	Not listed	Near Threatened	PMP
Taxidea	*taxus*	American badger	Not Listed	Least Concern	DERP
Mustela	*putorius furo*	Polecat (domestic ferret)	Not listed	Least Concern	DERP
Mephitis	*mephitis*	Stripped skunk	Not listed	Least Concern	DERP
Eira	*barbara*	Tayra	Not listed	Least Concern	DERP

General Information

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.

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* mustelid populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every 5 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 Mustelid 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 mustelid management and care, which will ensure superior mustelid welfare at AZA-accredited institutions. Ultimately, success in our Mustelid management and care will allow AZA-accredited institutions to contribute to mustelid conservation, and ensure that Mustelids are in our future for generations to come.

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.

Natural History and Taxonomy: The family Mustelidae contains approximately 25 recent genera and 67 species (Nowak & Paradiso 1983; Schreiber et al. 1989; Nowak 1999), which inhabit a wide variety of habitats ranging from humid tropical forest to arctic tundra and marine situations. Husbandry standards for mustelids are variable because of differences in body size, habitat preference, and natural behavior. Species range in size from that of the least weasel with a head and body length (HBL) of 11-26 cm (5-10 in) and a body weight of 28 g (1 oz), to that of the wolverine with a HBL up to 105 cm (41 in) and a weight of as much as 32 kg (70 lb). Male mustelids are on an average 25% larger than females in all species (Nowak & Paradiso 1983). Some species have potent anal gland secretions for defense (Moore 1997).

Mustelids may be diurnal or nocturnal, and terrestrial, semi-aquatic, or arboreal; many genera are excellent climbers and jumpers (fishers), diggers (badgers), and swimmers (mink). Due to their behavioral plasticity, climbers may dig, swimmers may jump, diggers may climb, etc. All species require shelter and will take refuge in crevices, burrows, brush piles, and/or tree cavities (Moore 1997). Mustelids are generally carnivorous, although some also eat plant material and carrion (Moore 1997).

Mustelid females, males and young may be referred to by different names. Typically the AZA Small Carnivore Taxon Advisory Group (SCTAG) uses female, male, and kit or cub for the young. More specific terms for the Badger are: females = sow, males = boar and young = kits; Ferret (European polecat): female = jill, male = hob and young = kit.

The following sub-family tables give the species names, body length, information on diet, preferred habitat strata (e.g., terrestrial or arboreal), activity pattern, and typical social grouping of each species in this taxa. Species listed in **bold type** are those recommended for management by the AZA SCTAG in the 2004-2007 and 2009 Master Plan. There are five subfamilies of mustelids, and new species and subspecies continue to be described (Schreiber et al. 1989). Recent work has resulted in placement of the skunks in their own Family by some experts (Ledje & Árnason 1996a & b). The following brief notes on each subfamily are taken from Schreiber et al. (1989) and Nowak & Paradiso (1983).

Mellivorinae: This is a family consisting of a single genus and species, the honey-badger (See Table 3). Honey-badgers are solitary, terrestrial mustelids which are symbiotic with the honey-guide (*Indicator* sp.), a bird which leads honey-badgers to bees' nests; after the badger digs the nest up both species share the honey, larvae, and wax.

Table 3: Biological and ecological information for the Mellivorinae

Name	Body Length	Arbor/Ter/Both/Water Facultative or Primary Carnivore	Noct / Diur / Crepus Solitary / Pair /Groups
Honey badger	60-77 cm (24-30 in)	B/F	N?/S, P

Mephitinae: This subfamily, which has been elevated to a family (Mephitidae) includes skunks; mustelids well known for their conspicuous black and white pelage and noxious odor (See Table 4). Skunks are terrestrial hunters and are found in a wide range of habitats. Genera in this subfamily include *Spilogale,*

Mephitis, and *Conepatus*. Striped and spotted skunks often live communally while hog-nosed skunks are more solitary; all eat insects and rodents (Nowak & Paradiso 1983).

Table 4: Biological and ecological information for the Mephitinae

Name	Body Length	Arbor/Ter/Both/Water Facultative or Primary Carnivore	Noct / Diur / Crepus Solitary / Pair /Groups
Hooded skunk	28-38 cm (11-15 in)	T/F	N/S?
Striped skunk	**58-80 cm (23-31** in)	**T /F**	**N/S, pairs poss.**
Eastern spotted skunk	32-46 cm (13-18 in)	T/F	N/S, P, G
Pygmy spotted skunk	12-35 cm (5-14 in)	T/F	N/
Eastern hog-nosed skunk	30-49 cm (12-19 in)	T/P	N/
Striped hog-nosed skunk	30-49 cm (12-19 in)	T/P	N/

Mustelinae: This subfamily consists primarily of small slender species (See Table 5). They are generally terrestrial hunters of small vertebrates but several species (*Martes* sp.) are excellent climbers. The smallest recent carnivore (least weasel) as well as the largest mustelid (wolverine) belong to this subfamily. Other genera include *Vormela* and *Eira* (which may forage in social groups of up to 20 individuals), *Galictis* (a social species), *Lyncodon, Ictonyx, Poecilictis* and *Poecilogale.*

Table 5: Biological and ecological information for the Mustelinae

Name	Body Length	Arbor/Ter/Both/Water Facultative or Primary Carnivore [1, 2, 4]	Noct / Diur / Crepuscular Solitary / Pair / Groups [3, 4]
Long-tailed weasel	23-26 cm (9-10 in)	T/P	D,N/S
American mink	35-55 cm (14-22 in)	T,W/P	N,C/S
Ermine or stoat	19-33 cm (7-13 in)	B,W/P	N,D/S,G
Least weasel	13-26 cm (5-10 in)	B/P	D,C,N/S
Black-footed ferret	**35-50 cm (14-20 in)**	**T/P**	**N/S**
Tropical weasel	25-33 cm (10-13 in)	B/P?	-
Mountain weasel	22-29 cm (9-11 in)	T/P	C,N/S,P?
Steppe polecat	35-52 cm (14-20 in)	T/P	N/
Colombian weasel	22 cm (9 in)	T, W?/P ?	-
Yellow-bellied weasel	25-27 cm (10-11 in)	?/P	-
Malaysian weasel	30-36 cm (12-14 in)	B/P ?	N/S likely
Polecat (domestic ferret)	**35-46 cm (14-18 in)**	**T/P**	**D,N/S,G**
Siberian weasel	28-39 cm (11-15 in)	B,W/P	C,N/S
Back-striped weasel	25-33 cm (10-13 in)	B/P?	N?/S?
European mink	37-43 cm (15-17 in)	T,W/P	D,N/S
Marbled polecat	27-35 cm (11-14 in)	T/P	C,N/S,G
American marten	40-45 cm (16-18 in)	B,W/P	N/S, maybe P
Fisher	**85-107 cm (34-42 in)**	**B/P**	**N,D/S**
Yellow-throated marten	57-72 cm (22-28 in)	B/P	D/P,G
Stone or beech marten	43-59 cm (17-23 in)	B/F	C,N/S,P,G
Pine marten	40-53 cm (16-21 in)	B/F	C,N/S generally
Japanese marten	47-55 cm (19-22 in)	B/F	N/S
Sable	38-58 cm (15-23 in)	B/P	D,N/S
Tayra	**56-68 cm (22-27 in)**	**A-B/F**	**D,N,C/S,P,G**
Little grison	40-45 cm (16-18 in)	B,W/F	D,N,C,/S/P/G
Greater grison	48-55 cm (19-22 in)	B,W/F	D,N,C/S,P,G
Patagonian weasel	30-35 cm (12-14 in)	?/P?	-
Zorilla	28-39 cm (11-15 in)	B/P	N/S
Saharan striped weasel	23-29 cm (9-11 in)	T/P	-
White-naped weasel	25-36 cm (10-14 in)	T/P	-
Wolverine	**70-105 cm (28-41 in)**	**B,W/F**	**N,D/S,P**

[1] Arboreal (A) – species that primarily live in trees; Terrestrial (T) – species that primarily live on the ground, typically not known to climb in trees; Both (B) – species that primarily live on the ground but are known to climb into trees while hunting, to rest, or to avoid danger (it should be remembered that all species can climb if motivated by fear, aggression, etc.); Water (W) - species that spend some time in the water or are known to take readily to water.

[2] Primary (P) carnivores – strictly, or primarily, eat animal protein, this includes vertebrate and invertebrate prey, may occasionally eat berries, etc.; Facultative (F) carnivores – eat a mix of animal and vegetable food items; the ratio may vary from seasonal dependence on vegetative foods, habitual foraging for vegetable matter to regular, occasional taking of certain vegetable items (Partridge & Jordan 1995; Reed-Smith et al. 2003).

[3] The final column indicates whether the species is primarily considered to be Nocturnal (N), Diurnal (D), or Crepuscular (C) and if they are most commonly found/exhibited as Solitary (S), Pairs (P), or Groups (G).

[4] A '?' indicates that the information has not been substantiated and is based on a closely related species (Nowak 1999; Reed-Smith et al. 2003).

Melinae: The badgers are accomplished diggers that live in underground burrows (See Table 6). Most species are ferocious when cornered, have conspicuous white facial markings, and excrete a pungent odor when aroused (Nowak & Paradiso 1983).

Table 6: Biological and ecological information for the Melinae

Name	Body Length	Arbor/Ter/Both/Water Facultative or Primary Carnivore	Noct / Diur / Crepus Solitary / Pair /Groups
American badger	**60-79 cm (24-32 in)**	**T/P**	**N/S, P seasonal**
Eurasian badger	56-90 cm (22-35 in)	T/F	N/G, P
Hog-badger	65-105 cm (26-41 in)	T/F	N/S
Sunda stink badger	38-51 cm (15-20 in)	T/P	-
Palawan stink badger	32-46 cm (13-18 in)	T/P	-
Chinese ferret-badger	32-46cm (13-18 in)	B/F	-
Everett's ferret-badger	32-46 cm (13-18 in)	B/F ?	-
Burmese ferret-badger	32-46 cm (13-18 in)	B/F ?	-

***Ex situ* Population Management Plan:** While there are a few individuals of other mustelid species held in North American zoological institutions, the AZA SCTAG has designated the following species of Mustelidae (Lutrinae are covered in a separate document) to be managed under the AZA Taxon Advisory Group (TAG) 2009 Regional Collection Plan (RCP). These are: American badger (*Taxidea taxus*), striped skunk (*Mephitis mephitis*), wolverine *(Gulo gulo)*, fisher (*Martes penanti*), polecat/domestic ferret (*Mustela putorius*), and black-footed ferret (*Mustela nigripes*) (covered by a separate Animal Care Manual). The Eastern spotted skunk (*Spilogale putorius*) and American marten (*Martes Americana*), managed as DERP species through the 2003 RCP, are now recommended as Phase Out species (SCTAG RCP 2009). The following guidelines and recommendations are designed specifically with these species in mind but include information on related species in some instances.

Conservation Status: The following table (Table 7) provides information on the conservation status of all mustelid species, based on CITES, US Fish and Wildlife Services (USFWS), and IUCN lists.

Table 7: Mustelid species conservation status (Lutrinae not included)

Species Latin Name*	Species Common Name	CITES Listing (Appendix)	USFWS Status	IUCN Status
Arctonyx collaris	Hog-badger**	-	-	Near Threatened+
Meles meles	Eurasian badger**	-	-	Least Concern+
Melogale everetti	Bornean ferret-badger+	-	-	Data Deficient+
M. moschata	Small-toothed ferret-badger+	-	-	Least Concern+
M. orientalis	Burmese ferret-badger**	-	-	Data Deficient+
M. personata	Large-toothed ferret-badger+	-	-	Data Deficient+
Mydaus javanensis	Sunda stink badger**	-	-	Least Concern+
M. marchei	Palawan stink badger**	-	-	Least Concern+
Mellivora capensis	Ratel**	III (Ghana Botswana)	-	Least Concern+
Conepatus humboldtii	Humboldt's hog-nosed skunk	II *	-	Least Concern+
C. chinga	Molina's hog-nosed skunk		-	Least Concern+
C. leuconotus	American hog-nosed skunk	-	-	Least Concern+
C. semistriatus	Striped hog-nosed skunk**	-	-	Least Concern+

Species Latin Name*	Species Common Name	CITES Listing (Appendix)	USFWS Status	IUCN Status
Mephitis macroura	Hooded skunk**	-	-	Least Concern+
M. mephitis	Striped skunk**	-	-	Least Concern+
Spilogale putorius	Eastern Spotted skunk+	-	-	Least Concern+
S. pygmaea	Pygmy skunk**	-	-	Vulnerable+
Eira barbara	Tayra**	III (Honduras)*	-	Least Concern+
Galictis cuja	Little grison**	-	-	Least Concern+
G. vittata	Greater grison**	II (Costa Rica)*	-	Least Concern+
Gulo gulo	Wolverine**	-	-	Near Threatened+
Ictonyx libyca	Lybian striped weasel+	-	-	Least Concern+
I. striatus	Zorilla**	-	-	Least Concern+
Lyncodon patagonicus	Patagonian weasel**	-	-	Data Deficient+
Martes americana	American marten**	-	-	Least Concern+
M. flavigula	Yellow-throated marten**	III (India)*	Endangered subspecies*	Least Concern+
M. foina	Stone marten+	III (India)*	-	Least Concern+
M. gwatkinsii	Yellow-throated marten** Nilgiri marten***	III (India)*	-	Vulnerable+
M. martes	European pine marten**	-	-	Least Concern+
M. melampus	Japanese marten**	-	-	Least Concern+
M. pennanti	Fisher**	-	-	Least Concern+
M. zibellina	Sable**	-	-	Least Concern+
Mustela africana	Amazon weasel**, Tropical weasel***	-	-	Least Concern+
M. altaica	Altai weasel+	-	-	Near Threatened+
M. erminea	Ermine**	III (India)	-	Least Concern+
M. eversmanii	Steppe polecat**	-	-	Least Concern+
M. felipei	Colombian weasel***	-	-	Vulnerable+
M. frenata	Long-tailed weasel**	-	-	Least Concern+
M. kathiah	Yellow-bellied weasel**	III (India)	-	Least Concern+
M. lutreola	European mink**	-	-	Endangered+
M. lutreolina	Indonesian mountain weasel***	-	-	Data Deficient+
M. macrodon	Sea mink***	-	-	Extinct+
M. nigripes	Black-footed ferret**	I**	Endangered**	Endangered+
M. nivalis	Weasel**	-	-	Least Concern+
M. nudipes	Malaysian weasel**	-	-	Least Concern+
M. putorius	Polecat/domestic	-	-	Least Concern+

Species Latin Name*	Species Common Name	CITES Listing (Appendix)	USFWS Status	IUCN Status
	ferret**			
M. sibirica	Siberian weasel**	III (India)**	-	Least Concern+
M.strigidorsa	Stripe-back weasel**	-	-	Least Concern+
M. vison	American mink**	-	-	Least Concern+
Poecilogale albinucha	African striped weasel+	-	-	Least Concern+
Vormela peregusna	European marbled polecat**	-	-	Vulnerable+
Taxidea taxus	American badger**	-	-	Least Concern+

* Wilson & Reeder 1992; ** Corbet & Hill 1991; + 2009 Ver.1 IUCN Red List June 30 2009 (www.redlist.org)
(Many species listed as Least Concern are believed to have decreasing populations.)

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). Mustelids 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 mustelids 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).

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.

Temperature: Because mustelids are so diverse and occur over such a wide range, most species are tolerant of wide temperature extremes. Animals kept outdoors, especially temperate and cold-adapted species, should always have access to natural or artificial shade for protection from direct sunlight when temperatures exceed 10 ºC (50 ºF). Species from tropical areas should be provided with heated shelter when air temperatures are below 20 ºC (69 ºF). Radiant heat is acceptable, as are “hot rocks,” etc. Animals kept indoors should be protected from temperatures above 25 ºC (78 ºF), and the enclosure should be provided with a thermal gradient for individual selection of comfortable areas by each animal (e.g., enclosures should be maintained at less than 20 ºC (69 ºF) ambient air temperature, with heat lamps or “hot rocks” provided within) (Wallach & Boever 1983). In northern states, acclimated temperate specimens (e.g., wolverine) may be provided with unheated shelters (nest boxes with hay or other material and waterproof tops), even during minimum temperature extremes (Moore 1997).

The important factor to remember is that appropriate temperature ranges vary amongst individuals as well as between species and animals should be given the opportunity to select a comfortable ambient temperature.

Humidity: Temperate species should be maintained at a low humidity when housed indoors. Typically, relative humidity should be 30-70%, but may be higher for the tropical forest species (Moore 1997); animals housed outdoors in high-humidity areas should always be provided with a means of cooling (e.g., pools, fans, shade, etc.) and given plenty of shade to allow them some choice of ambient temperature even though there is no control over humidity. Animals showing signs of stress should be given access to temperature/humidity controlled holding areas. These signs include extreme lethargy and panting.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all mustelids in the care of AZA-accredited zoos and aquariums. While it has not been definitively proven for all species, a seasonal change in light duration is involved in the onset of estrus in at least some of these species, e.g., *Martes* sp. (Martin 1996). Mustelids kept in artificially lit enclosures, or locked inside at night, should be kept on a light cycle that mimics the natural photoperiod of their native range, which is easily accomplished using a light timer.

Proper lighting is believed to be necessary to the health and well-being of *ex situ* populations of mustelids. Lights should be evenly distributed and of sufficient intensity to permit routine inspection and cleaning. Nocturnal species may be housed under reversed light cycles (blue or red lighting) to demonstrate natural activity patterns (Bernard 1997; Moore 1997).

Currently there are no data on the impact of varying light intensity, or type of light (fluorescent versus natural) on these species; this is an important topic for future research.

There may be a connection between photoperiod and the onset of estrus in northern mustelid species so seasonal day length should be varied if animals are exhibited indoors. Powell (1993) refers to studies indicating that the timing of the testicular cycle in fisher, stone marten, and sable is probably dependent on day length.

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.

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: Ideally, indoor exhibits should have a negative air pressure of 5-8 air changes per hour (for odor control) of non-recirculated air, however, negative air pressure is not required and recirculated air can be used in some cases. For esthetics, separate ventilation systems should be provided between humans and animals (Moore 1997).

Water Quality: Fresh drinking water should always be provided. Drinking water should be checked as necessary in summer to ensure there is always water available and in temperate climates protected from freezing in winter. Automatic water systems have been used in commercial mink farming operations (Siegmund 1973) and with several other mustelid species (J.Reed-Smith, personal communication). Watering devices should be sturdy, non-porous, and feature non-corroding containers. Water containers should be cleaned and disinfected daily (Moore 1997).

No water quality standards have been set for water provided in pools for non- or semi-aquatic species (see below for mink guidelines). Chemical residues, bacterial counts, mineral levels, and salts should be kept as low as possible. Fecal material and food remnants should be removed daily. While a coliform count of 100 (human standard) is currently considered acceptable for pools used by semi-aquatic species (mink), this is an area that requires future research. The pH tolerance for mustelids is not known, however, it is not likely to be important for species that do not habitually go in the water (this should be researched in the future). For the semi-aquatic species, e.g., mink, a pH consistent with normal drinking water (pH 6.5-7.5) should be acceptable. Turbidity, except for isolated areas, should be kept to a minimum to encourage use of the pool.

Water changes should be performed on a regular basis with non-filtration systems and periodically with filtered systems. Animals should not be given access to pools recently treated with chlorine (levels should be < 0.5ppm).

Mink: Pool water for this species should be maintained at a neutral or basic level. This is because they are highly susceptible to methylmercury toxicity, and acidic water methylates mercury, whereas, methylation is reduced as pH increases (J.Ogden, personal communication).

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by mustelids in the care of AZA-accredited zoos and aquariums. Many mustelids 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. Animals 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 should be given to the design and size of all enclosures, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3).

The quality of space is very important for these active animals (Wallach & Boever 1983). Hollow logs, digging sites, natural trees, bushes and vines, water features, vertical space, comfortable hiding places, and species-appropriate enrichment items will contribute to the overall quality of the environment and provide opportunities for the expression of species-specific behaviors of mustelids.

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.

Enclosure Size: Determining appropriate exhibit size for each species is more of an art form than a science. Successful exhibits will take into account the species' and individual's needs; highly enriched and structurally varied exhibits may be smaller than exhibits with less spatial, visual, and furniture complexity. Exhibit sizes recommended here are based on the species size, behavioral repertoire, home range size, activity pattern and daily movements, as well as professional experience with *ex situ* populations of these species.

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.
  a. Small animals: 10-15 inches – $(HBL/12 \times 6)^2$ = # feet^2
  b. Medium animals: 15-30 inches – $(HBL/12 \times 10)^2$ = # feet^2
  c. Large animals: over 30 inches – $(HBL/12 \times 12)^2$ = # feet^2
- **Formula II** – (HBL/12 x X) x 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.
  a. Small animals: 10-15 inches – (HBL x 6)/12 x 3 feet = # feet^2
  b. Medium animals: 15-30 inches – (HBL x 10)/12 x 6 feet = # feet^2
  c. Large animals: over 30 inches – (HBL x 12)/12 x 10 feet = # feet^2
- **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.

There are exceptions to the above formulas; these are listed below for specific species along with home range and travel distance information. It should be remembered that in the case of smaller exhibit sizes given, spatial quality and complexity is very important. For American mink, the formula used provides a larger exhibit size (31.2 m$^{2/}$336 ft^2) than is recommended by the European Mink Captive Breeding and Husbandry protocol (10 m^2/108 ft^2) (Maran & Robinson 1996). The recommendations for the American marten are larger than the size-based formula provides due to their high activity level.

Table 8: Exhibit size recommendations for enclosures containing 1-2 animals based on exhibit size formulas

Species	Ave. HBL (cm)	Formula used	Exhibit size
American marten	45.7 cm (18 in)	Formula Ib	31.2m^2/336ft^2
American mink	55.9 cm (22 in)	Formula Ia	31.2m^2/336ft^2
Tayra	68.6 cm (27 in)	Formula IVb	47m^2/506ft^2
Fisher	106.7 cm (42 in)	Formula IVc	164m^2/1764ft^2
Wolverine	106.7 cm (42 in)	Formula Ic	164m^2/1764ft^2
Striped skunk	78.7 cm (31 in)	Formula IIc	29m^2/310ft^2
Badger	81.3 cm (32 in)	Formula IIc	30m^2/320ft^2

An additional 25% should be added for each additional animal, particularly for exhibits used to house multiple wolverines. Exhibit size and dimensions can be slightly smaller if the space allows an equivalent square footage in navigable surface. Arboreal species should have a vertical enclosure height of at least 2.1 m (7 ft). See below for educational animal requirements. Exhibit size recommendations may change as more experience is gained and research conducted into the physiological and behavioral needs of these little known species.

Badger: This species has been exhibited in a 12 m^2 (129 ft^2) enclosure with access to tunnels and aisle ways leading to denning chambers 1 m^2 (10.8 ft^2) in size. It is important that this species is offered areas in which they may dig and plenty of bedding material that the animal can carry into the sleeping dens (Kidner 1995). Badgers have been shown to have a strong attachment to a home area (Nowak 1999). One study (Messick & Hornocker 1981) recorded average home ranges of 2.4 km^2 (0.93 mi^2) for males and 1.6k m^2 (0.62 mi^2) for females. Another study (Sargeant & Warner 1972) recorded seasonal range variation from 752 hectares (1,858 acres) in the summer to 2 hectares (5 acres) in the winter for one female.

Fisher: Fisher have been recorded by several researchers as being active both day and night. There is some indication that in zoos and areas of high human activity they tend to be more nocturnal (Powell 1993). Males have larger territories than females; research indicates that the fisher tends to move around its territory in a circuitous fashion. Daily movements average about 5km per day, typically during the course of two activity bouts. Active periods range from 2-5 hours (Powell 1993). Due to their sensitivity to human presence and far-ranging habits it is recommended that this species be exhibited in large enclosures. It may be beneficial to minimize visitor noise to encourage activity while visitors are present. Facilities interested in breeding this species should provide a complex enclosure larger than the minimum recommended here.

Stoat and common European weasel: Seclusion (hideouts and nest boxes) and plenty of space are important factors when designing exhibit space for stoats (ermine) and weasels (Partridge & Jordan 1995). Both stoats and common weasels have been known to travel up to 1.5-2 km (0.9-1.2 mi) in a few hours (King 1989). Weasel males generally have larger home ranges, 1-5 hectares (2.47-12.36 acres) in open grassland to >7-15 hectares (17.3-37.07 acres) in woodland, than females with ranges of 1-4 hectares (2.47-9.88 acres) in woodland. Both sexes use the hedgerows and protected areas more frequently than open spaces, and in at least one study both sexes were shown to frequent 2-5 favorite denning sites and 3-10 daytime resting places within core areas of their home ranges (King 1989). Stoat home range size varies widely, from 2-7 hectares (4.94-17.3 acres) for alpine females, to 254 hectares (627.65 acres) for farmland males, depending on habitat. Male home ranges are larger than female home ranges (King 1989). Exhibits should be furnished with good cover and abundant climbing, foraging, and resting sites such as deadfall, rocky screes, hedgerows, stonewalls, etc. Densely furnished exhibits are as important to the psychological well being of these species as total size.

Least weasel: Home range sizes reported by researchers vary from 3-10 hectares (7.41-24.71 acres) (King 1989). This species is found in fencerows, fields, along rivers, streams, and lakes where they make nests of grass, cornhusks, etc. which may be lined with fur. This species will benefit from soft substrates that allow for burrowing.

African striped weasel: A highly active animal, African striped weasels are prone to developing stereotypies if not stimulated frequently with enrichment and environmental variation. Exhibit furniture should be routinely changed with large logs rearranged monthly and new perching added every 4-6

months. The AZA SCTAG does not have an exhibit size recommendation specific to this species, but does recommend they are housed in highly complex environments with enrichment offered several times a day at varying times.

Tayra: In one study (Eisenberg 1989), a female was shown to use a home range of 9-16 km^2 (3.5-6.1 mi^2). As a forest dweller, it is important to offer this species vertical height and a high level of spatial complexity. A height of 2.44 m (8 ft) is recommended.

Wolverine: Exhibits larger than the dimensions recommended above are beneficial to the active, wandering wolverine (Blomqvist 2001), which have home ranges of 40-1500 km^2 (15.4-579.15 mi^2) (Magoun 1985; Blomqvist 2001). Home range size appears to vary with habitat, food availability and the sex and status of the individual animal. Lactating females reportedly utilize the smallest home ranges (40-100 km^2/15.4-39 $miles^2$), non-breeding females and males occupying home ranges varying from 200-1,500 km^2 (77-579 $miles^2$) , and young or very old animals have been observed using larger ranges (Landa et al. 1998). At this time, there appears to be a correlation between large exhibit size and increased breeding success, in particular to exhibits provided with a highly varied environment (e.g., furniture, plantings, trees, etc.). It is recommended that facilities interested in breeding wolverine or fisher house them in space larger than the accepted minimum (>150 m^2/1615 ft^2).

Night Quarters: For a single individual, the smallest enclosure dimension should be at least six times the average adult head-body length (HBL), with a width no smaller than four times the adult HBL (these dimensions are valid for temporary or overnight holding only). Nest boxes used for sleeping/hiding within these holding areas or enclosures need only be large enough for the animal to turn around in but should be spacious enough to accommodate all individuals simultaneously for the more social species or animals housed in pairs, groups, etc. Night/temporary enclosures of this type should be at least 50% larger for each additional animal, and larger than that for breeding pairs (Moore 1997; J.Reed-Smith, personal communication).

Enclosure Complexity: Natural substrates are recommended for all of the mustelid species. Recommended surfaces include: dry sphagnum moss, hay, soil, sod, pine needles, leaves, pebbles, sand, 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, or 3) show an allergic reaction to it. Some wood shavings (e.g., from conifers – some pines or fir) contain residues that can strip the water proofing from the coat of semi-aquatic species and/or may cause sneezing.

Cedar contains aromatic phenols that 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.

As with all species, large 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 structures/objects. 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. Smaller climbing structures, horizontal limbs, etc. should be replaced more frequently, generally every 1-3 months. All exhibits should be constructed to allow for easy introduction and removal of trees, logs, or branches required to create complex, usable space for the species exhibited (i.e., access should be provided to heavy machinery).

Animals housed indoors should be protected as far as possible from disturbance by the visiting public. Noise from environmental systems should be kept at a reasonable 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: Many of the mustelid species (for example: wolverine, mink, fisher) benefit from access to pools or streams. These water areas should be kept free of fecal material and food remnants with daily cleaning. Appropriate water features for these species include small pools used for drinking, larger pools for swimming or wading, streams/creeks, and waterfalls. Water/land interfaces should be sloped to allow for easy ingress and egress and provided with rocks, boulders, deadfall, etc. Water features should be located throughout the exhibit to allow for use by more timid animals that are hesitant to approach the public.

The land-to-water ratio for the more aquatic oriented species, such as the European mink, should not be less than 4:1 for smaller enclosures, and a ratio of 8:1 is considered suitable for larger exhibits (Maran & Robinson 1996). Care should be taken that fecal material and discarded pieces of food do not accumulate in these areas. Size and depth of any pools should be tailored to the species being exhibited. For example, wolverines will spend quite a bit of time in water, particularly if it is shallow enough for them to wade in (Moore 1997; J. Reed-Smith, personal experience). Water depth should be varied with depth ranges appropriate to the size of the species being exhibited. In general, water depths comparable to the animal's height, allowing them to submerge if desired, is appropriate. Mink are an exception; water depth in their exhibits should not be less than 0.37 m (1.2 ft), allowing them swimming room (Maran & Robinson 1996). For wolverines, water depth should be varied from shallow areas to depths of 0.6-0.9 m (2-3 ft) (Blomqvist 2001).

Some of the mustelid species will benefit from moving water (e.g., waterfalls and associated streams flowing into pools) and complex shorelines (banks should not be straight lines, and should be supplied with deadfall, rocks, shallow pools, etc); both of these, when incorporated into an active enrichment program, have been successful at stimulating psychological and physical well-being.

Misters also provide opportunities for the animals to cool off and explore other dimensions of their surroundings. All water features should be constructed to allow for easy cleaning. Space dedicated to pools/streams, etc. should be deducted from the usable floor-space calculations (Carnio 1996).

Species-appropriate Behavior: Natural or manmade shelters should be provided to protect individuals from inclement weather and provide a hiding place for nervous or stressed animals. There should be at least one nest box for each adult, particularly for species solitary in nature. Social species should be provided with sleeping area choices, and at least one that will accommodate all individuals in the enclosure simultaneously. Pre-parturient females should be provided with multiple nest boxes so they can move kits from box to box if they wish. Nest box size should be appropriate to each species (allowing enough room for the animal to stand up and turn around in). In the case of larger boxes, these may be divided by a baffle "security wall" in the middle to make the box feel more secure. Outdoor boxes should be waterproof and should have roofs higher at the front than at the back to allow for runoff. Nest box rooms should be accessible to keepers, and be removable for animal management and cleaning procedures. Entrance holes should be small enough to allow the animal to feel secure within the box. Entrances should have doors that keepers can close for management purposes (Moore 1997).

Forest species such as the tayra, fisher, marten, and mink (this species also is found in steppe systems such as the Great Plains) should be provided with good vertical and ground cover to mimic their natural habitat of swamps and forest. More terrestrial/woodland species such as the badgers, wolverine, and skunks should be provided with vertical space, ground cover, and open areas. It has been found that wolverines benefit from a complex vertical space including climbable trees, rock piles, ledges, deadfall, hollow logs, etc. The wolverine also benefits from pools and streams located within their exhibit. These water bodies should be provided with shorelines of varied complexity and water levels of varying depths.

A wide variety of exhibit furniture is important not only for shelter but also as stimuli for scent marking and other social behaviors. All mustelids engage in scent marking; some urinate, defecate, and deposit scent from their anal glands on high, conspicuous points (e.g., wolverine, some *Mustela* species), while others predominantly use secretions from their anal/musk glands, abdominal rub, and/or deposit scat (e.g., wolverine) (Partridge & Jordan 1995; Blomqvist 2001). Rocky screes (piles) may assist in stimulating breeding responses by wolverines (Blomqvist 2001), as well as provide another form of enrichment and behavioral stimulation.

Nest boxes, food and water stations, and covered sleeping/hiding spots should be located in the trees for arboreal species (e.g., tayra), on the ground for terrestrials (e.g., badger, wolverine), or a combination thereof (e.g., fisher, marten, wolverine), depending on the species' natural niche. 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. Limbs, branches, vines, etc. should all be secured to prevent them from falling. However, some should allow movement and sway with the animal's weight.

Marten: Porter et al. (2005) examined fine-scale habitat selection for specific activities such as resting, foraging, traveling, and scent marking. Their study detected more selectivity by marten for resting than for foraging and scent-marking sites, and no selectivity for traveling. Specifically, they found that marten showed a preference for "…several habitat structures that are characteristic of older forests (e.g.,

rootballs and wide-diameter snags), but that can be retained in some manipulated forests". Exhibits should incorporate resting structures of this type. Ruggiero et al. (1998) also found that large snags, large logs, rocks, and squirrel middens were important when natal den sites were selected, in particular squirrel middens were strongly favored.

African striped weasel: Exhibits should be provided with a natural substrate, complex climbing structures, and large logs, etc. on the floor to encourage exploration and provide the animal with a sense of security. The substrate should be replaced at least every three months, or sooner if needed. Large furnishings such as logs should be rearranged monthly and the entire exhibit re-perched every 6 months.

Wolverine: Off-exhibit areas for wolverines should provide natural substrates, if possible, space for running, hiding, and climbing, and at least one nest box per individual (Blomqvist 2001). *Ex situ* populations of wolverines also utilize sleeping platforms (~60 cm/2 ft off the ground with 30 cm/1 ft high sides) provided with bedding (J.Reed-Smith, personal experience).

Enclosure Cleaning: Enclosure furniture, including perches and nest boxes, should not be included in the daily cleaning regime because these species scent mark their territory, and a thorough cleaning of their home space may be a source of stress. One quarter of the enclosure furniture may be disinfected at a time, as needed, leaving scent marks on the rest. Old, soiled furnishings may be replaced 25% at a time rather than total replacement, which is commonly done for species that do not scent mark heavily. Substrates from large "naturalistic" enclosures should be removed and replaced as necessary; the larger the enclosure, the less frequently this activity will need to be performed (Moore 1997). However, it should be done periodically to keep animals engaged with their environment.

Wolverine: As with all of the mustelids, scent plays an important role in wolverine communication. The wolverine marks with secretions from their well-developed anal musk glands and with abdominal rubbing (Landa & Tömmerås 1996).

2.2 Safety and Containment

Containment: Animals housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3). Mustelids are not recommended for free-ranging environments.

Animal 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 must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

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

Mustelid species are not good candidates for free-ranging situations. Many mustelid 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 have containment perimeters and tops; hot-wire should be placed 1-1.52 m (3-5 ft) from the floor to prevent animals from climbing (climbable surfaces) and falling. Open-top exhibits have been successful with wolverine (see below), and at a minimum should have an inward facing overhang at the top (of at least 80 cm/2.6 ft), unless they are of a height that precludes an animal jumping over (see below). Trees, bushes, and other exhibit furniture should be placed away from the perimeter so they cannot be used as a means of escape. Outdoor exhibits should have security entrances with a secondary catch area for animals that sneak through the door.

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.

Wolverine: Wolverines are good climbers and jumpers, and so particular care should be taken when placing exhibit furniture. Wolverines should be prevented from climbing large trees located closer than 2

m (6.5 ft) to the perimeter fence; hot wire or non-climbable collars can be placed around these trees. Exhibit perimeter walls should be of a non-climbable material, or, if constructed of a wire-mesh material, they should be at least 2 m (6.5 ft) with an inward overhang of at least 0.8 m (2.6 ft) and a 45º angle (Blomqvist 2001). Perimeter walls should be sunk at least 0.8 m (2.6 ft) into the substrate and preferably, extended the same distance under the ground back into the exhibit. If a climbable material is used for all, or part, of the walls, hotwire (three strands are recommended) should be run just above ground level to prevent the animals' from climbing (Blomqvist 2001).

Emergency and Safety Procedures: 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).

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 animals must have appropriate safety procedures in place to prevent attacks and injuries by these animals (AZA Accreditation Standard 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

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.

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).

Emergency protocols specific to mustelids should be developed by each institution based on their policies, enclosure design, species exhibited, and AZA guidelines as stated above.

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. All possible relevant regulatory agencies always should be checked for shipping, health, and permit requirements before transporting animals (USFW, State, CITES, etc.).

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.

When transporting mustelids there always should be at least two people present; if animals have been anesthetized the veterinarian always should 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.

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.

Transport Crate: All shipping containers should be clearly labeled on all sides as containing live animals. In general, the following crate design guidelines are true for all species: 1) Crates should be able to withstand external damage from other freight and able to withstand any internal destruction that may be caused by the animal. 2) Crate doors should not come open accidentally, but should be securely fastened. 3) All shipping crates should allow for adequate ventilation. 4) Ventilation apertures should 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 should be large enough to allow the animal to stand up and turn around (IATA 2009).

The equipment should provide for the adequate containment, life support, comfort, temperature control, food/water, and safety of the animal(s). Air kennels of the appropriate size have been used extensively to ship many of the mustelid species. Kennels should be supplied with bedding (e.g., shredded paper, shredded cardboard, etc.), but the lining of kennels with wire of any kind is not advised due to the possible injury to feet or the animal's mouth as a result of chewing (M. Dulaney, personal communication).

Wolverines: Crates used for the shipping of wolverines need to be of heavy construction to prevent the animal from destroying them.

Additional Supplies and Personnel: All supplies should be gathered in advance; to include scales, transport crates and vehicles, food, transport labels/permits, applicable record sheets, catch-up equipment, and veterinary supplies if required.

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.

3.2 Protocols

Transport protocols should be well defined and clear to all animal care staff. It is always preferable that animals are trained to voluntarily enter crates. This should be planned out in advance and become part of the institutional Mustelid transport policy if possible. Some institutions have trained mustelid species to regularly enter squeeze cages that can be used to transfer the animal into a shipping crate.

Below is an example of a squeeze cage routinely used for fisher (Photo credit: Peg Dwyer):

If animals are not trained to enter crates or shipping containers, some mustelids (domestic ferret) can be hand-caught, some may be candidates for netting by trained, experienced personnel (this should be decided upon by individual institutions), and others will require anesthesia via a blow dart. Use of a squeeze cage similar to the one in the photo also allows for hand-injections of anesthesia if required.

Mustelids should always be shipped individually. Pregnant or lactating females should not be shipped.

Food and Water: The crate should allow for feeding and watering of the animal if needed. The food and water ports should be clearly marked on the outside of the crate. On long flights, provisions should be made for feeding in transit (this may necessitate shipping food with the animal).

In general, due to the high-metabolic rate of many mustelids, it is best if they do not go more than 12 hours without food and water. Animals in transit longer than 12 hours should be provisioned with frozen fruit pieces or frozen mice. Least weasel should always be shipped with frozen mouse pieces in their crate. The larger wolverine, badger, and skunks may go 24 hours without feeding but should not go longer.

Substrate and Bedding: The crate bottom should be leak-proof and bedded with some form of absorbent material that the animal is familiar with. Transport company regulations should be checked for any restrictions on bedding materials used in animal crates.

Temperature, Light, and Sound: USFWS and IATA regulations for shipments to the United States indicate that temperatures in the holding area, cargo, or terminal should be a minimum of 12.8 ºC (55 ºF) and a maximum of 26.7 ºC (80 ºF). If ambient temperatures are higher than 24 ºC (75 ºF), ancillary ventilation should be provided (Ott Joslin & Collins 1999).

For shipments within the U.S., the AWA (Animal Welfare Act) requires that ambient temperatures in the holding area should not be less than 7.2 ºC (45 ºF) or more than 29.5 ºC (85 ºF) for animals held for more than four consecutive hours. Animals being transported between holding areas to the aircraft should not be exposed to ambient temperatures of more than 29.5 ºC (85 ºF) or less than 7.2 ºC (45 ºF) for more than 45 minutes (Ott Joslin & Collins 1999). These guidelines are suitable for the Mustelidae species for brief periods (no more than 15 minutes at temperatures above 23.8 ˚C/75 ˚F). However, these species may be highly susceptible to heat stress and should not be shipped if ambient temperatures are over 21 °C (70 ºF) if possible.

Whenever possible, shipments should be planned to avoid temperatures at either extreme, especially the higher temperatures which, as stated, could lead to heat stress in many of these species. Body mass of species being shipped should be taken into consideration, as thermoregulation may be more of an

issue for the smaller species particularly if they have been housed indoors and are suddenly exposed to colder temperatures.

Mesh doors or side windows (i.e., 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). Regulations should be checked first before air kennel type crates are used, as they may not meet specifications for some Mustelid species.

Covering of the openings with air-permeable material will help to provide a sense of security for animals being shipped. 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: Transport periods greater than 24 hours (12 hours in smaller species) 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. The decision to provide food will depend on the species involved. These decisions should be made by the zoological institutions concerned. Dry food should be provided with international shipments (M. Dulaney, personal communication). In instances where provisioning may be required while an animal is in transit, access to food and water containers from the outside, without opening the transport crate, should be accommodated and planned for.

Once shipping has been completed, 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.

Chapter 4. Social Environment

4.1 Group Structure and Size

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

Group Structure: Most mustelids should be maintained as singletons (e.g., domestic ferret, striped skunk, fisher, spotted skunk, badger, tayra), singletons or seasonal pairs (e.g., marten, badger, wolverine, striped skunk, spotted skunk, tayra), or as pairs (e.g., wolverine, ferret). However, many of these species have been successfully maintained in pairs or small groups year-around (wolverine). In rare cases, small groups are possible for some species (e.g., domestic ferret, tayra, spotted skunk).

The polecats (stoats and weasels) may be housed in groups consisting of one male and several females in large enclosures depending on exhibit design and individual personalities (Partridge & Jordan 1995). Male/male pairings of skunks have been successfully housed together; however, there was some seasonal aggression (D. Smith-Weber, personal communication). In this case, a temporary separation of the males with a later reintroduction resolved the strife within the exhibit (D. Smith-Weber, personal communication). Introduction of mustelids should always be done with caution and monitored for any aggression (see section 4.3).

Wolverine: Attempts to keep 1.2 groupings (1 male. 2 females) have never been successful, always resulting in the eventual need to remove the subordinate female (Blomqvist 2001). Groups of hand-reared wolverines have been housed together for extended periods.

Single-sexed Groups: Young of the same sex may be kept together, but, in some species, animals should be monitored for aggression as they age (e.g., wolverine, skunk). Aggression will be accompanied by growling and injurious biting. Animals also should be monitored for signs of stress, hiding, weight loss, hair loss, or the development of stereotypies.

Wolverines have been successfully kept in all male groups provided the animals are siblings reared together or introduced at a very young age (Blomqvist 2001). In these cases, the animals should never be separated for extended periods. Mature male stoats and weasels should not be kept together (Partridge & Jordan 1995). Male/male pairings of skunks have been successfully housed together; however, there was some seasonal aggression. Temporary separation of the males and later reintroduction resolved the strife within the exhibit (D. Smith-Weber, personal communication).

4.2 Influence of Others and Conspecifics

Influence of Conspecifics: Barriers between individuals housed separately should be designed to prevent paws, jaws, or other body parts from being extended into a nearby cage. Animals should be provided with visual barriers when housed adjacent to conspecifics. Males of some of these species (e.g., wolverine, fisher) should not be housed where they can see or make physical contact with each other. Breeding pairs not kept together year around should be housed in visual and olfactory contact.

Enclosures must be constructed to prevent escape and injury to adjacent animals, keepers, or the public (AZA 2008). Enclosures separating adjacent individuals should have double thickness fencing and be at least 12 cm (4.5 in) apart (Moore 1997). Animals housed in adjacent night quarters or off-exhibit holding should be separated by mesh fine enough to prevent feet from becoming caught (e.g., wolverine), or with an opaque covering (e.g., fisher, wolverine, skunk, etc.), and provided with other visual barriers.

Typically, females of these species should be separated for parturition and given an area where disturbances are kept to a minimum. The need for isolation is particularly true for some species such as wolverine, weasels, and fishers. Parturient females should always be offered whelping box choices, which should be put in place in advance of imminent births allowing the female ample opportunity to scent mark and become accustomed to them.

Mixed-species Exhibits: In general, mustelids are not good candidates for mixed species exhibits. Skunks may be a possible exception, but there is no information on successful mixed exhibits for these species.

4.3 Introductions and Reintroductions

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

As predators, mustelids are capable of inflicting serious wounds to conspecifics and keeper staff. Thus, the introduction of potential mates should be done carefully to prevent fighting, injury, or death. Introductions may take anywhere from a few hours to weeks. There are some introductions that will never be successful. Animals should be allowed to become accustomed to each other's scent first, and then introduced visually. Once affiliative behaviors are observed, physical introduction may be attempted. Whenever possible, it is preferable that introductions take place in neutral territory. Rotating animals through the exhibit and holding dens will aid in breaking down a sense of territoriality.

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 mustelid species has not been explored as thoroughly as in some of the other mammal and avian species, but should be explored further in the future, especially in relation to animal introductions.

Chapter 5. Nutrition

5.1 Nutritional Requirements

> **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.

A formal nutrition program is recommended to meet the behavioral and nutritional needs of all mustelids (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), and veterinarians as well as AZA Taxon Advisory Groups and Species Survival Plans®. 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.

Within the Mustelid family there is great variation in food habits. Some are strict carnivores (*Mustela*), reported to consume small terrestrial and aquatic vertebrates, invertebrates, birds, and eggs (Kruska 1990; Nowak 1999; Fernandez-Moran 2003). Some species are "largely carnivorous" omnivores (*Spilogale*, *Taxidea*, *Eira*), consuming primarily small vertebrates and invertebrates, but also fruits and berries (Verts 1967; Kruska 1990; Macdonald 1999; Fernandez-Moran 2003). Otters (not covered in this document) are primarily piscivorous, consuming aquatic vertebrates and invertebrates (Kruska 1990; Macdonald 1999; Fernandez-Moran 2003; AZA Small Carnivore TAG 2008).

Digestive System Morphology and Physiology: The stomach of mustelids is simple, characteristic of carnivores. Similar to procyonids and ursids, the distal segment of the intestine is marked only by a change in the mucosa, and there is no cecum present (Stephens & Hume 1995). The intestine of *Mustela vison* is approximately 3 times body length, with a short and simple hindgut (Stephens & Hume 1995). Transit time in mink has been observed to be 2-4 hours, and should be considered when designing feeding schedules (Leonard 1966). In general, the mustelid gastrointestinal tract is designed to process readily digestible diets, higher in protein and fat than carbohydrates and fiber. High levels of protein from plant sources have been associated with urolithiasis in mustelids, and are therefore undesirable (Fernandez-Moran 2003). Fish sources should be carefully monitored as some species are highly susceptible to Hg and PCB toxicity (e.g., mink) (J. Ogden, personal communication).

Nutrient Requirements: Although many of the items consumed by mustelids are known, 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. Some work has been done to define target nutrient levels for mink (NRC 1982) and Asian small-clawed otters (*Aonyx cinereus*) (Maslanka & Crissey 1999), but it does not represent the entire family. The target nutrient levels established herein are based on some of this previous work, as well as that with well-studied carnivores, such as cats (NRC 2006; Legrand-Defretin & Munday 1993; AAFCO 1994), and omnivores, such as dogs (NRC 2006; AAFCO 1999), mink (NRC 1982), and foxes (NRC 1982). 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 or more carnivorous individuals (see Table 9). These ranges are provided in comparison to the straight requirements of cats, mink, dogs, Arctic fox, and Asian small-clawed otter as reference comparisons. See Appendix G for descriptions of the nutrients listed in Table 9.

Table 9: Target nutrient ranges for baseline species (dry matter basis)

Nutrient	More Omnivorous[1] Skunk and Tayra	More Carnivorous[2] Badger, Ferret, Fisher, Wolverine
Protein (%)	17.5-26.0[1a]	19.7-32.5[2a]
Fat (%)	5-8.5	9.0-30
Linoleic Acid (%)	1.0-1.3	0.5-0.55
Vitamin A (IU/g)	0.5-5.9	2.44-10
Vitamin D (IU/g)	0.5-0.55	0.25-1.0
Vitamin E (mg/kg)	27-50	27-120
Thiamin (mg/kg)	1.0-2.25	1.0-5.6[2b]
Riboflavin (mg/kg)	1.6-10.5	1.6-4.25
Pantothenic acid (mg/kg)	7.4-15.0	5.0-8.0
Niacin (mg/kg)	11.4-20.0	9.6-60
Pyridoxine (mg/kg)	1.0-1.8	1.6-4.0
Folacin (mg/kg)	0.18-0.5	0.2-1.3
Biotin (mg/kg)	0.1-0.12	0.07-0.12
Vitamin B_{12} (mg/kg)	0.022-0.035	0.02-0.035
Calcium (%)	0.5-1.2[1b]	0.5-1.0[2c]
Phosphorus (%)	0.5-1.0[1b]	0.5-0.8[2c]
Potassium (%)	0.4-0.6	0.4-0.6
Sodium (%)	0.04-0.3	0.05-0.4
Magnesium (%)	0.04-0.06	0.03-0.08
Iron (mg/kg)	30-90	80-114
Zinc (mg/kg)	50-120	50-94
Copper (mg/kg)	6.0-12.4	5.0-8.8
Iodine (mg/kg)	0.9-1.54	0.35-2.2
Selenium (mg/kg)	0.1-0.35	0.1-0.4

[1]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).

[1a] Dog NRC (2006) suggests 10% protein for maintenance, but this is lower than would be recommended for all animals covered by the ACM.

[1b] Authors of this chapter would caution feeding diets with 0.3% calcium and/or phosphorus as the Dog NRC (2006) suggests, thus a more reasonable minimum value is recommended.

[2] Cat NRC (2006), Legrand-Defretin & Munday (1993), Cat AAFCO (1994); Maslanka & Crissey (1999); 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).

[2a] Lewington (2002) indicated that lactation demand on female mink (*Mustela*) may require up to 45.7% CP on a dry matter basis (based on a calculated 83% protein digestibility).

[2b]Blomqvist (2001) has indicated that wolverines (*Gulo gulo*) may have a higher requirement for thiamin than other mustelids. Thiamin and Vitamin E should be supplemented in all diets where frozen/thawed fish comprise more than 33% of the total diet.

[2c] Authors of this chapter would caution feeding diets with 0.29% calcium and 0.26% phosphorus as the Cat NRC (2006) suggests, thus a more reasonable minumim value is recommended.

All carnivores are highly susceptible to metabolic bone disease (Kaufman 1978) and other classic nutrition deficiency diseases (Wallach & Boever 1983). High-quality balanced diets should be fed to all of these species. 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, reproducing animals (gestation and lactation), as well as needs for growing animals. The sample diets provided in section 5.2 have supported all life stages.

Kits and juveniles: Young martens will begin eating solid food at about 36-45 days and are weaned at about 6 weeks of age (Martin 1996). Badger cubs can begin weaning at 8-19 weeks of age. At this time baby foods, scrambled eggs, minced meat, or day old chicks should gradually be included in the diet.

Weaning should be completed by 3 months of age, but may take longer for some individuals (Kidner 1995: cited in Newman et al. 2004). For information on hand-rearing formulas, see Chapter 7, section 7.5.

Reproductive status: Maintaining adequate weight is especially important in breeding females, as both obesity and poor body condition can lead to fertility problems. Pregnant and lactating females may require higher caloric and calcium intake. Amounts offered to gestating and lactating females should be closely monitored to allow for maintenance of fetal development, appropriate weight gain, and maintenance of body stores during lactation that supports adequate kit growth. It has been shown that the feeding of large pieces of meat every second day increases the breeding success of wolverines (Blomqvist 2001). When offering any diet item it should be a part of a nutritionally complete diet (nutrient content compared to target nutrient values in Table 9). There has been speculation that a delay in puberty of *Martes* species both in the wild and in zoos and aquariums may be due to nutritional deficiencies (Martin 1996).

Seasonal changes: Some of the mustelids will undergo a physiological response to decreasing temperatures; examples of this are the badger, which shows a reduced level of food intake in winter (Kruuk 1989), and the striped skunk, which also may become sluggish during the winter (Hindmarsh 1995). For fisher, an increase in dietary fruit (apples in particular) should be considered in the winter to mimic a natural dietary shift documented in at least a portion of their range (Arthur et al 1989).

There may be seasons when consumption is depressed (*Mephitis*, *Taxidea*), and others when food is readily and quickly consumed, thus development of individual standard and predictable feeding behavior patterns based on seasons can serve as effective diet management tools. Exact guidelines for what is considered acceptable seasonal weight gain are not available. In general, each individual should be monitored over the course of a year to establish their normal weight and body condition. A seasonal weight gain of no more than 10-30% of their base body weight can serve as a beginning target until each individual's ideal seasonal weights are determined.

Fisher, badger, and striped skunk are some of the mustelids known to store body fat seasonally during the winter (Kruuk 1989; Hindmarsh 1995; Martin 1996); this physiological change should be allowed while still monitoring the animals for excessive weight gain. Skunks and badgers show a tendency to put on weight in the fall and care should be taken that they are not overfed (Hindmarsh 1995; Hancox 1995). American badgers in the wild show ~33% more body fat in the fall than expected which begins to decrease from that time through March (Harlow 1981a and b). Fishers may add seasonal body fat stores (Powell 1979); weasels and stoats are not known for putting on winter fat (King 1989). How important seasonal weight changes are physiologically to the long-term health of these species is unknown, and if seasonal weight gain is part of the management strategy, subsequent seasonal weight loss should also be part of the plan.

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. Mustelids, for the most part, have higher than predicted rates of basal metabolism compared to the Kleiber curve (McNab 1989). Basal metabolic rates are not species constant, and will be higher (as much as twice) for growing individuals than for adults (Robbins 1993). Gross energy requirements can be calculated using appropriate equations (Nagy et al 1998; KJ/d = 2.23 BWg ^ 0.85 for carnivorous mammals), but mustelid-specific equations are not readily available. Table 10 provides a listing of energy requirements for American mink.

Some individuals have a tendency toward obesity and should receive proportionately less food. Each genus, or species, will require a specific diet that may vary seasonally (e.g., mink may need higher dietary fat in winter) (Lewington 2002), and all diets should be thoroughly researched prior to animal acquisition. An animal's feeding ecology, target nutrient values, target body condition, available foods, and diets used by facilities already housing a species should all be considered when establishing a species' diet.

Table 10: Nutrition and energy requirements for American mink as percentage or amount per kg of dry matter (from Lewington 2002)

Constituent	Growth		Maintenance (mature)	Gestation	Lactation
	Weaning to 13 weeks	13 weeks to maturity			
Energy					
Males (kcal ME)[a]	4080	4080	3600	---	---
Females (kcal ME)	3930	3930	3600	3930	4500
Crude protein (%)	38[b]	32.6-38.0	21.8-26.0	38	45.7
Fat-soluble vitamins					
Vitamin A (IU)	5.930	[c]	[c]	[c]	[c]
Vitamin E (mg)	27	[c]	[c]	[c]	[c]
Water-soluble vitamins					
Thiamine (mg)	1.3	[c]	[c]	[c]	[c]
Riboflavin (mg)	1.6	[c]	[c]	[c]	[c]
Pantothenic acid (mg)	8.0	[c]	[c]	[c]	[c]
Vitamin B6 (mg)	1.6	[c]	[c]	[c]	[c]
Niacin (mg)	20.0	[c]	[c]	[c]	[c]
Folic acid (mg)	0.5[d]	[c]	[c]	[c]	[c]
Biotin (mg)	0.12	[c]	[c]	[c]	[c]
Vitamin B12 (µg)	32.6	[c]	[c]	[c]	[c]
Minerals					
Calcium (%)	0.4	0.4	0.3	0.4	0.6
Phosphorus (%)	0.4	0.4	0.3	0.4	0.6
Ca:P ratio	1:1-2:1	1:1-2:1	1:1-2:1	1:1-2:1	1:1-2:1
Salt (%)	0.5	0.5	0.5	0.5	0.5

[a] E: gross energy; ME: metabolizable energy. Nutrient requirements are based on an energy level of 5300kcal E or 4080kcal ME.
[b] Based on average quality protein with calculated digestibility of 83%. Higher quality protein and higher digestibility decrease the requirement; lower quality protein and lower digestibility increase the requirement.
[c] Quantitative requirements of minerals and vitamins not determined but dietary need has been demonstrated.
[d] May not be the minimum but this level is known to be adequate.

Work done by Muñoz-Garcia 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 11). Based upon this work Muñoz-Garcia and Williams (2005) concluded that "…species that eat meat have larger home ranges and higher BMR than species that eat vegetable matter."

Table 11: Basal Metabolic Rate (BMR) of selected Mustelidae species (from: Muñoz-Garcia & Williams (2005), citing original sources)

Species	Body Mass (g)	BMR (kJ/d)	Diet (%) (Meat/Invert/Veg)	Home range (km^2) (females only)
Spilogale putorius	624	140.77	50/50/0	1.5
Lutra lutra	8,854.3 ± 1,777	2,997.3 ± 869	97.5/2.5/0	19.2
Meles meles	10,715.2	1,323	13.5/62.2/24.3	12.4
Taxidea taxus	9,000	1,301.2	49/6.8/44.2	3.1
Gulo gulo	13,133.4 ± 3,593	2,590.6 ± 445	100/0/0	207.5
Eira barbara	2,950	586.22	69.3/10/21	16.03
Martes americana	1,038	329.34 ± 30	99/0.5/0.5	15.15
Martes martes	930.6	362.3	77.3/11.3/11.4	1.49
Martes vison	834.9	283.6	58.5/41.5/0	2.9
Mustela frenata (females)	153 ± 3	84.35 ± 12	100/0/0	0.52
Mustela erminea	169.6	146.5	91.5/0.5/8	0.04
Mustela nivalis	72.6	87.3	97.3/1.8/0.9	0.58

5.2 Diets

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the mustelid's psychological and behavioral needs (AZA Accreditation Standard 2.6.3). Food should be purchased from reliable, sustainable and well-managed sources. Nutritional analyses should be routinely performed on the diet ingredients and results compared to previous and reported values. Based on food type, microbiological testing as part of an established quality control monitoring program also may be appropriate.

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(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.

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.

AZA Accreditation Standard

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

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. Typically browse is not a dietary item for mustelid species. However, all plant items used in or around exhibits or those used for enrichment should be cleared by institutional management including the veterinarian, nutritionist and horticulturist. If there are any questions regarding the safety of a plant it should not be used.

AZA Accreditation Standard

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

Diet Composition: Most mustelids are easily maintained on commercially available, nutritionally complete meat diets, to which dry dog food, cat food, trout chow, fish, meat, or cereal is added (these additives are species-specific, and should not be viewed as inter-changeable) (Siegmund 1973; Wallach & Boever 1983; Fernandez-Moran 2003). Omnivorous mustelids need a broader spectrum diet. Whole animal carcasses (rodents, rabbits, birds, fish), freshly killed and thawed, may be substituted for part of the diet. Whole foods of this type need to be calculated into the overall nutritional content of the diet; care

should be taken to ensure proper nutritional balance and that whole carcass foods come from reliable, disease-free sources. Invertebrates may be substituted in diets of small species, and fruits and vegetables (e.g., apples, bananas, berries, and other seasonal fruits) offered as part of a balanced diet to both omnivorous and carnivorous (*Martes* sp.) species (Moore 1997; Fernandez-Moran 2003).

Sample Diets: There is a wide range of diets that can be appropriate for mustelids (Table 12). For the more carnivorous members of the family (*Mustela*), commercially prepared, nutritionally complete, meat diets, vertebrate and invertebrate whole prey items, fish, and wet/dry nutritionally complete food items can be used to formulate diets which meet target nutrient levels (see Table 9). For the more omnivorous members (*Mephitis*, *Spilogale*), diets that contain a mix of food items and groups appear most appropriate. It is important to keep in mind that the nutrient content of all items consumed in the diet (whole prey, meat mixes, bones, nutritionally complete foods, invertebrates, etc) should be known and included in the nutrient analysis of the diet. This will help maintain a diet that meets nutrient needs and avoids incidence of metabolic problems (metabolic bone disease, obesity, anorexia, etc). For a summary of the nutritional composition of whole prey items, refer to the "Nutrient Composition of Whole Vertebrate Prey (Excluding Fish) Fed in Zoos" (Dierenfeld et al. 2002).

In these guidelines, sample diets are provided as examples only. The goal is to provide a diet that meets target nutrient values and is readily consumed. See Table 13 for a comparison of sample diets to recommended nutrient values. Ideally, a palatable nutritionally complete food item (which would include some commercial meat mixes) should be used as the base of the diet to which can be added vertebrate and invertebrate prey, and produce (fruits, berries, etc) as appropriate, based on feeding strategy. Offering hard food items will encourage tooth abrasion and promote dental health.

Fish also contain high levels of polyunsaturated fatty acids (PUFAs) that oxidize quite readily and can lead to vitamin E deficiency. Steatitis (yellow fat disease) has been reported in mink that were fed diets high in PUFAs (McDowell 2000). Engelhardt & Geraci (1978) and Bernard et al. (1997) suggest adding 400mg/kg DM vitamin E to the diets of animals consuming fish or other items high in PUFAs.

Table 12: Sample diets from AZA institutions for mustelid species (as fed)*

Species	Common Name	Institution	Food Item[1]	Grams/day	% in diet
Martes pennant	Fisher	Institution A	Milliken Meat Feline	235	89.4
			Mice – 2 times per week	9.1	3.5
			Chicks – 2 times per week	10.6	4.0
			Egg, Hard-boiled	8.3	3.1
			Bones – small beef or lamb 1x/wk		
			Total	263	100
		Institution B 1.0	Nebraska Feline Diet	306	73.6
			Hills Science Feline Mature	34.3	8.2
			Carrot or Yam	51.4	12.3
			Whole body – elk, bison, fish, rat, mouse etc.	23.6	5.7
			Mazuri Carnivore Vitamin	0.75	0.2
			Bone – 1 x/wk		
			Total	415.4	100
		Institution B 0.1	Nebraska Feline Diet	139.3	58.9
			Hills Science Feline Mature	34.3	14.5
			Carrot or Yam	51.4	21.7
			Whole body – elk, bison, fish, rat, mouse etc.	10.7	4.5
			Mazuri Carnivore Vitamin	0.75	0.3
			Bone – 1 x/wk		
			Total	236.4	100
Gulo gulo	Wolverine	Institution A	Milliken Meat Feline	400	83.7
			Mice – 2 times per week	9.1	1.9
			Chicks – 2 times per week	10.6	2.2
			Egg, Hard-boiled	8.3	1.7
			Hill's Science Senior Dog Food dry	50	10.5
			Bones – Nebraska Brand beef – 1x/wk		
			Total	478	100
		Institution B	Nebraska Feline Diet	585	79.7
			Hills Science Feline Mature	51.4	7.0
			Carrot or Yam	51.4	6.1
			Whole body – elk, bison, fish, rat, mouse etc.	45.0	7.0
			Mazuri Carnivore Vitamin	150	0.2
			Bone – 1 x/wk		
			Total	882.8	100
		Institution C	Natural Balance Beef 10% fat	636	75.4
			Lake Smelt	130	15.4
			Capelin	26	3.1
			Herring	26	3.1
			Rats	26	3.1
			Small bones – beef rib bones		
			Total	844	100
		Institution D	Natural Balance Beef 10% fat	681	95.5
			Mackerel – 1 each Friday	28.6	4.0
			Mice – avg. 25 grams	3.6	0.5
			Bones – small non-meaty		
			Total	713.2	100
Taxidea taxus	Badger	Institution E	Natural Balance Beef 5% fat	86	50.6
			Premium Edge Adult Chicken/Rice/Veg	44	25.9
			Mealworms	7	4.1
			Crickets	7	4.1
			Fruit – rotated used apple	14	8.2
			Vegetable – rotated used yam	12	7.1
			Total	170	100
		Institution F	Natural Balance Beef 5% fat	85	5.3
			IAMS Weight Control Cat dry	142	8.9
			Mouse – avg. 22.5	22.5	1.4
			Rabbit – 1 kg	1000	62.9
			Root Vegetable used sweet potato	340	21.4

Species	Common Name	Institution	Food Item[1]	Grams/day	% in diet
			Total	1589	100
		Institution G	Nebraska Brand Feline	48.6	21.9
			Mice	34.3	15.4
			Egg, Hard-boiled	12.8	5.8
			Rat, small	23.6	10.6
			ZuPreem Feline canned	24.4	11.0
			Trout	21.4	9.6
			Produce – rotated used apple	57.0	25.7
			Total	222.1	100
		Institution B	Hills Science Feline Mature dry	114	55.9
			Nebraska Brand Feline Diet	60	29.4
			Apple	30	14.7
			Total	204	100
Mustela putorius furo	Domestic Ferret	Institution F	IAMS regular dry cat food	45	57.0
			Banana with peel	10	12.7
			Vegetables – assorted	24	30.4
			Total	79	100
		Institution H	Hills Science Diet Light Adult Cat Food	25	100
		Institution I	Mazuri Ferret Diet	50	100
Mephitis mephitis	Skunk	Institution J	PMI Premium 22 Dog Food[1]	21	37
			Old Mother Hubbard Canned Cat Food[2]	21	37
			Fruit	12	23
			Other	1.3	3
			Total	145	100
		Institution K	IAMS weight control cat dry	8.5	10.2
			Yogurt, low-fat	20	24.0
			Vegetables, frozen mixed	13.2	15.9
			Eukanuba reduced calorie dog dry	8.5	10.2
			Banana	12	14.4
			Apple	12	14.4
			Grape	9	10.8
			Total	83.2	100
		Institution A	Hills Science Diet Maintenance	20	8.3
			Vegetables, frozen mixed	145	60.4
			Fruit – rotated used apple	35	14.6
			Cottage cheese	20	8.6
			Yogurt	20	8.6
			Total	240	100
		Institution B	Hills Science Canine Light dry	40	64.3
			Vegetables used carrot	12	19.2
			Fruit used apple	10	16.1
			Salmon Oil	0.25	0.40
			Total	62.25	100
Eira barbara	Tayra	Institution L	Nebraska Brand Canine Diet	113	23.3
			Mazuri Ferret	157	32.3
			Banana	57	11.8
			Apple	57	11.8
			Sweet Potato	57	11.8
			Mice	22.5	4.6
			Egg, hard-boiled	16.9	3.5
			Chick	4.6	0.9
			Bone – small rib 2x/wk		
			Total	485	100
		Institution K	ZuPreem Feline canned	187	28
			Mazuri Omnivore biscuit	79	12
			Fruit – rotated used apple	233	35
			Carrot, cooked	67	10
			Sweet Potato, cooked	67	10

Species	Common Name	Institution	Food Item[1]	Grams/day	% in diet
	a		Mice	34	5
			Total	667	100

[1] Milliken Meats Products, LTD. Scarborough, Ontario Canada M1V 3P1; Central Nebraska Packing, Inc. North Platte, NE 69103; Hill's Pet Nutrition, Inc. Topeka, KS 66603; PMI Nutrition International. Brentwood, MO 63144; Natural Balance Pet Foods, Inc. Pacoima, CA 91331; Premium Edge Brand® Meta, MO 65058; P&G Pet Care (IAMS), Cincinnati, OH 45220; Zupreem; Shawnee, KS 66214; Old Mother Hubbard, Lowell, MA 01853.
* The AZA SCTAG does not specifically endorse the use of any mentioned products

The nutrient content of these sample diets compared to the target nutrient levels described in Table 12 are provided in Table 13.

Table 13: Nutrient content of sample diets[1] (dry matter basis)

Nutrient	Institution A Fisher	Institution B 1.0 Fisher	InstitutionB 0.1 Fisher		More Carnivorous
Protein (%)	63.6	41.9	38.2		19.7-32.5
Fat (%)	16.7	34.3	30.3		9.0-30
Vitamin A (IU/g)	33.6	54.2	82.1		2.44-10
Vitamin D (IU/g)	0.87	0.74	0.57		0.25-1.0
Vitamin E (mg/kg)	283	278	215		27-120
Thiamin (mg/kg)	0.55[2]	8.5	6.8		1.0-5.6
Riboflavin (mg/kg)	0.53[2]	0.05	0.04		1.6-4.25
Pantothenic acid (mg/kg)	1.45[2]	0.19[2]	0.30[2]		5.0-8.0
Niacin (mg/kg)	0.07[2]	2.4[2]	4.06[2]		9.6-60
Pyridoxine (mg/kg)	0.13[2]	0.71[2]	1.19[2]		1.6-4.0
Folacin (mg/kg)	0.05[2]	0.07[2]	0.12[2]		0.2-1.3
Biotin (mg/kg)	[2]	[2]	[2]		0.07-0.12
Vitamin B_{12} (mg/kg)	0.07	0.05	0.05		0.02-0.035
Calcium (%)	1.54	1.6	1.5		0.5-1.0
Phosphorus (%)	1.38	1.1	1.0		0.5-0.8
Potassium (%)	0.82	0.93	0.98		0.4-0.6
Sodium (%)	0.35	0.49	0.44		0.05-0.4
Magnesium (%)	0.08	0.11	0.10		0.03-0.08
Iron (mg/kg)	332	152	118		80-114
Zinc (mg/kg)	120	65.4	50.6		50-94
Copper (mg/kg)	4.05	7.2	5.82		5.0-8.8
Iodine (mg/kg)	[2]	0.02[2]	0.03[2]		0.35-2.2
Selenium (mg/kg)	0.03[2]	0.36	0.28		0.1-0.4

Nutrient	Institution A Wolverine	Institution B Wolverine	Institution C Wolverine	Institution D Wolverine	More Carnivorous
Protein (%)	52.5	43.4	53.7	51.8	19.7-32.5
Fat (%)	16.0	35.9	28.1	28.4	9.0-30
Vitamin A (IU/g)	21.7	36.1	14.0	14.9	2.44-10
Vitamin D (IU/g)	0.68	0.79	1.3	1.5	0.25-1.0
Vitamin E (mg/kg)	383	299	311	359	27-120
Thiamin (mg/kg)	0.25[2]	8.9	9.1	10.6	1.0-5.6
Riboflavin (mg/kg)	0.24[2]	0.13[2]	15.8	18.5	1.6-4.25
Pantothenic acid (mg/kg)	0.65[2]	0.73[2]	28.6	33.6	5.0-8.0
Niacin (mg/kg)	0.03[2]	1.46[2]	120	141	9.6-60
Pyridoxine (mg/kg)	0.06[2]	0.42[2]	11.2	13.1	1.6-4.0
Folacin (mg/kg)	0.02[2]	0.05[2]	25.1	29.4	0.2-1.3
Biotin (mg/kg)	[2]	[2]	1.5	1.7	0.07-0.12
Vitamin B_{12} (mg/kg)	[2]	0.06	0.11	0.13	0.02-0.035
Calcium (%)	1.32	1.6	1.8	1.8	0.5-1.0
Phosphorus (%)	1.20	1.2	1.0	1.0	0.5-0.8
Potassium (%)	0.84	0.88	0.46	0.34	0.4-0.6
Sodium (%)	0.32	0.50	1.0	1.1	0.05-0.4
Magnesium (%)	0.09	0.12	0.33	0.36	0.03-0.08
Iron (mg/kg)	252	163	136	145	80-114
Zinc (mg/kg)	90.8	70.0	192	211	50-94
Copper (mg/kg)	2.9[2]	7.5	17.1	18.9	5.0-8.8
Iodine (mg/kg)	[2]	0.02[2]	0.70	0.82	0.35-2.2
Selenium (mg/kg)	0.01[2]	0.39	0.19		0.1-0.4

Nutrient	Institution E Badger	Institution F Badger	Institution G Badger	Institution B Badger	More Carnivorous
Protein (%)	39.3	47.8	35.4	34.9	19.7-32.5
Fat (%)	16.8	12.7	23.7	25.4	9.0-30
Vitamin A (IU/g)	5.6	135	1.25	1.9	2.44-10
Vitamin D (IU/g)	0.61	0.79	0.19[2]	0.18[2]	0.25-1.0
Vitamin E (mg/kg)	305	74.9	15.7[2]	67.9	27-120
Thiamin (mg/kg)	5.5	8.2	1.9[2]	2.0	1.0-5.6
Riboflavin (mg/kg)	9.0	6.7	1.9[2]	0.03[2]	1.6-4.25
Pantothenic acid (mg/kg)	21.5	16.9	3.4[2]	0.14[2]	5.0-8.0
Niacin (mg/kg)	105	58.0	7.5[2]	0.17[2]	9.6-60
Pyridoxine (mg/kg)	6.9	7.7	0.76[2]	0.11[2]	1.6-4.0
Folacin (mg/kg)	0.16	0.82	0.14[2]	0.01[2]	0.2-1.3
Biotin (mg/kg)	0.64	0.30	0.09	[2]	0.07-0.12
Vitamin B_{12} (mg/kg)	0.05	0.09	0.01[2]	0.02	0.02-0.035
Calcium (%)	0.76	2.1	0.97	1.0	0.5-1.0
Phosphorus (%)	0.52	1.4	0.78	0.84	0.5-0.8
Potassium (%)	0.45	0.78	0.71	0.71	0.4-0.6
Sodium (%)	0.28	0.28	0.32	0.38	0.05-0.4
Magnesium (%)	0.22	0.15	0.07	0.07	0.03-0.08
Iron (mg/kg)	59.4	130	191	35.8	80-114
Zinc (mg/kg)	129	109	14.1[2]	15.3[2]	50-94
Copper (mg/kg)	9.9	16.8	1.62[2]	1.6[2]	5.0-8.8
Iodine (mg/kg)	0.45	0.69	0.04[2]	[2]	0.35-2.2
Selenium (mg/kg)	0.47	0.17	0.32	0.09[2]	0.1-0.4

Nutrient	Institution F Ferret	Instution H Ferret	Institution I Ferret		More Carnivorous
Protein (%)	33.2	35.0	43.3		19.7-32.5
Fat (%)	21.5	10.0	25.5		9.0-30
Vitamin A (IU/g)	40.3	6.6	27.8		2.44-10
Vitamin D (IU/g)	2.3	0.59	4.1		0.25-1.0
Vitamin E (mg/kg)	116	[2]	277		27-120
Thiamin (mg/kg)	30.1	[2]	71.1		1.0-5.6
Riboflavin (mg/kg)	14.9	[2]	22.2		1.6-4.25
Pantothenic acid (mg/kg)	43.2	[2]	28.9		5.0-8.0
Niacin (mg/kg)	154	[2]	122		9.6-60
Pyridoxine (mg/kg)	22.6	5.9	20		1.6-4.0
Folacin (mg/kg)	2.9	[2]	4.7		0.2-1.3
Biotin (mg/kg)	0.75	[2]	0.53		0.07-0.12
Vitamin B_{12} (mg/kg)	0.26	0.10	0.1		0.02-0.035
Calcium (%)	1.0	1.0	1.5		0.5-1.0
Phosphorus (%)	0.93	0.73	1.4		0.5-0.8
Potassium (%)	0.86	0.67	0.62		0.4-0.6
Sodium (%)	0.30	0.40	0.44		0.05-0.4
Magnesium (%)	0.09	0.06	0.13		0.03-0.08
Iron (mg/kg)	278	169	411		80-114
Zinc (mg/kg)	208	200	257		50-94
Copper (mg/kg)	28	[2]	25		5.0-8.8
Iodine (mg/kg)	2.3	[2]	2.2		0.35-2.2
Selenium (mg/kg)	0.56	0.67	0.62		0.1-0.4

Nutrient	Institution J Skunk	Institution K Skunk	Institution A Skunk	Institution B Skunk	More Omnivorous
Protein (%)	25.3	19.9	23.0	22.8	17.5-26.0
Fat (%)	11.0	6.9	7.4	8.8	5-8.5
Vitamin A (IU/g)	6.2	42.5	131	85.6	0.5-5.9
Vitamin D (IU/g)	1.5	1.4	[2]	[2]	0.5-0.55
Vitamin E (mg/kg)	51.2	81.4	10.2[2]	489	27-50
Thiamin (mg/kg)	1.0	14.9	3.5	0.34[2]	1.0-2.25
Riboflavin (mg/kg)	2.1	11.2	3.6	0.21[2]	1.6-10.5
Pantothenic acid (mg/kg)	1.7[2]	27.6	7.4	0.75[2]	7.4-15.0
Niacin (mg/kg)	1.6[2]	77.1	33.4	3.0[2]	11.4-20.0
Pyridoxine (mg/kg)	1.2	12.4	3.2	0.57[2]	1.0-1.8

Folacin (mg/kg)	0.2	1.6	0.85	0.05[2]	0.18-0.5
Biotin (mg/kg)	0.01[2]	0.37	[2]	[2]	0.1-0.12
Vitamin B_{12} (mg/kg)	0.02	0.18	[2]	[2]	0.022-0.035
Calcium (%)	1.3	0.66	0.39	0.64	0.5-1.2
Phosphorus (%)	1.0	0.56	0.47	0.55	0.5-1.0
Potassium (%)	0.6	0.92	0.94	0.81	0.4-0.6
Sodium (%)	0.3	0.19	0.38	0.22	0.04-0.3
Magnesium (%)	0.1	0.08	0.12	0.11	0.04-0.06
Iron (mg/kg)	65.6	194	26.3	1.9[2]	30-90
Zinc (mg/kg)	94.9	171	16.3	0.71[2]	50-120
Copper (mg/kg)	6.0	13.2	2.8	0.25[2]	6.0-12.4
Iodine (mg/kg)	1.1	2.0	[2]	[2]	0.9-1.54
Selenium (mg/kg)	0.08[2]	0.26	0.06[2]	[2]	0.1-0.35

Nutrient	Institution L Tayra	Institution K Tayra			More Omnivorous
Protein (%)	39.9	27.3			17.5-26.0
Fat (%)	21.2	17.7			5-8.5
Vitamin A (IU/g)	70.3	103			0.5-5.9
Vitamin D (IU/g)	2.9	1.7			0.5-0.55
Vitamin E (mg/kg)	174	96.2			27-50
Thiamin (mg/kg)	44.2	14.4			1.0-2.25
Riboflavin (mg/kg)	14.7	11.6			1.6-10.5
Pantothenic acid (mg/kg)	21.1	28.2			7.4-15.0
Niacin (mg/kg)	78.6	92.7			11.4-20.0
Pyridoxine (mg/kg)	14.6	7.9			1.0-1.8
Folacin (mg/kg)	3.1	1.9			0.18-0.5
Biotin (mg/kg)	0.33	0.37			0.1-0.12
Vitamin B_{12} (mg/kg)	0.06	0.05			0.022-0.035
Calcium (%)	1.3	1.4			0.5-1.2
Phosphorus (%)	1.1	0.97			0.5-1.0
Potassium (%)	0.72	0.86			0.4-0.6
Sodium (%)	0.33	0.26			0.04-0.3
Magnesium (%)	0.11	0.12			0.04-0.06
Iron (mg/kg)	340	301			30-90
Zinc (mg/kg)	182	146			50-120
Copper (mg/kg)	18.3	12.1			6.0-12.4
Iodine (mg/kg)	1.3	1.4			0.9-1.54
Selenium (mg/kg)	0.41	0.21			0.1-0.35

[1]Target nutrient levels listed in Table 9.
[2] Missing values in database so nutrients most likely meet targets.

Provision of Diet: For many of the mustelids, food containers may not be desirable (e.g., wolverines) because of the animals' tendency to chew on any items they can lift. If animals are fed on floor surfaces, these should be thoroughly cleaned and disinfected daily. If bowls or metal trays are used, they should be placed at an appropriate height for each species and secured so the animal cannot remove or damage the bowl/tray, or themselves.

Food should be offered in containers that are cleaned and sanitized after each use. Meat, rodents, fish, chicken, or similar products can be hidden in the exhibit, particularly for solitary species. Feeding techniques of this type used for pairs or groups should be monitored to ensure all individuals are receiving their share.

Ox tails, rib bones, or knuckle bones should be provided on a regular basis to maintain oral hygiene and muscle tone.

Feeding schedules: As a group, mustelids are mostly diurnal or nocturnal. While it is not possible to mimic the same diet (or environment) for *ex situ* populations of animals as they would consume if they were free-ranging, it is recommended that the diet is offered during the period of the day when the animals would typically be expected to forage actively. This will not only discourage pest species, but will encourage typical foraging behavior. All species should be fed to coincide with their activity patterns. Animals that are not habitually active in the morning should be fed later in the day (to coincide with their "evening", in the case of nocturnal animals housed indoors on reverse-light cycles).

Due to a high metabolic rate and rapid digesta passage rate, it is recommended that mustelids be fed at least twice a day, with more frequent feedings for the more active members of the family (such as weasels, stoats, fisher, mink) (Partridge & Jordan 1995). Unless dictated by age, condition, veterinary treatment, hibernation, etc., some species may require more frequent feedings (e.g., weasels), or respond to more frequent feedings with an increase in overall activity (J. Reed-Smith, personal experience; Fernandez-Moran 2003). Similarly, activity levels will influence nutritional requirements for all of these species and should be considered during diet formulation.

- Skunks: Feeding skunks small amounts of food throughout the day has proven successful at reducing the frequency of regurgitation in these species (D. Smith-Weber, personal communication).
- Weasels: Weasels should be fed 3-4 times a day. At least 2-3 of these feedings should be provided in a novel fashion, varying the feeding times and delivery methods.

However often animals are fed, food remnants should be removed from each previous feeding to prevent spoilage. However, species such as wolverines may benefit from the periodic provision of whole carcasses and/or meat chunks that can be cached for later consumption (Blomqvist & Rudbäck 2001; J. Reed-Smith, personal experience). Food caching by wolverines should be allowed, but monitored for spoilage, particularly in warmer climates and during temperate summers. Varying of feeding times is strongly recommended to prevent the development of "pre-feeding" stereotypical pacing.

Social feeding: Group dynamics often play a role in whether animals are able to consume a nutritionally complete diet. Feeding should be observed to ensure the subordinate animals receive the correct proportions of ingredients. Increasing the number of feeding times per day, placing the food in several locations, distracting some of the animals to allow others adequate access, or separating animals when possible to ensure adequate nutritionally complete feed consumption, may all be necessary for animals housed in a social group.

Species-appropriate Feeding and Foraging: All mustelid species should be fed part of their diet as a scattered, enrichment feed. If possible, whole carcass foods of some type should be offered several times a week. Live fish, insects, and hidden, favored food items also promote scavenging.

Wolverine: The scavenger wolverine has evolved as an opportunistic hunter, feeding on whatever is available when preferred sources become scarce. This variety includes plant material and berries in summer, rodents, scavenging carcasses, and meat caching for later consumption. Studies in Norway indicate that there is a correlation between peaks in rodent cycles and reproductive success in this species (Blomqvist 2001).

The provision of whole carcass foods including such things as rabbits, fish, rats, chicks, mice, amphibians, large carcass pieces with bones, etc., make good additions to diets of *ex situ* populations of mustelids. These items promote good dental health and species-appropriate martelism (caching), digging, foraging, and hunting behaviors (Blomqvist & Rudbäck 2001). The feeding of large carcasses or pieces of meat to wolverines that they can cache and feed on for several days may contribute to increased breeding success (Grove 2001). Again, if food caching is allowed, food pieces should be closely monitored for spoilage.

American marten and fisher: American marten and fishers consume a percentage of vegetation as part of their wild diet; part of which may be as a by-product of the prey species they consume, but intentional consumption of vegetable matter (e.g., berries) also occurs (Martin 1996). While vegetation does appear to be important for both of these species, on a seasonal basis, it is believed to be of secondary importance to meat in their diet (Martin 1996). One study reported the fisher eating false truffles (Hypogeous fungi), which has only been recognized in the last 15 years as an important food item to many forest vertebrates (Martin 1996). Wild fishers are known to consume apples in New England from December to March, and habitat studies have shown a disproportionate use of old orchards during this period (J. Ogden, personal communication). In these studies, food habit analysis identified apple as the most abundant item in scat from December to March (Krohn & Gilbert 1989).

A study of wild marten conducted by Bull (2002) analyzed the frequency of occurrence of prey items found in 1014 scat samples associated with 31 radio collared American martens in northeastern Oregon. The scat samples included: "…62.7% vole-sized prey, 28.2% squirrel-sized prey, 22.4% insects, 19.5% birds, 13.3% plant material, and 2.4% lagomorphs". See Buskirk & MacDonald (1984), Lucherini & Crema

(1993), Clevenger (1993), Putman (2000), and Cumberland et al. (2001) for additional information on marten, pine marten, and stone marten diet in the wild.

In the winter, American martens and European pine martens are known to forage extensively under the snow for rodents (Powell 1993). This feeding behavior can be catered to in zoos by hiding small whole prey under snow or other suitable substrates.

Weasel: Several researchers have shown that weasels forage on the ground, in low trees, shrubs, and under the snow (Powell 1993); all of these locations should be used for scattered or hidden feeds.

African striped weasel: This species should be fed several times (3-4) a day (feline diet and rodents). At least two of these rodent feedings should be enrichment feedings. Diet can be offered in different locations, scattered, or in feeding devices requiring the animal to work to access the food. Some of the feeders that have been used successfully include: PVC or cardboard tubes, boxes, suet feeders, puzzle balls, exercise balls, wire mesh feeders, hanging grass huts, toys with holes for food, hanging from plastic chain, carved pumpkins, boomer balls, triangle feeder with cut-outs, bird toys with large holes, phone books, cricket rock with two halves, and logs.

5.3 Nutritional Evaluations

An animal's weight should be monitored regularly, and the diet adjusted to maintain the individual at its optimum overall or seasonal weight. An individual's size should be taken into consideration when formulating a diet instead of using generic male/female diets. Some individuals have a tendency toward obesity, and season and activity patterns can affect consumption and subsequent body condition (Verts 1967; Fernandez-Moran 2003). For example, some mustelids undergo a physiological response to decreasing temperatures – storing body fat in fall and winter, and subsequently reducing intake during the cold winter months (Kruuk 1989; Hindmarsh 1995; Martin 1996). For these reasons, "goal weights" for individuals should be established (in general and on a seasonal basis), and body weight checked frequently, so that diet adjustments can be made in a timely fashion to avoid over or under-condition.

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, body weight should be managed on an individual basis, as some species and individuals tend to become obese if given the chance.

The health status of an individual should be considered when formulating a diet. Animals with chronic conditions should be monitored to ensure that they are consuming sufficient calories and a well-balanced diet. Conditions caused by nutritional deficiencies should be addressed promptly.

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).

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.

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Veterinary resources recommended by the AZA SCTAG Veterinary Advisor are (this should not be considered an exhaustive list):

- International Zoo Vet Forum (requires AAZV membership)
- AAZV listserve (requires AAZV membership)
- For contraception questions and issues (www.stlzoo.org/animals/scienceresearch/contraceptioncenter/)
- The Latinvets forum , to join e-mail Dr. Roberto Aguilar (raguilardvm@yahoo.com)
- Zoo and Wild Animal Medicine series of books, edited by M.E. Fowler
- Current journals
- For immobilization, anesthesia and analgesia : Zoo Animal and Wildlife Immobilization and Anesthesia by Gary West, Darryl Heard, and Nigel Caulkett (www.amazon.com/Zoo-Animal-Wildlife-Immobilization-Anesthesia/dp/0813825660/ref=sr_1_1?ie=UTF8&s=books&qid=1248108862&sr=8-1)
- For drug dosages:
    - Exotic Animal Formulary (3rd Edition) by James W. Carpenter (www.amazon.com/Exotic-Animal-Formulary-James-Carpenter/dp/0721601804/ref=sr_1_1?ie=UTF8&s=books&qid=1248110295&sr=8-1)
    - Plumb's Veterinary Drug Handbook: Desk Edition by Donald C. Plumb www.amazon.com/Plumbs-Veterinary-Drug-Handbook-Desk/dp/0813810973/ref=sr_1_1?ie=UTF8&s=books&qid=1248110333&sr=8-1)
- For neonatal care: Hand-Rearing Wild and Domestic Mammals by Laurie J. Gage (www.amazon.com/Hand-Rearing-Wild-Domestic-Mammals-Laurie/dp/0813826837/ref=sr_1_1?ie=UTF8&s=books&qid=1248110366&sr=8-1)

There are no training programs that specialize in Mustelids, however the residencies listed on the American College of Zoo Medicine website (www.aczm.org) are good resources. Contact any residency ahead of time to obtain more detail regarding the focus of the upcoming year, as some residencies have a rotating focus.

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

AZA Accreditation Standard

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

Common pharmaceuticals used for mustelids include those for preventive care (vaccines) and therapeutic use (antibiotics). These drugs should be securely stored in a locked pharmacy to which only the veterinary staff and selected animal keeper staff have access. It should be a dry, cool, dark place (e.g. locked cabinets in the hospital). Additionally all controlled drugs need to be kept in compliance with DEA guidelines.

Animal recordkeeping is an important element of mustelid care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining an animal record keeping system and for conveying relevant laws and regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be accurate and documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be 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).

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.

Thorough and accurate medical records are essential to learn and understand more about the medical problems of any *ex situ* species. Medical records should be systematic, and entries should identify the history, physical findings, procedures performed, treatments 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 SCTAG encourages the use of ZIMS 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.

Keeper vigilance and familiarity with these species is paramount; as with most small mammals, mustelids can swiftly become severely ill, requiring immediate intervention.

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 to 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. See Appendix H for the AAZV Small Carnivore Medical Management Guidelines.

6.2 Identification Methods

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

AZA Accreditation Standard

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

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 then 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.

AZA member institutions must inventory their population at least annually and document all mustelid acquisitions and dispositions (AZA Accreditation Standard 1.4.1). Transaction forms help document that potential recipients or providers of the animals should adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy (see Appendix B), and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities. All AZA-accredited institutions must abide by the AZA Acquisition and Disposition policy (Appendix B) and the long-term welfare of animals should be considered in all acquisition and disposition decisions. All species owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2).

AZA Accreditation Standard

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

6.3 Transfer Examination and Diagnostic Testing Recommendations

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

Pre-shipment Examination Recommendations: All mustelids should receive a thorough pre-shipment physical examination as outlined in section 6.5. 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. 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 disc or send them via e-mail (Petrini 1998). The receiving institution veterinarian should be contacted to identify which tests the receiving institution requires. For out-of-state transfers, the state veterinarian should also be contacted to identify any state required tests.

6.4 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals (AZA Accreditation Standard 2.7.1). All quarantine, hospital, and isolation areas should be in compliance with AZA standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix C). All quarantine procedures should be supervised by a veterinarian, formally written and available to staff working with quarantined animals (AZA Accreditation

AZA Accreditation Standard

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

AZA Accreditation Standard

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

Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or AALAS accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

AZA Accreditation Standard

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

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 mustelids, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers must care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items must be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with resident animals.

AZA Accreditation Standard

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

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 must 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. Mustelids should be evaluated for ectoparasites and treated accordingly. Blood should be collected, analyzed and the sera banked in either a -70ºC (-94°F) freezer or a frost-free -20ºC (-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 mustelid 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 mustelids may vary from an initial quarantine test to yearly repetitions of diagnostic tests as determined by the veterinarian. Mustelids should be permanently identified by their natural markings or, if necessary, marked when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Release from quarantine should be contingent upon normal results from diagnostic testing and two negative fecal tests that are spaced a minimum of two weeks apart. Medical records for each animal should be accurately maintained and easily available during the quarantine period.

AZA Accreditation Standard

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

Mustelids 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 Appendix N for AZA SCTAG necropsy protocol.

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. The 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.

AZA SCTAG Recommendations:

AZA Accreditation Standards and Related Policies

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

The importance of a preventive medical program for zoo animals cannot be emphasized enough. Animals entering a collection must 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. Quarantined animals require specialized care during acclimation to new surroundings and diets (Aiello & Mays 1997). Since diets change between institutions it is recommended that the sending institution's diet is 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.

All quarantined animals should receive regular enrichment, including the stimulation of scent, manipulable objects, pools (mink and wolverine), climbing structures, hidden scatter feeds, and bedding. Housing mustelids in social isolation on a temporary basis (e.g., hospitalization or quarantine) is typically not an issue, because most of these species are not found in social groups.

During quarantine, animals should have their permanent ID checked, and receive appropriate vaccinations and diagnostic testing (see recommended vaccination and testing schedule in section 6.5). They should be examined for ecto- and endoparasites and treated appropriately. 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 (Aiello & Mays 1997).

A minimum of three consecutive negative fecals (fresh direct and float or sedimentation), each one week apart, should be obtained before the animal is cleared 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. See Appendix N for necropsy protocol and forms.

6.5 Preventive Medicine

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

AZA Accreditation Standard

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

Routine Physical Examinations: It is recommended that all mustelids have regular routine physical examinations. Young healthy animals can be examined biennially, while clinically healthy but geriatric animals or those with shorter lifespans 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 should be 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 routine physical examinations the following procedures are recommended (see also Appendix H). All results should be recorded in the animal's permanent record.

- Transponders and/or tattoos should be checked and reapplied if they are not readable. Location and type of chip should be recorded in the animal's record; location of tattoo also should be recorded.
- 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 checked.
- 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 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 (see below).
- 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.

The threat of zoonotic disease is not greater with mustelid species than any other wildlife. Institutional policies regarding safeguarding against the spread of disease from animal to staff always should be followed and posted for staff.

Vaccinations: Preventive medicine should be tailored to the risk, which varies by location and with management practices. The veterinary staff at each institution should set up a preventive protocol that is appropriate for the risk of exposure and clinical disease. Vaccination schedules should be viewed in light of the real risk of animals contracting these diseases, 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 the titers are measured accurately, it is not known what that means in terms of protection. In order to assess the latter point, it is recommended that institutions still gather titer information for use at a later date, if possible.

Mustelids have varying sensitivity (species- and exposure-dependent) to feline panleukopenia, canine distemper, rabies, and leptospirosis; most resources recommend vaccination of mustelids for rabies and canine distemper (Fernandez-Moran 2003).

The safety and efficacy of modified live canine distemper vaccinations in exotic species of carnivores has been problematic. Blomqvist & Rudbäck (2001) stated that in their opinion live and modified-live vaccines should never be used on mustelids because vaccine-induced distemper has occurred. Additionally, killed distemper vaccines have not provided long-standing protection in most species (Fernandez-Moran 2003).

Recently, a recombinant canarypox-vectored canine distemper virus vaccine (Merial, Ltd., Inc., Athens, Georgia) has been found safe and efficacious and is commercially available in a monovalent form. This appears to be the best choice for general mustelid protection against canine distemper virus. If a canine distemper modified live vaccine is used, it should be given separately as it may cause immunosuppression or other unforeseen vaccine interactions that could lead to disease (Fernandez-Moran 2003).

Ferret or mink cell culture-derived modified live virus vaccines should never be used (Fernandez-Moran 2003). A modified live canine distemper vaccine of primate kidney tissue cell origin, Onderstepoort type (Galaxy D, Schering-Plough Animal Health Corp., Omaha, Nebraska), has been proven to be safe and efficacious in hybrid black-footed ferret-Siberian polecat. Currently the only vaccine approved by the USDA for a ferret is Fervac-D (United Vaccines, Madison, Wisconsin), an egg-adapted strain that has induced anaphylaxis in some mustelids, so its use is not recommended (Fernandez-Moran 2003).

See Appendix H for AAZV Small Carnivore Medical Management Guidelines and general vaccination recommendations, and Appendix I for recommendations for Merial's PUREVAX™ Ferret Distemper Vaccine in Exotic Carnivores. Castro & Heuschele (1992) indicated the following vaccinations are appropriate for weasels, skunks, and North American mink:

Table 14: Suggested vaccinations for weasels, skunks, and North American mink (Castro & Heuschele 1992)

Vaccine	Vaccine type	Frequency**
Canine distemper	Killed*/ Canary pox vectored	Annual
Feline panleukopenia	Killed/modified live	Annual
Canine adenovirus – 2	Killed/modified live	Annual
Leptospira Bacterin-CI	Killed/modified live	Annual
Rabies	Imrab3 (killed)/ Canary pox vectored	Annual

* Vaccine should not be of ferret origin; avian origin is preferred.
** The attending veterinarian should decide if all are needed based on the risk of exposure of the animals.

Canine distemper: Mustelids, procyonids, and viverrids have been reported to be susceptible to canine distemper (reviewed in Deem et al. 2000). One study reports the use of a MLV vaccine in badgers with good safety and reasonable efficacy (Goodrich et al. 1994). However, modified live vaccines should be used with caution, as these have caused fatal vaccine-induced disease in black-footed ferrets (Carpenter et al. 1976; Pearson 1977). 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). It should not be used in these species. They have also resulted in post-vaccinal encephalitis in ferrets (Denver 2003). 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. Siberian mink have contracted vaccine-induced distemper when using Galaxy-6 (B. Rideout, personal communication). 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, and after 10 weeks of age in ferrets (reviewed in Deem et al. 2000). Vaccination schedules may require modification during CD epidemics or periods of increased risk of exposure. Yearly vaccine boosters are recommended in species for which data on post-vaccination antibody persistence are lacking (i.e., most species). For vaccination against canine distemper, it is recommended to use the canarypox vectored CDV vaccine (PUREVAX Ferret Distemper Vaccine, Merial Inc., Athens, Georgia 30601, USA) 1ml IM (Coke et al. 2005). Neonates receiving colostrum should be vaccinated every 3-4 weeks between 6-16 weeks of age. Neonates not receiving colostrum should be vaccinated every 3-4 weeks beginning at two weeks of age; the final vaccination should be after ten weeks of age (it is believed that maternal antibodies acquired in utero disappear by 4-6 weeks of age) (Fernandez-Moran 2003). Adults should receive an annual booster, but the risk of contracting the disease

should be weighed against the risk of vaccine-induced disease by each institution (Fernandez-Moran 2003).

Rabies: Rabies vaccinations are recommended for all carnivores. Only a killed rabies vaccine product should be used. The most commonly used is ImRab3® (Merial™). Animals at risk of contracting rabies should be vaccinated at 16 weeks and annually thereafter (dose: 1ml, i.m.). 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 intra-tracheally), and supportive care (Fernandez-Moran 2003).

PUREVAX□ Feline Rabies (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096) is a live canarypox vectored, non-adjuvanted recombinant rabies vaccine that is currently being used at some institutions for small carnivores (dose: 1ml; i.m.). Animals should be vaccinated once at age 8 weeks or older, then annually. 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.

Feline panleukopenia: All mustelids except the domestic ferret (*Mustela putorius*) are susceptible (Parrish et al. 1987). Canine parvovirus (CPV), mink enteritis virus (MEV), and feline panleukopenia virus (FPLV) are very similar, and it has been reported that vaccination against CPV protects against MEV in mink (Langeveld et al. 1995). Vaccinate with killed vaccines, such as domestic cat vaccine without respiratory virus components (Joslin et al. 1998).

FPV-1Ò Feline Panleukopenia Vaccine (Biocor Animal Health Inc., 2720 North 84th Street, Omaha, NE 68134) is a new non-adjuvanted, killed vaccine. Frequency of vaccination should be at least two vaccines three weeks apart at/after 12 weeks of age. If started before 12 weeks, a third vaccine should be given. Vaccinations can then occur annually. This vaccine has been shown to be safe in pregnant domestic cats.

Canine leptospirosis & canine hepatitis: In areas where these are a problem, vaccination may be considered (Shotts 1981; Carnio 1996). If canine leptospirosis vaccination is deemed necessary, vaccinate annually with multivalent Bacterin (Joslin et al. 1998).

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 treatment for these parasites is generally similar. Species housed out of doors should be routinely administered heartworm preventative in areas where this parasite is endemic (Denver 2003).

Table 15: Recommendations for parasite testing and treatment

Parasites	Testing and treatment
Internal	- Annual fecal examination (direct smear, fecal flotation, and sedimentation or Baermann). De-worming should be done as determined by the results of regular fecal exams. If pooled samples from the same exhibit test positive, then separate fecal examinations should be performed to determine the positive individual; it is very likely that all animals in the enclosure will require treatment.
	- Pre-shipment fecal examinations, direct smear, and flotation.
	- Quarantine fecal examination, three negative results each one-week apart (direct smear and fecal flotation).
	- 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 et al. 2000), and raccoons (Snyder et al. 1989b)
External	- Animals should be inspected for external parasites, including ear mites, during any physical examination (Petrini 1998).

Marten and ermine: Hoberg et al. (1990) reported on the occurrence of helminthes in ermine and marten in Washington State. In their findings they stated: “Among 22 adult ermines, 41% were infected by one or more of five species (*Taenia mustelae, Alaria mustelae, Molineus patens, M. mustelae* and *Trichinella spiralis*). Among 78 adult martens from three geographic localities, the prevalence was 83%. Nine

species were identified (*Mesocestoides* sp., *T. mustelae* and *T. martis americana, Euryhelmis squamula, M. patens, Baylisascaris devosi, Physaloptera sp., Soboliphyme baturini* and *T. spiralis*). *Trichinella spiralis* occurred with a maximum prevalence of 50% in martens, but only occurred in 9% of ermines. Compression and digestion techniques provided a similar estimate of prevalence of *T. spiralis*, yet neither was entirely accurate in identifying all infected hosts. The species richness of the helminth community of martens in Washington was greater than that reported from other regions of North America."

Wolverine: Endo- and ectoparasites are usually rare in wolverines, if endoparasites are found by a fecal examination, Ivermectin is effective at 0.4mg/kg orally or subcutaneously and repeated in two to four weeks. For cestodes, praziquantel at 5-10mg/kg orally or subcutaneously and repeated once after two weeks is recommended (Blomqvist 2001).

Medical Management of Neonates: For information on the feeding of hand-reared neonates, see the hand-rearing protocols in Chapter 7, section 7.3. Depending on the preventive health protocols in place, and the aggressiveness of the neonate-monitoring protocols of each institution, young animals may need to be handled for sexing, weighing, microchip implants, and vaccinations.

Exhibit furnishings (including open water) may need to be modified for young and aged animals, particularly in arboreal species to prevent accidental falling (M. Dulaney, personal communication).

Table 16: Neonatal examination & monitoring guidelines (from Read & Meier 1996)

Vital signs	Temperature, include activity level Pulse, rate and character Respiration, rate and character
Organ systems	---
Weight	**---**
Hydration	Skin tone and turgor
Mucous membranes	Color and capillary refill
Vitality	Response to stimulation, activity levels: type, frequency, duration
Physical condition	**---**
Laboratory values (optional)	Complete blood count White blood cell count Serum chemistries, including blood glucose & blood urea nitrogen Urinalysis and urine specific gravity (recommended)
Urination	Frequency, amount, and character
Defecation	Frequency, amount, and character
Condition of umbilicus	**---**
Total fluid intake	Amount in 24 hours Parenteral fluids: amount, frequency, and type Oral fluids: amount, frequency, type, nipple
Housing temperature	**---**

Medical Management of Pregnant Animals: In general, pregnant mustelids should be offered quiet and seclusion. The energy requirement and food intake of reproductive females increases significantly during pregnancy and lactation. In many mammals, up to 90% of fetal growth occurs during the third trimester of pregnancy, so increased energy should be provided in the diet to accommodate for that. The energy expenditures of lactating females increase 4-7 times the basal metabolic rate (Nicoll & Thompson 1987). High quality meat or kitten food may be added to the diet of pregnant and lactating mustelids to provide additional protein, fat, and energy, starting at the end of the second trimester and continuing until the weaning period is nearly complete.

Medical Management of Geriatrics: Geriatric animals may have a variety of special needs involving changes in diet fed, weight management, ambient temperature requirements, musculoskeletal issues, vision problems, or more frequent dental care. Older animals should be provided with an environment that takes into account their special needs.

General Medical Guidelines

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

AZA Accreditation Standard

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

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.

As with all carnivores, mustelids are susceptible to rabies. Institutional policies set in place for staff working with possible rabies carriers should be followed. Staff should wash their hands after working in mustelid areas and foot baths used if animals are suspected of being ill.

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

Also stated in Chapter 6.4, a tuberculin testing and surveillance program must be established for animal care staff, as appropriate, to protect the health of both staff and animals (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for animals may vary from an initial quarantine test to annual repetitions of diagnostic tests as determined by the veterinarian. To prevent specific disease transmission, vaccinations should be updated as appropriate for the species. Mustelids are reported to be carriers of Bovine TB, however, reports of transmission to humans could not be found. Staff should routinely be TB tested following the institutional policy.

6.6 Capture, Restraint, and Immobilization

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

Capture/Restraint: All mustelid species are good candidates for crate training. Historically, these species have not been worked with extensively in this manner, and so traditional capture methods are outlined below. However, the AZA SCTAG recommends that facilities use standard, protective contact behavioral training techniques to encourage these species to enter crates, stand on scales, and stand for visual inspections.

While all members of the Mustelidae can be handled with nets, snares, or squeeze cages, care should be exercised because they have sharp teeth, are extremely agile, and they can inflict a severe bite when agitated. Leather gloves should be worn when handling or netting any of the mustelids (Fernandez-Moran 2003).

The ferret is best restrained when grasped above the shoulders, with one hand gently squeezing the forelimbs together and the thumb under the chin of the animal. Minks are grasped by the tail with one hand, while the other hand grasps the animal behind the neck with the thumb and finger around the head. The preferred method with polecat, ermines, weasels, and martens is initially to restrain with a net and then inject manually. Larger mustelids, like the wolverine or badger, can be caught in squeeze cages for manual injections or injected directly by the use of a blowpipe or pole syringe (Fernandez-Moran 2003).

Skunks defend themselves by spraying their anal sac secretions; in the case of intact skunks, handlers should wear protective eye gear. Skunks can be successfully restrained manually by wrapping the animal in a towel and then masking them with anesthesia. It is easiest to draw blood from skunks if the animal is held sternally with the front legs off the end of the table and the head lifted to expose the jugular vein (D. Smith-Weber, personal communication).

Mustelids are susceptible to stress and injury caused by improper handling. Only trained personnel should handle mustelids, and usually a combination of chemical and physical restraint is warranted to reduce stress and the subsequent capture myopathy that may occur. Restraint should be brief, and care should be taken to avoid oral cavity and limb traumas (Fernandez-Moran 2003). Training of the animal to encourage participation in husbandry procedures is of great value with any species. Target training an animal to willingly enter a squeeze cage or transport/anesthesia chamber can help reduce the stress placed on the animal during routine and emergency medical procedures, and is strongly recommended by the AZA SCTAG.

Chemical Restraint: A variety of drugs have been used for the chemical immobilization of mustelids (see Table 17). In most species, dissociative/benzodiazepine/alpha$_2$-agonist combinations have been used very successfully for induction or short-term anesthesia. Ketamine can be used with midazolam, diazepam, xylazine, medetomidine, or acepromazine to improve muscle relaxation. Xylazine or medetomidine combined with ketamine has been recommended for several of these species, as both medetomidine and xylazine can be reversed with atipamezole. The combinations listed in Table 18 usually provide short periods of chemical restraint. If longer periods of anesthesia are required, gas anesthesia (methoxyflurane (rarely used), halothane, isoflurane, and sevoflurane) delivered by induction chamber*, mask, or endotracheal tube works well (*it should be noted that results from the use of induction chambers might vary) (Steffey 1996; Fernandez-Moran 2003).

Table 17: Drugs and dosages recommended for immobilization of selected mustelids (from Fernandez-Moran 2003)

Species	Recommended Anesthetic Combination (mg/kg)	Comments/Alternative (mg/kg)
American badger	Tiletamine-zolazepam (4.4)	Ketamine (15) or xylazine (1)
Eurasian badger	Ketamine (5-10) + medetomidine (0.05-0.1) (atipamezole) or tiletamine-zolazepam (10)	Ketamine (10-16) + xylazine (2-6) or medetomidine (0.04) + tiletamine-zolazepam (2.5)
Black-footed ferret	Ketamine (3) + medetomidine (0.075) (atipamezole)	Ketamine (15) + diazepam (0.1)
Ferret	Ketamine (10-30) + xylazine (1-2) or diazepam (1-2) or acepromazine (0.05-0.3)	Tiletamine-zolazepam (22), but recovery time can be prolonged
Ermine & weasel	Ketamine (5) + medetomidine (0.1) (atipamezole)	Ketamine (3) or tiletamine-zolazepam (11-22)
Marten	Ketamine (10) + medetomidine (0.2) (atipamezole)	Ketamine (60) + xylazine (12)
Mink	Tiletamine-zolazepam (15) or ketamine (40) + xylazine (1)	Ketamine (5) + medetomidine (0.1) (atipamezole)
Ratel	Tiletamine-zolazepam (2.2)	Ketamine (6) + xylazine (0.5)
Striped skunk	Tiletamine-zolazepam (10)	Ketamine (15) + acepromazine (0.2)
Tayra	Tiletamine-zolazepam (3.3)	---
Wolverine	Ketamine (5-8) + medetomidine (0.1-0.15)	Ketamine (20) + acepromazine (0.2)

In general, one of the more common anesthetic complications is respiratory depression, this may be caused by an alpha$_2$-agonist. If the animal is being maintained using an inhalant anesthetic, the alpha$_2$-agonist can be antagonized post-induction. However, bradypnea and hypoventilation may be seen with other drugs or drug combinations, and is particularly common in aquatic species (i.e., otters). Other

complications may include hyperthermia, hypothermia, bradycardia, tachycardia, and abnormal breathing (Maran & Robinson 1996). Poor muscle relaxation, excitable recoveries, and tonic clonic convulsions may occur if ketamine is used alone (Blomqvist & Rudbäck 2001). For this reason, when possible, ketamine should NOT be used alone in mustelids. Instead, it is recommended to combine it with a sedative(s), and this agent(s) should not be antagonized less than 45-60 minutes post-ketamine injection.

Animals being anesthetized should be kept as calm and quiet as possible; voices should be kept low, and only those staff members necessary for the procedure should be present during the catch-up, manual restraint, and initial anesthesia induction. It is recommended that animals recovering from anesthesia be monitored until conscious, and be kept in a dark den box, or confined space, to facilitate smooth recovery (Fernandez-Moran 2003).

- Marten: See Bull & Heater (1996) for information on live-trapping and immobilization of wild marten.
- Wolverine: Blomqvist & Rudbäck (2001) suggest using medetomidine and xylazine for wolverines, which can be reversed with atipamezole at 0.3-0.4mg/kg. “Atipamezole should be used after a minimum of 15-20 minutes, and is always recommended to be used partly intra-muscularly and subcutaneously, but never intravenously” (Blomqvist & Rudbäck 2001).

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 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-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

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

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.

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 animals 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.

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. For information on recommended necropsy protocols, refer to the AAZV 'Small Carnivore Medical Management Guidelines' in Appendix H. A complete report, including histopath and test results, should be submitted to the AZA Small Carnivore TAG veterinary advisor on an annual basis. See Appendix N for necropsy protocol and forms. After it has been decided by authorized staff that euthanasia is indicated, mustelids should be anesthetized (see anesthesia section) first. 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. The 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. See Section 7.6 for contraception information.

The following table (Table 18) is intended as a list of diseases observed in mustelids and their associated clinical signs; it is not intended as a comprehensive table (See also Appendix M). For proper treatment and management, the reader is referred to more extensive medicine texts such as: Fernandez-Moran (2003), Lewington (2007), and Oglesbee (2006). For an extensive review on the infectious disease agents that affect North American river otters, and that may affect other mustelids, refer to Kimber & Kollias (2000). For the 'species reported' information, this represents the species in which the disease has been reported; other species may also be susceptible (A. Moresco, personal communication).

Table 18: Common mustelid diseases. Adapted by A. Moresco from Fernandez Moran (2003)

VIRAL DISEASES	
Rabies	
Transmission	Contact of infected saliva with mucosal surface or open wound.
Clinical signs	In ferrets, signs are usually mild and non-specific: anxiety, lethargy, and posterior paresis. Should be considered in any animal with outdoor access with neurologic signs.
Diagnosis	Only diagnosed definitively postmortem. Histopath on brain.
Species reported	All warm blooded animals are susceptible.
Canine distemper	
Transmission	Aerosol exposure or direct contact with conjunctiva, nasal exudates, urine or feces.
Clinical signs	Anorexia, vomiting, diarrhea, weight loss, hyperemia of face and ears, hyperkeratosis of nasal planum and footpads, oculonasal discharge, neurologic signs.
Diagnosis	Immunofluorescent antibody test or PCR of conjunctival swab. Histopath exam of affected tissue. 100% fatal to ferrets.
Species reported	Domestic ferret, BFF, badgers, weasels, skunks minks, martens, Eurasian otter.
Influenza (type A)	
Transmission	Inhalation of aerosolized droplets.
Clinical signs	Sneezing, conjunctivitis, otitis (unilateral), fever, photophobia, naso-ocular discharge.
Diagnosis	Clinical signs and presence of HI antibodies (hemo-agglutination inhibition test).
Species reported	Domestic ferret and mink. Also one Stone marten reported to have been infected with H5N1.[1]
Aleutian disease (*Parvoviridae*)	
Transmission	Infected
Clinical signs	Weight loss, hypergamma-globulinemia, reproductive failure, hemorrhagic enteritis and immune mediated glomeruloeohritis.
Diagnosis	Gammaglobulin >20% serum total protein, IFA test.
Species reported	Mink, ferret, striped skunk (typically of farmed mink).
Ferret kit disease (*Rotavirus*)	
Transmission	Affects kits. Can become enzootic at a facility.
Clinical signs	Watery diarrhea, anorexia and lethargy.
Diagnosis	Identification of viral particles in fresh feces.
Species reported	Ferret
Infectious peritonitis (*Coronavirus*)	
Transmission	Unknown, recently reported disease.

Clinical signs	Diarrhea, granulomatous lesions.
Diagnosis	Biopsy, immunohistochemistry.
Species reported	Ferret[3]

BACTERIAL DISEASES

Salmonellosis (*Salmonella spp*)

Transmission	Associated with feeding uncooked meat. Can be found in some clinically normal animals.
Clinical signs	Hemorrhagic enteritis, dehydration, weight loss, fever, lethargy.
Diagnosis	Culture of fresh feces.
Species reported	Many species.

Tuberculosis *(M. tuberculosis)*

Transmission	Inhalation of aerosolized particles, ingestion of contaminated tissues.
Clinical signs	Weight loss, enlarged lymph nodes, chronic respiratory disease.
Diagnosis	PCR, direct examination of tissue and culture.
Species reported	Usually only a problem in free-ranging badgers from the UK and in free ranging ferrets from New Zealand.

Campylobacteriosis (*Campylobacter jejuni, C. coli*)

Transmission	Raw meat diets carry some risk of infection, ferrets may be asymptomatic carriers.
Clinical signs	Diarrhea, tenesmus, fever, anorexia, vomiting, leukocytosis, abortion.
Diagnosis	Fecal culture.
Species reported	Ferret and mink.

Botulism (*C. botulinum*)

Transmission	Ingestion of contaminated food linked with capture stress in wild otters.
Clinical signs	Death, paralysis, and dyspnea before dying. Enerotoxemia, acute gastric distension, cyanosis.
Diagnosis	Fecal Gram stain and toxin assay.
Species reported	Otter and black-footed ferret.

Pneumonia (various agents)

Transmission	Due to a number of organisms, concurrent infection with calici and picornavirus can predispose.
Clinical signs	Thick yellowish nasal discharge, labored breathing, dyspea, cyanosis, fever, lethargy, anorexia.
Diagnosis	Increased lung sounds, complete blood count results, culture, cytology.
Species reported	Most mustelids.

FUNGAL DISEASES

Dermatomycosis

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). Ferrets are not prone to skin mycotic disease, but some species of dermatophytes could present a zoonotic risk.
Diagnosis	Definitive diagnosis is done by culture.
Species reported	Most species.

PARASITIC DISEASES

Toxoplasmosis

Transmission	Exposure to sporulated oocysts, ingestion of intermediate host or ingestion of uncooked infected meat.
Clinical signs	Anorexia, lethargy, fever, lymphadenitis, spenomegaly, corneal edema, myocarditis, hepatitis, pneumonitis.
Diagnosis	Antibody titers.
Species reported	BFF highly susceptible. NARO reported to have had titers.

Coccidiosis (*Isospora, Eimeria spp*)

Transmission	Fecal oral.
Clinical signs	Often asymptomatic. Lethargy, diarrhea, dehydration, weight loss do occur.
Diagnosis	Fecal examination.

Species reported	European otter[4], Ferret, mink[2]

Lungworm

Transmission	Transmission can be direct, by ingestion of L1 in feces or sputum of infected animals, or indirect by ingestion of intermediate host depending on species of lungworm involved.
Clinical signs	Cachexia, anemia, coughing, dyspnea, hyperpnea, nasal discharge, neurological signs.
Diagnosis	First stage infective larva in fecal exam.
Species reported	Mink, skunk, sable, Eurasian badger, otter, ermine.

Kidney worm

Transmission	Lifecycle is complex and not completely known. Involves annelids as first intermediate host and freshwater crustaceans, mollusks and fish as second intermediate hosts.
Clinical signs	Weight loss, hematuria, polyuria & other signs associated with renal failure.
Diagnosis	Necropsy finding – usually in the right kidney.
Species reported	Mink, otter, weasel, ermine, marten, fisher, and grison.

Tapeworms and roundworms

Transmission	Mustelids may be susceptible to them, usually not a problem in *ex situ* populations with a regular endoparasite control program in place.
Clinical signs	---
Diagnosis	Fecal exams (sedimentation and floatation).
Species reported	

Microfliaria spp.

Transmission	Bite from infected mosquito.
Clinical signs	Respiratory and cardiac signs. Not all microfilaria infections develop into clinical disease.
Diagnosis	Clinical signs, finding microfilaria in blood smears.
Species reported	River otters.

Sarcoptic mange

Transmission	Exposure to infected animals.
Clinical signs	Scabs around head and neck, tail, feet.
Diagnosis	Finding the mites in skin scrapings or biopsy.
Species reported	Most mustelids.

Fleas

Transmission	Fleas can transfer from other species, but tend to prefer their specific host.
Clinical signs	Signs may vary from asymptomatic to fleabite allergy. Pruritus, inflammation. In young or sick animals with heavy infestation also anemia.
Diagnosis	Finding fleas or flea dirt in the coat.
Species reported	Most mustelids.

Ticks

Transmission	As with other mammals.
Clinical signs	Itching, may transmit other diseases.
Diagnosis	Finding ticks on animals. Others in group may be affected.
Species reported	Many.

NON-INFECTIOUS DISEASES

Excertional myopathy

Risk factors	Recent stressful, capture, immobilization, transport of wild animals.
Clinical signs	May vary. Elevated temperature, dark colored urine (myoglobinuria), ataxia, weakness, depression, elevated muscle enzymes in serum.
Diagnosis	Urinalysis, blood chemistry, physical exam.
Species reported	Badger, otter, black-footed ferret.

Teeth abscesses

Risk factors	Cage trauma (biting), tartar and calculus calcium build-up.
Clinical signs	Decreased appetite, facial swelling, weight loss.
Diagnosis	Radiographs, physical examination.
Species reported	Otters.

Urolithiasis

Risk factors	Diet and genetics may play a role. Sterile urolithiasis, more common in domestic ferret, but UTI may predispose. Most common: struvite, cystine.
Clinical signs	Signs depend on location, number, and size of urolith and may include asymptomatic, polakyuria, dysuria, hematuria, staining of perineal area, urine dribbling, signs of pain when obstructed.
Diagnosis	Abdominal radiographs, urinalysis (pyuria, hematuria, changes in pH).
Species reported	Small-clawed otter is particularly susceptible. Also reported in mink, ferret, Eurasian otter, domestic ferrets.

Amyloidosis

Risk factors	Was reported in a relatively large number of black-footed ferrets and may point toward a genetic predisposition.
Clinical signs	Relate to specific site of amyloidosis accumulation. Can include anorexia, lethargy, sign of renal disease.
Diagnosis	Histologic evaluation of tissues submitted.
Species reported	Black-footed ferrets.

Thiamine (vitamin B1) deficiency

Risk factors	Thiaminase present in some fish.
Clinical signs	Anorexia, salivation, ataxia, papillary dilation, sluggish reflexes.
Diagnosis	Response to treatment.
Species reported	Piscivorous species (mink on raw fish diet).

Post-estrous anemia

Risk factors	Estrus that persists for over one month.
Clinical signs	Non-regenerative anemia, ecchimoses, bleeding.
Diagnosis	CBC- aplastic anemia, vulvar discharge.
Species reported	Ferrets.

Pancreatic cancer (insulinoma)

Risk factors	High incidence in domestic ferrets.
Clinical signs	Hind leg weakness, blank look, staring, drooling, nausea, as the disease progresses seizures as well.
Diagnosis	Blood tests for fasting low blood sugar. See texts referenced above for test details and risks.
Species reported	Ferrets.

Adrenal neoplasia (adrenocortical carcinoma)

Risk factors	High incidence in American ferrets.
Clinical signs	Alopecia, pruritus, vulvar swelling in sterilized jills, sexual behavior (aggression in males), weight loss.
Diagnosis	Clinical signs, ultrasound, sometimes palpation is possible, abdominal exploratory surgery. Dexamethasone suppression test ACTH stimulation test not reliable in ferrets.
Species reported	Ferrets.

Lymphoma

Risk factors	Unknown, potentially viral origin.
Clinical signs	Lymphadenopathy, respiratory distress (if any organs in the chest cavity are involved).
Diagnosis	Histopathology of enlarged lymph nodes or other affected organs biopsied, cytology of fine needle aspirate of enlarged organs may be of limited value.
Species reported	Ferrets.

[1] Klopfleisch et al. (2007)
[2] Lewington (2007)
[3] Martinez et al. (2008)
[4] Torres et al. (2000)

Tayras: Some tayras have been reported to suffer seasonally from allergy-induced alopecia. Pruritis (intense itching) led to tail amputation in one case reported by C.Waldron (personal communication). Waldron indicated that the administration of antihistamines alleviated the symptoms somewhat in the affected individuals. He also states that antihistamines administered prophylactically at the beginning of the allergy season proved helpful in alleviating symptoms.

Useful Medical Articles: This section will expand in the future and should not be considered exhaustive.

Fahlman A, Arnemo JM, Persson J, Segerstrom P, Nyman G. 2008. Capture and medetomidine-ketamine anesthesia of free-ranging wolverines (*Gulo gulo*). Journal of Wildlife Diseases 44(1):133-142.

Capture and anesthesia with medetomidine-ketamine were evaluated in free-ranging wolverines (Gulo gulo) immobilized for marking with radiocollars or intraperitoneal radio-transmitters in Norrbotten, Sweden, during early June 2004 and 2005. Twelve juvenile wolverines were captured by hand and injected with 0.14 +/- 0.03 mg/kg (mean +/- SD) medetomidine and 7.5 +/- 2.0 mg/kg ketamine. Twelve adult wolverines were darted from a helicopter or the ground, or captured by hand. Adults received 0.37 +/- 0.06 mg/kg medetomidine and 9.4 +/- 1.4 mg/kg ketamine. Arterial blood samples were collected between 15 min and 30 min and between 45 min and 60 min after drug administration and immediately analyzed for selected hematologic and plasma variables. Hyperthermia was recorded initially in one juvenile wolverine and some adults. Rectal temperature, heart rate, and lactate decreased significantly during anesthesia, whereas hemoglobin oxygen saturation, pH, partial pressure of arterial carbon dioxide, and base excess increased. Adult wolverines darted from a helicopter had a significantly higher rectal temperature, higher glucose and hematocrit values, and a lower heart rate than juveniles captured by hand. Impaired arterial oxygenation was evident in all wolverines. This study provides baseline data on physiologic variables in adult and juvenile wolverines captured with different methods and anesthetized with medetomidine-ketamine.

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.

Information on the development and reproductive parameters of selected mustelids can be found in Tables 19 and 20. Most mustelids are seasonal breeders with the length of mating season varying from roughly one month (African striped weasel) to 12 months (Eurasian badger); estrus may last anywhere from 3 days to 8 weeks (Fernandez-Moran 2003). The table below (Table 19) provides details of the reproductive and developmental parameters of wolverines, fishers, American martens, and long-tailed weasels. Table 20 provides reproductive and developmental information for tayras, American badgers, and striped and Eastern spotted skunks.

Table 19: Selected mustelid reproduction/development parameters (from Reed-Smith et al. 2003)

Parameter	**Wolverine** *(Gulo gulo)*	**Fisher** *(Martes pennanti)*	**American marten** *(M. americana)*	**Long-tailed weasel** *(Mustela frenata)*
Breeding season	Late April to July	March to April	Late June to early August	July or August
Estrous frequency	Monestrous	Monestrous, with postpartum estrus & possible 2nd estrus after mating	Polyestrous, vulva enlarges at onset of estrus	Reported as both monestrous & polyestrous
Estrus duration	---	2-8 days 3-9 days after parturition	1-4 periods of sexual receptivity each lasting 1-4 days during breeding season	36-71 day cycle until bred successfully. Estrus lasts 3-4 days from 1st breeding.
Courtship	Females emit low growls & lead way in movement. Courtship bond breaks down after few days	Chasing, tail-wagging, and vocalization by female; she chooses when to breed	May last >2 weeks, consists of playing & wrestling; female scent-marks extensively	---
Copulation	Lasts about 12-56 minutes	Lasts 20 minutes to an average of 4 hours	Several times a day lasting for about 1 hour	---
Gestation (days)	215-272 total* Actual ~30-50	~30 actual gestation, dormant for 9 months*	220-276 total* Actual ~28	205-337 total, averaging 279* Actual ~27 days
No. of offspring	1-5, usually 2-4	1-6, averaging 2-3	1-5, average ~3	1-10
Birth weight (g)	~84-100 (3-3.5 oz)	≤40 (1.4 oz)	~28 (1 oz)	~3 (0.11 oz)
Eyes open	---	~45-55 days	~34-39 days	By ~5 weeks
First solid food	---	~7-8 weeks	~36-45 days	~3 weeks
Weaned (weeks)	8-10	~8-10	~6	Begin at 3 ½
Sexual maturity[1]	Females at 15-36 months, 3.4 yrs in wild (Persson et al. 2006); males at 2-4 yrs	12 months; males generally should be 2 yrs or older	Generally 15-39 months old at 1st breeding.	Females at 3-4 months; males at 1 yr.

* Delayed implantation

[1] Capable of breeding but not always successful until older

Table 20: Selected mustelid reproduction/development parameters (from Reed-Smith et al. 2003)

Parameter	**Tayra** *(Eira barbara)*	**American badger** *(Taxidea taxus)*	**Striped skunk** *(Mephitis mephitis)*	**Eastern spotted skunk** *(Spilogale putorius)*
Breeding season	Nonseasonal	May to Aug. with a peak late July to early Aug.	Mid-February – mid-April	Late March and April
Estrous frequency	Polyestrous	Monestrous	Facultatively polyestrous	May be polyestrous with late, second litter
Estrus duration	17 day cycle, receptive for only 1-2 days	Estrus is brief and asynchronous	---	---
Courtship	---	---	Males wander in search of mates	---
Copulation	---	---	---	---
Gestation	63-70 days	~6 weeks*	59-77 days**	50-65 days***
No. of offspring	1-3, usually 2	1-5, usually 2-3	1-10, usually 4-5	2-6
Birth weight (g)	~74-92 (2.6-3.2 oz)	~456 (16.1 oz)	~30-35 (1.06-1.2 oz)	~9.5-22.5 (0.34-0.8 oz)
Eyes open	14+ days	4-6 weeks	17-35 days	~30 days
First solid food	---	4-5 weeks	~6 weeks	---
Weaned	2-3 months	8 weeks	~8-10 weeks	~54-60 days
Sexual maturity[1]	---	Females at 4 months; males at 2 years	10-12 months	---

* Delayed implantation; ** Slight delay in implantation; *** May have slight delay in implantation
[1] capable of breeding but may not be successful until older

Many of these species experience embryonic diapause (see Table 21), and several are believed to be induced ovulators (Fernandez-Moran 2003). However, this area requires further research in many species (e.g., fisher).

Table 21: Reproductive characteristics of selected Mustelids (from Petrini 1992)

Reproductive characteristics	**Species**
Long Diapause*	American badger (*Taxidea taxus*) European badger (*Meles meles*) Fisher (*Martes pennanti*) N. American otter (*Lontra canadensis*) Pine Marten (*Martes martes*) Western spotted skunk (*Spilogale gracilis*) Wolverine (*Gulo gulo*) Stoat (Ermine) (*Mustela erminea*)
Short Diapause*	American mink (*Mustela vison*) Striped skunk (*Mephitis mephitis*)
Induced Ovulation	American mink (*Mustela vison*) Striped skunk (*Mephitis mephitis*) Domestic ferret (*Mustela putorius*) Wolverine (*Gulo gulo*) Western spotted skunk (*Spilogale gracilis*)

* The hog badger, all of the martens, ratel, ermine, long-tailed weasel, and marbled polecat also experience delayed-implantation (Fernandez-Moran 2003).

It has been shown that the males of most mustelid species have active spermatogenesis for only 3-4 months a year, with a concomitant enlarging of the testes that generally begins sometime before the female's estrous season and extends beyond the end (Fernandez-Moran 2003). For example, Mead (1989) states that the testes of all *Martes* species studied to date are permanently scrotal, with the males exhibiting a distinct testicular cycle and discontinuous spermatogenesis.

Female American mink and striped skunk that mate early in the season experience a brief delayed implantation, those that breed later have shorter gestations (Martin 1996). The least weasel and all of the ferrets do not experience embryonic diapause (Martin 1996).

Martes spp.: Many sources state that, in general, females of the *Martes* species (American marten, stone marten, Eurasian pine marten, fisher, sable) do not breed successfully in zoos and aquariums until they are 24-27 months of age; discrepancies in published reports are likely due to individual variation, delay of puberty due to nutritional deficiencies, or inaccurate aging of the animal (Martin 1996). The short-tailed weasel and western spotted skunk are known to be capable of breeding at six months of age (Martin 1996).

Generally breeding occurs from late June through early August for most of the *Martes* species. The exceptions are fisher and yellow-throated martens, which breed between October and early November in Lithuania (Martin 1996). The onset of estrus coincides with an enlargement of the female's vulva, with most matings occurring when the swelling is at its maximum (Martin 1996). It is not known if superfetation occurs in this genus as a whole; induced ovulation has only been documented for the sable. All *Martes* species experience embryonic diapause (Martin 1996).

Fisher: In the fisher, parturition and the breeding season occur in late winter and early spring. Due to the delayed implantation of the blastocyst, total gestation lasts approximately one year (Powell 1993). Females first show signs of estrus, which lasts roughly 6-8 days, with an enlargement of their vulva; males' testes also enlarge during the breeding season (Powell 1993). Field studies have shown that the fishers become more active during the breeding season, covering greater distances, and spending more time moving around (Coulter 1966; Arthur et al. 1989; Powell 1993). Fishers are the only *Martes* species that experience a postpartum estrus (Martin 1996).

Wolverine: Wolverine have a low reproductive rate with a mean litter size of 1.88 (N=74, Persson et al. 2006) to 2.2 (N = 274, Sweden, Finland & Russia, (Blomqvist 2001)), and in zoos and aquariums they have a cub mortality rate of 23% in the first month and 20.5% in the first year. Cub mortality in the wild is not well known (Blomqvist 2001).

Breeding season for wild and *ex situ* populations of wolverines is reported to occur from June to August (Wright & Rausch 1955; Blomqvist & Larsson 1990; Mead et al. 1991; Blomqvist 1995; Landa et al. 1998). If breeding is not desired, pairs should be separated from early May to late July (Blomqvist 2001). Hedmark et al. (2007) report the following findings from their paternity study of 145 wild wolverines with known mothers in Scandinavia:

> "Our results demonstrate that the wolverine exhibits a polygamous mating system as some males were shown to produce offspring with more than one female in a single year. Females often reproduced with the same male in subsequent breeding years, but sometimes changed their partner, potentially as a consequence of a change in the territory-holding male in the area. In the majority of litters, siblings were unambiguously assigned the same father, indicating that multiple paternity is rare. Of 23 breeding pairs, for which telemetry data were available, 20 had overlapping home ranges, suggesting that pair formation generally is consistent with the territories held by wolverine males and females."

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.

Laparoscopic intrauterine insemination has been successful in European ferret (*Mustela putorius furo*) with a 70% success rate (Wildt et al. 1989; Howard et al. 1993). This procedure, using fresh or cryopreserved semen, has also been successful in the Siberian polecat (*Mustela eversmanni*) and black-footed ferret (*Mustela nigripes*) (Wildt et al. 1989; Howard 1999).

At this time, AI also has been used successfully in mink but is not a practical tool for use in other small carnivores identified as PMP or SSP species by the AZA SCTAG.

7.3 Pregnancy and Parturition

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

Separation of Sexes/Young: Some of the mustelid species may breed more reliably in zoos if separated seasonally (i.e., for a few months prior to the breeding season) and then reintroduced, or maintained as singletons and introduced at the beginning of the breeding season. This is a technique that can be tried with non-breeding pairs to attempt stimulation of interest.

In managed care, young of most mustelids should be removed by, or before they reach sexual maturity. For example: fisher females are sexually mature by one year; yearling male fishers produce sperm but are generally not successful breeders until they are older (at least two years) (Powell 1993). American marten females mature sexually at two years in the wild, but have reproduced successfully at 15 months in zoos (Powell 1993). Males mature sexually at about the same age but, as in the fisher, may have to be older before they are reproductively successful (Powell 1993). Female American badgers can mature as early as four months but males generally do not mature until two years of age (Shefferly 1999). In the wild, sable, stone marten, and pine marten reach adult size by the age of 12-16 weeks and disperse before the next mating season (Martin 1996).

In the wild, wolverines are generally almost independent of their mothers by 6-7 months and typically leave their dam at roughly one year of age (Blomqvist 2001). In zoos, young wolverines can be maintained with their dam for approximately one year before aggression begins to occur (Blomqvist 2001).

Wolverine: In the wild, while predominantly solitary, wolverines have overlapping home ranges (Blomqvist 2001). Researchers have observed males (sires) regularly visiting the home range of the dam and her cubs. All interactions in these cases were reported to be amicable, with the male sniffing the cubs and playing with them (Blomqvist 2001).

While some facilities leave the male in with the female in large enclosures during birth, it is far more typical for the male to be removed or the female isolated. *Ex situ*, wolverine females should be separated in mid-January, offering the dam enough time to adapt to her reproductive den. In Europe, 45% of the estrus periods occurred in the first two weeks of June, with 60% of the births taking place in the last two weeks of February. A more recent European survey revealed 81% of the births occurred in February and March in responding institutions (Blomqvist 2001).

Introduction of Sexes: Pairs should be introduced at the first signs of estrus in the female. If individual animals show few signs of estrus, pair formation should be attempted at the onset of the breeding season. All pairings should be closely monitored for aggression or excessive stress.

Marten: Heath et al. (2001) studied reproductive behavior of the endangered Newfoundland marten (*Martes americana atrata*) in zoos.

> "Patterns of scent-marking and behavioral interactions were recorded before and after a male marten was introduced to two females. After introduction of the male, marking by the receptive female increased, whereas the non-receptive female marked less and became less active. Activity and marking bouts were significantly correlated throughout the day for the male and the receptive female, and they often marked in the same locations. The male marked more frequently when the receptive female was active and the female's marking was often associated with

behavioral interactions. These findings suggest a major female influence on male marking and activity and suggest that marking may facilitate social interaction" (Heath et al. 2001).

The receptive female did produce a litter the following spring, indicating the timing of male introduction may be important to successful breeding of this species.

Wolverine: New, opposite sex pairs have been introduced throughout the year without significant problems (Blomqvist 2001). As with all introductions, the animals should be allowed time to become accustomed to the scent and sight of one another before introductions are attempted (see Chapter 4, section 4.3 for additional information).

Pregnancy: Pregnancy can be determined by urinary progesterone and conjugated estrogen levels, palpation, radiography (at the end of the gestation period), and ultrasonography (Fernandez-Moran 2003). Hormonal tracking of a male or female's reproductive status is also possible using fecal hormonal metabolite testing. If hormonal tracking is required, the AZA SCTAG Chair should be contacted for the current Reproductive Advisor's name and contact 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 "cub-proofed." The females of all mustelid species should be provided with ad lib nesting material and at least two nest box choices to which they are introduced several weeks before the expected due date. Typically, the pair should be separated if they are habitually housed together; otherwise the male should be removed from her exhibit. Once the young are born, the female and young should not be disturbed for at least 7-14 days unless absolutely necessary, although normal keeper routines should be maintained as much as possible. The establishment of nursery groups (i.e., mothers with young) is believed to be atypical for many of the mustelid species, but is reported for related females in some mustelids (e.g., otter, J. Ogden, personal communication). Some species of skunks may be found sharing nests, but these are not species typically held in zoos at this time.

Nest Sites: It is important that mustelid females be provided with birthing location choices; all females should be offered at least two nest boxes, as well as more natural locations when possible. Some European facilities postulate from empirical information that female wolverines provided with rocky scree experience higher reproductive success (Blomqvist & Rudbäck 2001). In addition to multiple nest boxes, females should be offered ad lib bedding material, monitored for appetite (increase a lactating female's diet when needed), offered as much privacy and quiet as the animal requires (generally high for female mustelids), and they should only be cared for by familiar staff while maintaining as much of the typical routine as possible.

Fisher: A nest box 43.2 cm x 44.5 cm x 61 cm (17 in high x 17.5 in wide x 24 in) long has been used by the Rosamond Gifford Zoo successfully with fisher (P. Dwyer, personal communication).

Wolverine: The recommended size for a wolverine nest box is approximately 0.7 m x 0.5 m x 0.7 m (2.3 ft x 1.6 ft x 2.3 ft), made of a solid material strong enough to prevent the female from destroying it. Wooden nest boxes are usually chewed and do not last long, therefore, it is suggested that boxes be made of bricks or concrete. The entrance should not be larger than 0.3 m x 0.4 m (0.98 ft x 1.3 ft) to allow for privacy. In addition to the entrance to the box, the nest box should contain an inspection door in the roof or back. Nesting material should be offered ad lib to the female before the delivery. The denning facility should be located away from roads and in an area of minimum disturbance. During the first two weeks after delivery, only qualified staff should be allowed entrance into the denning facility. Newborn cubs should not be disturbed for the first two weeks unless absolutely necessary, as any disturbance may result in loss of the young, especially with inexperienced dams. However, unnecessary caution should be avoided, as animals are accustomed to the pre-set routines of their keepers (Blomqvist 2001).

The following sample nest boxes have been used successfully at breeding institutions housing wolverine.

- Institution C: The holding den mesh was covered with plywood. A plywood privacy door also was added to the area with a peek door to allow for monitoring by staff. The platform bed is one the animals use year around. For more information about this nest box design contact the AZA SCTAG Chair

Holding pen	-	1.4 m x 1.3 m x 1.8 m (56 in x 54 in x 72 in) high
	-	Three transfer doors measuring 0.4 m x 0.6 m (16 in x 25 in)
	-	Camera above front right corner.
Bed	-	0.7 m x 0.6 m x 0.2 m (28 in x 23 in x 9 in) high
	-	Slatted bottom so urine can run out. 2.5 cm (1 in) off the floor.
	-	Filled with straw.
Privacy door	-	1.3 m x 1.8 m (51 in x 72 in) high. Simple plywood hinged door.
	-	Small 0.2 m x 0.2 m (7 in x 7 in) hinged peek hole in the door.

- Institution M: Three different dens have been used. For more information on these three den types, please contact the AZA SCTAG Chair (Photo credit: Dale Pedersen)

Den 1: Two rooms, 122 cm (48 in) high x 107 cm (42 in) wide x 61 cm (24 in) deep. The left room is 66 cm (26 in) wide and the right room is 41 cm (16 in) wide.

Den 2: One room, 102 cm (40 in) wide x 53.3 cm (21 in) high x 66 cm (26 in) deep.

Den 3: Two rooms, 114.3 cm (45 in) wide x 61 cm (24 in) high x 107 cm (42 in) deep, and each side is 56 cm (22 in) wide.

- Institution N: Three litters have been raised successfully in this box (seen at right). The sides are insulated due to extremely low temperatures. The base is roughly 91.4 cm x 91.4 cm (3 ft x 3 ft). For more information on the design of this nest box, contact the AZA SCTAG Chair (Photo credit: Sylvie Bouchard)
- Institution D: The female slept in the nest box occasionally, but gave birth in the den. The dimensions of the nest box are: 86.36 cm x 71.12 cm x 56 cm (34 in long x 28 in high x 22 in) deep. The top is hinged and there is a narrow but long slit in the back for drainage. The legs are 5 cm (2 in) high in the front and only 4 cm (1.5 in) in the back to assist with drainage. The opening is 28 cm x 25.4 cm (11 in x 10 in) and is 15.25 cm (6 in) up from the bottom. There was a 10.15 cm x 10.15 cm (4 in x 4 in) peek hole in the back to allow for monitoring of the inside once the nest box was wired in place. However, the female moved the box around making it impossible for staff to see inside through this hole. Minimal damage was done to the box by the female prior to giving birth. The den dimensions are: 86.35 cm wide x 183 cm long x 2 m tall (34 in wide x 72 in long x 6.5 ft tall), with a camera mounted on the ceiling. The animal opening is about 51 cm (20

in). The den is part of the building, so it's made of cinder block and concrete. For more information on this nest box design contact the AZA SCTAG Chair (Photo: Cindy Colling)


Den


Nest box

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 staffs in AZA-accredited institutions are able to assist with the rearing of these offspring if necessary. If young are removed for hand-rearing, they typically should not be reintroduced to the mother. However, if this situation arises, the AZA SCTAG Chair and other institutions housing the species should be consulted for current practices and any advancement in assisted rearing practices.

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 (typically known as kit in most mustelids, but badger young may be called cubs). 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 (e.g., 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 kits as soon as possible. See Table 16 for a recommended 'Neonatal Examination and Monitoring Protocol' (Read & Meier 1996).

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 and possibly call continuously. 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 kits. 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 interact with (Muir 2003).

Physical care: Incubators are the best source of warmth; heat lamps are too intense and can be dehydrating; hot water bottles can be used when necessary and hypothermic neonates can be warmed slowly by placing them next to your body (Muir 2003).

Small kits should be kept at a temperature between 26.5-29 ºC (80-85 ºF); young animals die very quickly if they are kept at too high a temperature (Muir 2003). Wallach & Boever (1983) give 29.4 °C (85 °F) and a minimum 50% humidity as the desired incubator setting for mustelids. Meier (1986) suggests 29.4-32 °C (85-90 °F) and 50-60% humidity. The temperature should be gradually reduced to room temperature, 21.2-23.9 °C (70-75 °F), over the course of about three weeks (unless the neonate becomes ill). If the ambient temperature is too high, it may cause hair loss. Most neonates will feel more secure if wrapped in layers of towels; this also aids in keeping them warm (Muir 2003).

Feeding: 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 required 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 x body wt (in kg.)$^{0.75}$ (Kleiber 1947). For a 30g kit (e.g., skunk), the BER would be: 70 x 0.03$^{0.75}$ = 5.0 kcal/day. For a 90g kit (e.g., wolverine), the BER would be: 70 x 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).

Table 22 below provides some pre-calculated MER values. 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.

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 kits 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. A MER factor of 3 is appropriate for large mustelids (e.g., wolverine) that grow at a slower rate than the smaller species, whereas a factor of 4 may be more appropriate for small mustelids such as mink, black-footed ferrets, and small weasels.

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 (30 g ~ 1 oz). It is important that units are the same for body weight and stomach volume. The stomach capacity is the amount of formula a kit 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.

- Find Maintenance Energy Requirement (MER): 70 x body wt (kg)$^{0.75}$ x 3 or 4.
- Determine stomach capacity (amount that can be fed at each meal): Body weight (in grams or ounces) x 0.05.
- 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.
- 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.
- Divide 24 hours by the number of feedings/day to find the time interval between feedings.

Table 22: Example neonate feeding calculations for hand-reared mustelids

Example/Species	Calculations*
Example 1: Newborn hog-nosed skunk. Approx. birth wt = 30g	1. 70 x 0.03kg $^{0.75}$ x 3 = 20.2kcal/day 2. 30g x 0.05 (stomach capacity of 5% body wt) = 1.5g (ml) can be consumed/feeding 3. With a formula that contains 1.53kcal/ml: 20.2kcal/day = 13.2ml/day 1.53kcal/ml 4. 13.2ml/day = 8.8 feedings/day (round up to 9) 1.5ml/feeding 5. 24 hours/ 9 feedings = 2.5-3 hours between feedings during the first week.
Example 2: Newborn wolverine. Approx. birth wt = 84-94g	1. 70 x 0.09kg.75 x 3 = 34.5kcal/day 2. 90g x 0.05 [5% body wt] = 4.5g (ml) 3. With a formula that contains 1.02kcal/ml: 34.5kcal/day = 33.8ml/day 1.02kcal/ml 4. 33.8ml/day = 7.5 feedings (round up to 8) 4.5ml/feeding 5. 24hours / 8 feedings = feed every 3 hours

* New calculations should be performed every few days so formula volume can be adjusted to accommodate growth. The general target average daily gain for kits is 5% increase of body wt/day while on formula feeding, and 5-10% body wt increase/day on weaning diet (Grant 2005a,b,c).

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 can be started at a diluted concentration, generally at a 1:4 ratio (mixed formula: water) for another 2-3 feedings. It generally takes 48-72 hours to get the animal on full-strength formula by gradually offering higher concentrations. Depending on the species, 3-4 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 is important that the kits 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 kit's body weight (see Table 23).

Table 23: Chart used for determining kcal/day and stomach capacity for various body weights (Grant 2004)

Weight (grams)	MER (kcal/day) [70 x bw (kg)$^{0.75}$ x 3]	MER (kcal/day) [70 x bw (kg)$^{0.75}$ 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

As a general rule, animals should not have an overnight break between feedings 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 kits 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 kit is hungry and suckling vigorously. Weak kits may be hypothermic, dehydrated, and/or hypoglycemic. Do 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% or 5% dextrose to raise glucose level, if necessary. Neonates 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 and 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 needs to suit the neonate's sucking reflex. Also, if a nipple is too stiff, the kit may tire and refuse to nurse.

The neonate should be held 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 kit to push against with its front feet. If milk comes through their nose, the nipple hole may be too large or the kit may be trying to eat too quickly.

If an animal aspirates fluids the recommended protocol is to hold the kit 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, or chemistry. It is possible to start a course of antibiotics while results from the bloodwork 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), including: a) inappropriate milk formula, b) feeding frequency, c) overfilling the stomach, and d) rapid changes in the diet. When digestive upset occurs, characterized by diarrhea, bloating, inappetance, and/or extreme fussiness, it is recommended that one factor is analyzed and/or changed at a time.

Hand-rearing formulas: It is important that the artificial milk formula matches the maternal milk in protein, fat, and carbohydrate composition as closely as possible.

Different formulas and combinations have been used for mustelids. Some experienced hand-rearers recommend using formulas based on goat's milk, because small carnivores cannot absorb the fat globules in cow's milk (Muir 2003). However, the composition of goat's milk varies significantly from that of mustelids. Goat's milk contains 27.7% protein, 31.5% fat, and 34.6% carbohydrates (DM basis). Of the documented mustelid maternal milks, the range for protein is 26-40%, for fat it is 31.2-45.1%, and for carbohydrates it is 7.8-21% (DM basis) (Jenness & Sloan 1970). Goat's milk is up to 31% deficient in protein, and exceeds the carbohydrate content by 1.6-4 times that of mustelids. This excessive carbohydrate level has a great potential to cause gastrointestinal disease if goat's milk is fed alone. Modifications to goat's/cow's milk, by adding egg yolk and gelatin powder to increase protein and fat, has been used with *ex situ* populations of felids in South Africa (Hedberg 2000) and may be adequate as an emergency formula. However, it should be noted that this diet would not be balanced in vitamins and minerals for mustelids. More typically, feline or canine milk replacers are used for hand-rearing mustelids (Muir 2003). It is preferable to use nutritionally complete formulas such as KMR® and Multi-Milk® (or Milk Matrix™ 42/25 + 30/55) should be combined/balanced to match the maternal milk as closely as possible. See Table 25 for maternal milk compositions and recommended hand-rearing formulas.

Table 24: Maternal milk composition and hand-rearing formulas for mustelids (values given are on "as fed" basis. DM basis provided in parentheses)

Species/formula***	Solid%	Fat %	Protein%	Carbs %	Kcal/ml
Badger (maternal milk)[1]	18.6	6.3 (33.9)	7.2 (38.7)	3.5 (18.8)	1.0
Badger (hand-rearing formula)[2] Esbilac (33/40) - 1 part KMR (42/25) - 1 part Water - 3½ parts	18.4	6.5 (35.3)	7.3 (39.7)	3.5 (19.0)	1.02
Hog-nosed skunk (maternal milk)[1]	34.6	10.8 (31.2)	10.8 (31.2)	2.7 (7.8)	1.51
Hog-nosed skunk (hand-rearing formula #1)[2] KMR (42/25) - 1 part Multi-milk (30/55) - 1¼ parts Water - 2¼ parts	28.2	11.4(40.4)	10.1(35.8)	2.5 (8.9)	1.53
Hog-nosed skunk (hand-rearing formula #2)[2] Esbilac (33/40) - 1 part Multi-milk (30/55) - 1/3 part Water - 1½ parts	24.8	11.7(47.2)	8.4(33.9)	2.9 (11.7)	1.51
Mink (maternal milk)[1]	21.7	7.2 (33.0)	5.6 (26.0)	4.6 (21.0)	1.05
Mink (hand-rearing formula #1)[2] Multi-milk (33/40) – 1 part Multi-milk (25/13) – 1/3 parts Water – 2 parts	21.7	6.6 (30.4)	6.9 (31.8)	3.3(15.2)	1.02
Mink (hand-rearing formula #2)[2] Esbilac (33/40) – 1 part KMR (42/25) – 1 part Water – 3 parts	20.8	7.3 (35.1)	8.3 (39.9)	4.0 (19.2)	1.15
Striped skunk (maternal milk)[1]	30.6	13.8 (45.1)	9.9 (32.4)	3.0 (9.8)	1.76
Striped skunk (hand-rearing formula #1)[2] Multi-milk (30/55) - 1 part Non-fat dry milk - 1/3 part Water - 1 1/3 parts	28.2	12.3 (43.6)	8.7 (30.9)	3.1 (11.0)	1.58
Striped skunk (hand-rearing formula #2)[2] KMR (42/25) - ½ part Multi-milk (30/55) - 1 part Water - 1½ parts	27.0	12.4 (45.9)	9.7 (35.9)	2.3 (8.5)	1.59
Striped skunk (hand-rearing formula #3)[2] Esbilac (33/40) - 1 part Heavy whipping cream - ¼ part Water - 1 ¼ parts	25.7	13.8	7.3	3.5	1.68
Wolverine (maternal milk)**	n/a	n/a	n/a	n/a	n/a
Wolverine (**hand-rearing formula)[2] Esbilac (33/40) - 1 part KMR (42/25) - 1 part Water - 3½ parts	18.4	6.5 (35.3)	7.3 (39.7)	3.5 (19.0)	1.02

[1] Jenness & Sloan (1970); [2] Marcum (1997)

** Maternal milk composition is not available for wolverines. Hand-rearing formula for badgers is acceptable for wolverines (n/a = not available).

*** Pet Ag® (manufacture KMR®, Esbilac®, Multi-Milk® and the Zoologic Milk Matrix line: 261 Keyes Ave., Hampshire, IL. 60140, 1-800-323-0877/ 1-800-323-6878 www.petag.com).

The amino acid taurine is present in the colostrum and milk of many mammals, and is present at particularly high levels in the milk of obligate carnivores (Robbins 1993). Domestic cat milk contains 287µmol of taurine in 100ml of milk, and the level in dog milk is 181µmol/100ml of milk (Robbins 1993). This compares with 1.0µmol taurine/100ml in cow's milk. Although the taurine content of mustelid milk has not been documented, it is reasonable to expect a concentration comparable to that of cats and dogs. Many species have the ability to synthesize taurine from other sulfur-containing amino acids, such as cysteine and methionine; obligate carnivores do not. Taurine deficiency results in cardiomyopathy and degeneration of the retina, both of which have been documented in *ex situ* populations of felids (Howard et al. 1987; Burton et al. 1988).

Taurine is not included in the Pet-Ag™ formulas Esbilac (33/40)® or Multi-Milk (30/55)®. At this time, KMR (42/25)® is the only commercial formula with added taurine, because it is an essential amino acid in felids. Chicken baby food and clams/clam juice also are reportedly good sources of taurine (Hedberg 2000). While the mustelid requirement for taurine is unknown at this time, it may be beneficial to supplement milk formulas which do not include KMR®, as part of the base, with taurine. The recommended taurine supplementation for felids is 250mg/animal/day (McManamon & Hedberg 1993).

Weaning: By 5-6 weeks of age, solids should be introduced, either finely ground nutritionally complete meat mix with the formula, or something similar depending on the species (however, chicken has tended to cause diarrhea in some small carnivores). If necessary, this can be offered on the handler's fingers to encourage them to eat. Some experienced handlers recommend that formula should be offered in a bowl as long as the animal will take it. This will ensure the young animal is receiving adequate calcium. However, it is important that the animal is eating its adult diet as well (Muir 2003).

- Ferret: If at all possible it is best to leave kits with the dam. Kits can be left with the jill to continue stimulation of milk production while being fed supplemental milk formula. Puppy (Esbilac®) or kitten (KMR®) milk replacers have both been used with the addition of whipping cream to bring the fat content to 20% (roughly 3:1). A 3cc syringe fitted with a cannula works well until the kit is able to suck from a small pet-nursing bottle. Initial feedings should offer about 0.5cc increasing to ~1.0cc by the end of the first week. By the end of three weeks, the kit should be taking about 6-8cc from the bottle; at this point they can be weaned to a bowl. Initially, kits should be fed every two hours around the clock, gradually reducing the number of night feedings over the next couple of weeks. By three weeks, feedings should be every 3-4 hours and softened adult food may be offered (McKimmey 2002).
- Long-tailed weasel: Long-tailed weasels have been raised successfully from about one month of age using powdered Esbilac® at a 1:2 ratio, Esbilac® to water. The kittens should be fed every two hours ± 30 minutes. While a break of four hours between feedings during the night is acceptable, it is preferable to feed around the clock when kittens are younger, because this species has a very high metabolism (D. DeMyer, personal communication). At approximately 34 ± 2 days, chopped pinkies may be offered at every other feeding in addition to formula. The kittens readily consume solids even though their eyes are not open yet. It is important to ensure a nutritionally complete diet, so pinkies should be supplemented with an appropriate carnivore diet early on. Kittens may be weaned by the time their eyes are open at approximately 45 days. The management techniques important to the successful rearing of this species are (D. DeMyer, personal communication): 1) keeping kittens warm and offering them a choice of temperature (heat lamp, heating pad), 2) providing hiding places (cork bark, pvc pieces, etc.), 3) consistent staff (kittens with their eyes closed can react aggressively to strange smells), and 4) frequent feedings.
- Mink: While the mink are not a species recommended for management by the AZA SCTAG, there has been a great deal of work on this species (e.g., Kaar et al. 1998; Jeppesen et al. 2000; Sorensen et al. 2001), which may be helpful for other closely related species as well.
- Wolverine: General development milestones for mother-reared kits include the following (from an AZA-accredited zoo's records – Table 25):

Table 25: Development of mother-reared wolverine kits

Day	Developmental stage
~15	Coat beginning to change color (face darkening)
18	Doubled in size
26	Eyes beginning to open
33	Beginning to walk
40	Moving around den/sometimes sleeping on own
~53	Climb out of den on own
80	First solid foods
90	Eating solids well

From left to right: Wolverine kits (Institution C) at 1 week, 5-6 weeks, and 3 months of age (Photo credit: L. Monska).

7.6 Contraception

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

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 (Harrenstien et al. 1996; Munson et al. 2002; Munson 2006). Other progestins (e.g., Depo-Provera®, Ovaban®) are likely to have the same deleterious effects. For carnivores, the AZA Wildlife Contraception Center now recommends GnRH agonists, e.g., Suprelorin® (deslorelin) implants (e.g., Bertschinger et al. 2001) or Lupron Depot® (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® was developed for domestic dogs and has been used successfully in many species of otters, mongoose, and ferrets.

Gonadotropin releasing hormone (GnRH) agonists: GnRH agonists (Suprelorin® implants, or Lupron Depot®) 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 mustelids has been conducted.

A drawback of these products is that time of reversal cannot be controlled. Neither the implant (Suprelorin®) nor the depot vehicle (Lupron®) can be removed to shorten the duration of efficacy to time reversals. The most widely used formulations are designed to be effective for 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 (e.g., Calle et al. 1997, 1998), they are more commonly used in females. 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® has been tested primarily in domestic dogs, whereas Lupron Depot® has been used primarily in humans, but should be as effective as Suprelorin®, 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 (e.g., Melengestrol acetate (MGA) implants, Depo-Provera® injections, Ovaban® 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 mustelids, but may cause permanent sterility in many carnivore species after only one or two treatments. This approach 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.

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 approach is not recommended for mustelids.

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. As far as possible, all mustelids should routinely shift into a holding area and readily separate into specific holding areas on cue. Animals should be trained to come to the keeper when called for daily health checks; this is most often accomplished with fencing or a mesh barrier between keeper and animal (i.e., protected contact). A goal should be to have the individual animal calm and not aggressive during these checks. A third important routine husbandry behavior is to have an animal enter a crate on cue; it is a stress-free way to capture and transport the animal (Wooster 1998). The following table (Table 26) provides examples of the types of husbandry behaviors that have been trained with mustelid species. Experience and creativity may lead to more progress in this area See Appendix J for additional training information and examples of trained behaviors and Appendix K for additional resources available on training approaches and behaviors.

Table 26: Commonly trained behaviors – mustelids (American Association of Zoo Keepers (AAZK) Animal Training Committee Survey 2003, Institution O, Institution C, Institution P)

Badger	Skunk (striped and spotted)	Wolverine	African striped weasel	Fisher
Target	Shift	Station	Shift	Target
Shift	Separate	Target	Stand on scale	Crate
Stand on a scale	Target	Separate	Enter a crate/box	Stand on a scale
	Stand on a scale	Shift		
	Harness training	Stand on a scale		
	Enter a squeeze cage/crate	Enter a squeeze cage/crate		
	Tactile desensitization	Flashlight desensitization		
	Present back, belly, paws	Present belly, paws, feet		
	Nail trims			

Keepers should avoid use of aversive stimuli in the daily management of mustelids. 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 mustelids respond to profound aversive stimuli with fear and/or aggression. It is best to keep 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? What is the animal's motivation and how does it relate to the animal's behavior in the wild?) is a useful exercise when training problems occur. Patience and planning are keys to success (Wooster 1998).

Skunk: Skunks are routinely trained for voluntary nail trims; the animals are stationed, standing vertically on their hind legs, against mesh walls (D. Smith-Weber, personal communication).

Animal Management and Exhibit Design: In general, the mustelid species should be trained in a protected contact situation (i.e., keeper and animal should be separated by a mesh barrier); there are some species where an institution feels this precaution may not be called for, but these decisions should be carefully evaluated on an ongoing basis. 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.

When training some of these species, staff should be educated on safe methods of reward delivery. 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; some facilities do not allow hand feeding of skunks (D. Smith-Weber, personal communication).

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).

AZA Accreditation Standard

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

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 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.

The AZA SCTAG stresses the 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. All senses should be involved in any enrichment program (e.g., sight, hearing, touch, and smell), food should be accounted for in the animal's diet, and the exhibit display and its furnishings also should become part of the enrichment program. Successful enrichment techniques include variation of exhibit schedule or exhibit mates (where appropriate only), variation of feeding schedule, re-arranging of exhibit furniture/features, complete 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 to ensure that it encourages species-appropriate behaviors.

The 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 provided (accessed through 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 a 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?
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?
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 animals show signs of allergies to new items (e.g., food, browse, substrates)?
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.

Frequency of Enrichment Provision: 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 with appropriate enclosure designs, substrates, and furnishings may offer ample opportunities for animals to exercise natural behaviors with infrequent enrichment (once daily). Other exhibits or individuals may require more frequent enrichment (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. It is important to note that the provision of well-designed, complex environments is the foundation of a successful enrichment program. Enrichment should also be evaluated to see if it is achieving its goals. All enrichment items should be approved by the appropriate management staff, including the veterinarian, curator, horticulturist, and/or nutritionist.

More Information: Appendix K provides resources for enrichment and training. Appendix L provides a list of enrichment initiatives used at several institutions housing mustelids. All enrichment items should be approved by the appropriate management staff, including the veterinarian, curator, horticulturist, and/or nutritionist. Many of items listed in Appendix L can be used for all of the mustelid species but should be reviewed by animal management and veterinary staff for safety and health concerns.

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.

It is generally desirable to shift mustelids out of an exhibit before entering it; however, experienced personnel may be able to safely work in relatively close proximity to mustelid species provided they know the individual animals involved. Experienced staff can work in large exhibits with wolverine; however, it is preferable that animals are shifted out first. Education animals, such as domestic ferrets and skunks, should only be handled by trained staff and volunteers.

Animal management staff should be encouraged to form a trusting relationship with the animals in their care; this 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 and structure their work routine 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 mustelid species while the public is present should be primarily for educational purposes; interactions with these species due to a medical emergency or for 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 keepers should take care to keep outside the flight distance of the individual animal. This will minimize stress to the animal and the keeper. With some mustelids (e.g., wolverine or badger), it may be necessary to have backup staff present when entering small enclosures with an animal present.

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 list provides general recommendations for technical skills, knowledge, and experience for animal care staff working with mustelids:

- 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'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 mustelid 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 & safety of the animal's exhibit, holding area, and food-prep area.
- Keepers should have the skills to safely capture or restrain the mustelid species in question.
- Keepers should have an understanding of the species natural diet and foraging style.
- Keepers and managers should have an understanding of enrichment concepts and have a commitment to enhance the environments of the species in their care on a consistent basis.
- 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 for 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.

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.

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.

Mustelids used in education programs (e.g., skunks, ferrets) may be housed in somewhat smaller, less complex enclosures, provided the animals are routinely enriched, taken out for exercise and social interaction, and provided with other forms of stimulation, including climbing and play structures. Enclosure sizes should be in compliance with USDA guidelines for laboratory animals (www.nap.edu/readingroom/books/labrats/chaps.html) at a minimum. Currently, AZA Accreditation Standards state that education animals must be cared for by trained staff and housed in conditions that meet the standards set for the remainder of the animal collection. This is interpreted to mean that they must be environmentally and behaviorally enriched.

AZA Accreditation Standards and Related Policies

"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.

Explanation: As stated in the AZA Program Animal Policy, the management of program animals requires special consideration. Although the housing conditions for program animals may look different to those provided to exhibit animals, institutions must ensure that similar social, physical, behavioral and nutritional opportunities are provided to program animals. Providing program animals with control over their environment is essential to ensuring effective care and management" (AZA 2008).

Many factors should be considered in planning for the adequate and appropriate physical and social environment, housing, space, and management of education animals. These include the following: (USDA 2003*, AZA SCTAG committee**, State specific housing requirements, etc.):

- The species of animal and individual characteristics such as age, sex, size, behavior, previous experience and housing, and health*.
- The ability of the animals to form social groups with conspecifics through sight, smell, and possible contact, whether the animals are maintained singly or in groups (two or more)*.
- Design and construction of housing*.
- Enrichment possibilities*.
- Exercise**.
- Animal and handler safety**.
- Socialization for species that may benefit from this**.

- Environmental enhancements – features required to stimulate natural activities, i.e., den boxes, chewing items, etc**.

Based on USDA Lab Animal Regulations (USDA 2003), primary enclosures for animals housed in laboratory conditions should:

- Allow for the normal physiologic and behavioral needs of the animals, including urination and defecation, maintenance of normal body temperature, normal movement and postural adjustments, and where indicated, reproduction.
- Allow conspecific social interaction and development of hierarchies within or between enclosures.
- Make it possible for the animals to remain clean and dry (as is consistent with the species typical behavior).
- Allow adequate ventilation.
- Allow the animal access to food and water and permit easy filling, refilling, changing, servicing, and cleaning of food and water utensils.
- Provide a secure environment that does not allow escape of or accidental entrapment of animals or their appendages between opposing surfaces or by structural openings.
- Be free of sharp edges or projections that could cause injury to the animal.
- Allow easy observation of the animals without disturbing them.

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 program animal demonstration (AZA Accreditation Standard 1.5.3).

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

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

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

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.

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

(S1.5.11) 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.

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).

The only mustelid species routinely used in education programs are the domestic ferret and striped skunk. The AZA SCTAG has no requirements specific to the maintenance of these species but does highly recommend an active enrichment program and access to an exercise/play area at least once a day when possible. At this time the AZA SCTAG has not collected information on how ferrets are used in programs or how they are housed. This also is true for skunks, except for the program use note below. Staff working with skunks are vaccinated for Rabies as a precaution. Note: Some institutions report that skunks are "prone" to diabetes. No additional information is available at this time but this should be investigated by the SCTAG in the future.

Skunk programs:

- An institution consulted with a facility that had two skunks for outreach programs. The female showed aggressive behavior in the springtime. She would try to bite if someone tried to pick her up. They trained a "hands off" routine. First they trained her to target, then self load into a crate. For the program she would be released from the crate, walk to a flat bowl with dirt in it and dig in the dirt; next she would walk to a garbage bag. ("We stuffed the bag with newspaper. Made a whole in the bottom and taped a plastic container to the inside. We then placed a shelled almond in the container and covered it with balled up paper.") She would fling the paper aside to get the almond. It looked just like a wild skunk invading the trash. After she ate the almond she would load herself back into a crate. The objective of this routine was demonstrating how skunks can get into human trash and why they sometimes end up at wildlife facilities.

Conservation Messages: Small carnivores are among the least known and understood carnivores. Many have rarely been seen by biologists with new subspecies and occasionally species still being discovered (1986 a new Herpestid species, the giant striped mongoose (*Galidictis grandidieri,*) was discovered in Madagascar). Good resources for information on small carnivores include: IUCN Small Carnivore Specialist Group (www.smallcarnivores.org) and the IUCN Red List of Threatened Species (www.iucnredlist.org).

Wolverine: This species is managed as an SSP by the AZA SCTAG and is not considered a candidate for education programs. However, the stationing of "talking signs" at wolverine exhibits can help interpret the species to the visiting public. The IUCN lists this species as Near Threatened for the following reasons:

> "Justification: This species is listed as Near Threatened as although Wolverine occurs at low density and many Wolverine populations appear to be relatively small and isolated (Ruggiero et al. 2007 missing reference), there is evidence of resurgence in some places of its historical distribution (Rowland et al. 2003). Thus although there is an overall continued decline due to human persecution and land-use change, the global decline of this species is not at a rate sufficient (30% over 3 generations, or 18 years) to qualify for Vulnerable (A2cd) at this time. However, the European Mammal Assessment determined that the European Wolverine is currently Vulnerable (A2c), thus the Near Threatened listing is driven by the estimation that some large populations remain in north Asia and North America. Wolverines still face some threats such as overexploitation through hunting and trapping, predator poisoning programs and habitat resource extraction that caused the contraction of wolverines' historical range. More data on population trends, especially in north Asia, may result in this species being re-assessed as Vulnerable in the near future (Abramov et al. 2008)."

Wolverines were never common, in fact they are believed to have been less common than wolves historically. They have disappeared over much of their range due to persecution and human disturbance. This species requires a large home range (100km^2 to 600km^2), has tremendous physical endurance and is capable of traveling up to 40 miles a day looking for food.

> "Wolverines inhabit a variety of habitats in the alpine, tundra, taiga, and boreal forest zones. They are found in coniferous, mixed, and deciduous woodlands, bogs, and open mountain as well as tundra habitats (Mitchell-Jones et al. 1999). Snow is generally regarded as an important

component of the wolverine's seasonal habitat requirements (Banci, 1987; Hatler, 1989). Wolverine habitat selection is negatively affected by human activity, including roads, infrastructure, and backcountry recreation (May et al., 2006; Krebs et al. 2007)" (Abramov et al. 2008).

Wolverines are valued in Alaska as a symbol of the wilderness and for their fur which is used to trim parkas and for hoods. The wolverine guard hairs resist the build-up of frost. They are primarily scavengers with strong jaws capable of breaking up frozen bones. Their reputation of ferocity is greatly overstated. (Alaska Fish and Game 2009) Refer to the IUCN Red List of Threatened Species (www.iucnredlist.org/details/9561/0) for additional information on wolverine status and threats to N.A. populations.

Fisher: This species, listed by IUCN as Least Concern, is held by only a few institutions and is not routinely used in education programs. However, the stationing of "talking signs" at fisher exhibits can help the visiting public interpret the species. The IUCN Red List web site (www.iucnredlist.org) provides excellent information, including the following:

"During the 19th and early 20th centuries the fisher declined over most of its range because of excessive fur trapping and habitat destruction through logging. Aubry and Lewis (2003) state that over trapping appears to have been the primary initial cause of fisher population losses in southwestern Oregon. The high value of the skins, the ease of trapping fishers (Powell 1993), year-round accessibility in the low to mid-elevation coniferous forests, and the lack of trapping regulations resulted in heavy trapping pressure on fishers in the late 1800s and early 1900s (Aubry and Lewis 2003). Timber harvest can fragment fisher habitat, reduce it in size, or change the forest structure to be unsuitable for fishers. Habitat loss and fragmentation appear to be significant threats to the fisher.

There are currently efforts underway to implement a conservation strategy to reintroduce the fisher into its former range along the Pacific Coast. Genetic data indicate that British Columbia would be the most appropriate source population for future translocations that may be necessary to recover populations in Washington and portions of Oregon and California (Drew et al., 2003 In Press). The species is protected in large tracts of habitat in areas well distributed throughout the range. The primary conservation measure necessary is to prevent excessive harvest (Reid and Helgen 2008)."

Tayra: In some areas of tropical America this species is kept to protect homes and belongings from rodents (Schreiber et al. 1989).

Polecat (domestic ferret): Originally kept and used for hunting in the Old World, *Putorius* evolved into the domestic ferret. While predominantly replaced by the domestic cat, the ferret is still used in some parts of Europe and northwest Africa to hunt rabbits (Schreiber et al. 1989).

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.

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® sponsored research, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials (AZA Accreditation Standard 5.3).

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.

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 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.

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 Plans®.

Research methodologies used on mustelids include:

Behavior

- Audet, AM. 1998. Behavior of the tayra, Eira barbara (Carnivora: Mustelidae) in captivity. Zoologische Garten 68(5):300-320. An ethogram of tayra constructed based on literature search and behavioral observations of 1.1 tayra at the National Zoo.

Conservation

- Ericsson, G; Kindberg, J; Bostedt, G. 2007. Willingness to pay (WTP) for wolverine Gulo gulo conservation. Wildlife Biology 13(2), 2007, 2-12. Investigated willingness of Swedish citizens to pay for conservation; surveys were used.

Diet

- Van Dijk, J; Hauge, K; Landa, A; Andersen, R; May, R. 2007. Evaluating scat analysis methods to assess wolverine Gulo gulo diet. Wildlife Biology 13(2) 2007, 62-67. Using two wolverines they evaluated four widely used methods of quantifying dietary composition: dry weight, index of relative contribution, frequency of occurrence, and percentage of occurrence.
- Lofroth, EC; Krebs, JA; Harrower, WL; Lewis, D. 2007. Food habits of wolverine Gulo gulo in montane ecosystems of British Columbia, Canada. Wildlife Biology 13(2):31-37. Examined seasonal food habits of wolverine living in montane forests.

Genetic

- Cegelski, CC; Waits, LP; Anderson, NJ; Flagstad, O; Strobeck, C; Kyle, CJ. 2006. Genetic diversity and population structure of wolverine (Gulo gulo) populations at the southern edge of their current distribution in North America with implications for genetic viability. Conservation Genetics 7(2):197-211. Levels of genetic diversity and population genetic structure were examined in three states (Idaho, Wyoming, and Montana) and two Canadian provinces (Alberta and British Columbia) using both mitochondrial (mtDNA) and nuclear microsatellite DNA.

Health

- Harrington, RD; Baszler, TV; O'Rourke, KI; Schneider, DA; Spraker, TR; Liggitt, H; Knowles, DP. 20008. A species barrier limits transmission of chronic wasting disease to mink (Mustela vison). Journal of General Virology. 89(4), April 2008, 1086-1096.
- Gage, LJ. 2005. Use of buspirone and enrichment to manage aberrant behavior in an American badger (Taxidea taxus). Journal of Zoo & Wildlife Medicine 36(3):520-522.

Reproduction

- Hedmark, E; Persson, J; Segerstrom, P; Landa, A; Ellegren, H. 2007. Paternity and mating system in wolverines Gulo gulo. Wildlife Biology 13(2):13-30.
- Persson, J. 2005. Female wolverine (Gulo gulo) reproduction: reproductive costs and winter food availability. Canadian Journal of Zoology 83(11), November 2005 1453-1459. Looked at reproductive rates of food-supplemented and non-supplemented females.
- Larivière, S; Hwang, YT; Gorsuch, WA; Medil, SA. 2005. Husbandry, Overwinter Care and Reproduction of Captive Striped Skunks (Mephitis mephitis). Zoo Biology 24:83-91.

10.2 Future Research Needs

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

Chapter 1: Ambient Environment

Section 1.2. Light**:** Currently there are no data on the impact of varying light intensity or type of light (fluorescent versus natural) on these species; this is an important topic for future research.

Section 1.3. Water and Air Quality**:** While a coliform count of 100 (human standard) is currently considered acceptable for pools used by semi-aquatic species (mink), this is an area that requires future research.

Section 1.3. Water and Air Quality**:** The pH tolerance for mustelids is not known, however, it is not likely to be important for species that do not habitually go in the water (this should be researched in the future).

Section 1.4. Sound**:** 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 information available on the maximum duration of transport involving mustelids. Information on the health status of animals taken before and after transportation will provide useful information on how individuals coped with transportation durations of different lengths.

Chapter 4: Social Environment

Section 4.1. Group Structure and Size**:** More research is needed to determine how changes in life stage variation in patterns of social affiliation affect the management of mustelid species. General information collected on the behavioral changes associated with different life stages that affect social interactions needs to be collected and disseminated.

Section 4.2. Influence of Others and Conspecifics**:** In general, mustelids are not good candidates for mixed species exhibits. It is possible that skunks may be an exception to this general rule, but more information is needed on whether there have been successful mixed exhibits for this species, and which species they were successfully housed with.

Section 4.3. Introductions & Reintroductions**:** The use of training techniques in the management of the mustelid species has not been explored as thoroughly as in some of the other mammal and avian species, but should be explored further in the future, especially in relation to animal introductions.

Chapter 5: Nutrition

Section 5.1. Nutritional Requirements**:** Further research is necessary at this time to determine whether mustelid species show seasonal changes in nutritional requirements, and how these changes will influence the type of diet provided.

Chapter 6: Veterinary Care

Section 6.1. Veterinary Services**:** For the continuing evaluation of mustelid 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 mustelids, and the AZA Small Carnivore TAG requests this where possible. See Appendix H for additional information.

Chapter 7: Reproduction

Section 7.1. Reproductive Physiology and Behavior**:** Many of the mustelid species experience embryonic diapause, and several are believed to be induced ovulators. More research is needed to determine which species show these reproductive traits, and how these physiological adaptations can be accommodated in the daily management of breeding animals.

Section 7.2. Assisted Reproductive Technology**:** Techniques used to preserve and freeze semen has been achieved with a variety, but not all, taxa and should be investigated further.

Section 7.5. Contraception**:** Research on the effects that GnRH agonists have on future reproductive abilities when provided to prepubertal mustelids is needed, as current research is based on studies using domestic cats.

Chapter 9: Program Animals

Section 9.1. Program Animal Policy**:** Research into how mustelid species are used for education programs is required. Research on how these animals are housed and zoonotic precaution measures used also is required.

Acknowledgements

The AZA SCTAG and animal care coordinator for the AZA SCTAG would like to express thanks to the many AZA members and non-AZA members who contributed their expertise to the creation of these guidelines. We also would like to thank Dr. Joseph Barber for his help during this long and arduous process. It is important to note that the recommendations contained in this manual are fluid and may need to be modified to incorporate new knowledge and to offer best practice care to particular individual animals. The most important thing to remember is to know your animals and pay attention to their individual needs. Questions regarding any of the information contained in this manual may be directed to Jan Reed-Smith (lontracat@live.com) or Dusty Lombardi (dusty.lombardi@columbuszoo.org).

For additional information on small carnivores, their conservation and care as well as ongoing research, we recommend the IUCN/SSC Small Carnivore Specialist Group web site at: www.smallcarnivores.org or the SCTAG web site at: itech.pjc.edu/sctag.

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Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to mustelids 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®.
5. Animals may be acquired temporarily for reasons such as, holding for governmental agencies, rescue and/or rehabilitation, or special exhibits. Animals should only be accepted if they will not jeopardize the health, care or maintenance of the animals in the permanent collection or the animal being acquired.
6. The institution must have the necessary resources to support and provide for the professional care and management of a species, so that the physical and social needs of both specimen and species are met.
7. Attempts by members to circumvent AZA conservation programs in the acquisition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to acquire SSP species and adhere to the AZA Full Participation policy.
8. Animals are only to be acquired from sources that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this policy. Any convictions of state, federal, or international wildlife laws should be reviewed, as well as any previous dealings with other AZA-accredited institutions.
9. When acquiring specimens managed by a PMP, institutions should consult with the PMP manager.
10. Institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved Regional Collection Plans (RCPs) when making acquisition decisions.

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

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

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

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

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

1. Dispositions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all dispositions.
3. Any disposition must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics. Specifically, "a member shall make every effort to assure that all animals in his/her collection and under his/her care are disposed of in a manner which meets the current disposition standards of the Association and do not find their way into the hands of those not qualified to care for them properly."
4. Non-domesticated animals shall not be disposed of at animal auctions. Additionally, animals shall not be disposed of to any organization or individual that may use or sell the animal at an animal auction. In transactions with AZA non-members, the recipient must ensure in writing that neither the animal nor its offspring will be disposed of at a wild animal auction or to an individual or organization that allows the hunting of the animal.
5. Animals shall not be disposed of to organizations or individuals that allow the hunting of these animals or their offspring. This does not apply to individuals or organizations which allow the hunting of only free-ranging game species (indigenous to North America) and established long-introduced species such as, but not limited to, white-tailed deer, quail, rabbit, waterfowl, boar, ring-necked pheasant, chukar, partridge, and trout. AZA distinguishes hunting/fishing for sport from culling for sustainable population management and wildlife conservation purposes.
6. Attempts by members to circumvent AZA conservation programs in the disposition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to deacquisition SSP species and adhere to the AZA Full Participation policy.
7. Domesticated animals are to be disposed of in a manner consistent with acceptable farm practices and subject to all relevant laws and regulations.
8. Live specimens may be released within native ranges, subject to all relevant laws and regulations. Releases may be a part of a recovery program and any release must be compatible with the AZA Guidelines for Reintroduction of Animals Born or Held in Captivity, dated June 3, 1992.
9. Detailed disposition records of all living or dead specimens must be maintained. Where applicable, proper animal identification techniques should be utilized.
10. It is the obligation of every loaning institution to monitor, at least annually, the conditions of any loaned specimens and the ability of the recipient to provide proper care. If the conditions and care of animals are in violation of the loan agreement, it is the obligation of the loaning institution to recall the animal. Furthermore, an institution's loaning policy must not be in conflict with this A/D Policy.
11. If live specimens are euthanized, it must be done in accordance with the established policy of the institution and the Report of the American Veterinary Medical Association Panel on Euthanasia (Journal of the American Veterinary Medical Association 218 (5): 669-696, 2001).
12. In dispositions to non-AZA members, the non-AZA member's mission (stated or implied) must not be in conflict with the mission of AZA, or with this A/D Policy.
13. In dispositions to non-AZA member facilities that are open to the public, the non-AZA member must balance public display, recreation, and entertainment with demonstrated efforts in conservation, education, and science.
14. In dispositions to non-AZA members, the AZA members must be convinced that the recipient has the expertise, records management practices, financial stability, facilities, and resources required to properly care for and maintain the animals and their offspring. It is recommended that this documentation be kept in the permanent record of the animals at the AZA member institution.
15. If living animals are sent to a non-AZA member research institution, the institution must be registered under the Animal Welfare Act by the U.S. Department of Agriculture Animal and Plant Health Inspection Service. For international transactions, the receiving facility should be registered by that country's equivalent body with enforcement over animal welfare.
16. No animal disposition should occur if it would create a health or safety risk (to the animal or humans) or have a negative impact on the conservation of the species.

17. Inherently dangerous wild animals or invasive species should not be dispositioned to the pet trade or those unqualified to care for them.
18. Under no circumstances should any primates be dispositioned to a private individual or to the pet trade.
19. Fish and aquatic invertebrate species that meet ANY of the following are inappropriate to be disposed of to private individuals or the pet trade:
    a. species that grow too large to be housed in a 72-inch long, 180 gallon aquarium (the largest tank commonly sold in retail stores)
    b. species that require extraordinary life support equipment to maintain an appropriate 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 a PMP, institutions should consult with the PMP manager.
21. Institutions should consult WCMC-approved RCPs when making disposition decisions.

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

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

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

Appendix C: 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 70ºC (-94°F) - frost-free freezer or a -20ºC (-4°F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

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

Quarantine Procedures**:** The following are recommendations and suggestions for appropriate quarantine procedures for Mustelid/Mustelidae:

Mustelid/Mustelidae:

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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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: Accreditation Standards for Mustelids

The following specific standards of care and recommendations relevant to mustelids are taken from the AZA Accreditation Standards and Related Policies (AZA 2008):

Housing For Education Animals: As some mustelid species are commonly used as education or program animals, institutions must comply with the following AZA Accreditation Standard:

"*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. Explanation: As stated in the AZA Program Animal Policy, the management of program animals requires special consideration. Although the housing conditions for program animals may look different to those provided to exhibit animals, institutions must ensure that similar social, physical, behavioral and nutritional opportunities are provided to program animals. Providing program animals with control over their environment is essential to ensuring effective care and management*" (AZA 2008).

Transport: The standards of care identified in Chapter 3 are based on IATA regulations (IATA 2007). Institutions transporting mustelids are obliged to abide by these regulations as stated in the following AZA Accreditation Standard:

"*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*" (AZA 2008).

Quarantine: "*Quarantine, hospital, and isolation areas should be in compliance with standards/guidelines adopted by the AZA*" (AZA 2008)

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 … 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."

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 -70ºC (-94°F) freezer or a -20ºC (-4°F) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation. The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination."

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for small carnivores:

Required	**Strongly recommended**
1) Direct and floatation fecal exam	1) CBC/sera profile
2) Vaccinate as appropriate	2) Urinalysis
	3) Appropriate serology (FIP, FeLV, FIV)
	4) Heartworm testing in appropriate species

Appendix G: Description of Nutrients

Adapted from 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 H: Small Carnivore Medical Management Guidelines

Small Carnivore Medical Management Guidelines
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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 cinereus*), black-footed ferrets (*Mustela nigripes*), and red pandas (*Ailurus fulgens*). A list of veterinary advisors may be found at 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).
- 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® (InfoPet Inc., 415 W. Travelers Trial, Burnsville, MN 55337-2548); and 2) AVID® (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 be 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 is 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® 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 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® (Biocor Animal Health Inc., 2720 North 84th 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®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® 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® Feline Panleukopenia Vaccine (Biocor Animal Health Inc., 2720 North 84th 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, Ithica, 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 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 -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^3, section if necessary
   B. Place in cryovial
   C. Label with Animal, ID#, Date, Institution, Sample type
   D. Freeze **immediately** at -70°C (-94°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 -70°C (-94°F)

Appendix I: AAZV Recommendations for PUREVAX™ Ferret Distemper Vaccine

The following information contains background information and recommendations for the use of Merial's new PUREVAX™ ferret distemper vaccine in exotic carnivores:

Merial's new PUREVAX™ Ferret Distemper Vaccine which is now on the market, is a univalent, lyophilized product of a recombinant canary pox vector expressing canine distemper virus antigens. The vaccine cannot cause canine distemper under any circumstances and its safety and immunogenicity have been demonstrated by vaccination and challenge tests in susceptible ferrets. Pet ferrets appear to be susceptible to post-vaccinal hypersensitivity reactions however, and a low incidence (0.3%) of reversible anaphylactic reactions occurred in field safety trials carried out by Merial.

The same vaccine was provided by Merial under a special USDA permit to the AAZV Distemper Vaccine Subcommittee (via Dr. Dick Montali) for field trials at zoos and wildlife facilities between 1997-2001. The vaccine was used mostly for animals housed outside with a risk of exposure to canine distemper. Species vaccinated included giant pandas, red pandas, raccoons, coatis, cacomistles, maned wolves, channel island foxes, fennec foxes, cusimanses, otters, lions, tigers, pumas, cheetahs, and clouded leopards. In general, immunogenicity appeared to be favorable with some intraspecific variations and no untoward local or systemic reactions.

Titers to canine distemper virus in dogs and ferrets are generally lower with recombinant vaccines than with modified live products, and there is a cellular immune component in the recombinants, which apparently enhances immunogenicity. Thus, lower titers (e.g., below 100) do not necessarily indicate lack of protection.

Merial's Ferret Distemper vaccine contains no adjuvants, which in other vaccines have been associated with localized skin reactions and possibly tumors in other species. Recommendations for use of Merial's PUREVAX Ferret Distemper Vaccine in exotic carnivores are 1ml of reconstituted vaccine 2-3 times at 3-week intervals, followed by a yearly booster. This vaccine SHOULD BE GIVEN I/M instead of S/Q in exotic carnivores for increased effectiveness.

PUREVAX™ Ferret Distemper vaccine is recommended for use by the AAZV Distemper Vaccine subcommittee for all exotic carnivore species that are susceptible to canine distemper virus. Because of its high demonstrated safety record and inability to induce canine distemper as with earlier attenuated vaccines, any possible risks are considered minimal. However, as with any off-label use of a biological product, the vaccine should be given with the descretion of the user. Users are also encouraged to obtain pre and post vaccinal titers where possible and to report any new observations with this product to Dr. Dick Montali (montalir@nzp.si.edu).

Appendix J: Commonly Trained Behaviors for: Mustelids, Procyonids, and Viverrids - AAZK

Animal Training Committee AAZK, Inc.

Commonly Trained Behaviors for: Mustelids, Procyonids, and Viverrids

Purpose of the list and source of the data:
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.

Survey results pertaining to the list of behaviors:
219 AZA facilities were surveyed. There were 71 respondents. 31 of these train species within the Mustelid, Procyonid and Viverid 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 train each behavior is listed next to the behavior.

Facility Differences and Individual Animals*:*
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.

The ATC hopes that these data (following page) 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. For questions or comments about this list or the Trained Behaviors Survey, please contact the AAZK Animal Training Committee at www.aazk.org.

MUSTELIDS			
Otter (river, small clawed, & sea)		**Skunk (striped and spotted)**	
Shifting	83%	Shifting	33%
Separations	66%	Separations	17%
Target	79%	Target	67%
Scale	59%	Scale	33%
Squeeze entry/crate	76%	Harness training	17%
Anal/genital present	7%	Crate/Squeeze entry	83%
Back	10%	Nail trim	33%
Belly	21%	Back	17%
Ears	7%	Belly	17%
Eyes	14%	Paws/feet	33%
Head presentation	14%	Tactile desensitization	50%
Mouth	21%	Station	17%
Paws/feet	52%		
Sides	10%	**Badger**	
Oral meds	21%	Shifting	100%
Brushing teeth	3%	Target	0
Injection w/ syringe	7%	Scale	0
Stethescope	3%		
In-water behaviors	31%	**Wolverine**	
Vocalization	7%	Belly	50%
Stay (hold)	10%	Paws/feet	50%
Retrivals	17%	Separations	100%
Station	59%	Shifting	100%
Fecal Collection	7%	Station	50%
A to B	10%	Squeeze/crate	50%
Climb	24%	Flashlight desensitization	50%
Flashlight	7%	Scale	50%
X-ray	3%		
Opthalmoscope	3%		
Blood collection	3%		

Appendix K: Resources for Enrichment and Training Information

Resources for Enrichment and Training
(S. Maher)

Enrichment

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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. Website: 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. Website: www.enrichment.org
The American Association of Zoo Keepers Enrichment Committee: www.aazk.org
Disney Animal Kingdom: www.animalenrichment.org
AAZK Enrichment Notebook 3rd ed. 2004 ISBN1-929672-11-X, www.aazk.org/2004enrichnotebookcd.php.
Fort Worth Zoo's Enrichment Online: www.enrichmentonline.org/browse/index.asp

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Appendix L: Mustelid Enrichment Ideas – AZA Member Institutions

The following lists provide examples of mustelid enrichment items. All items should be approved by facility management, including the appropriate curator, veterinarian, nutritionist, and horticultural staff.

Ferret/polecat

Sensory

- Crickets in escape-proof container
- Snake shed
- Spices and scents
- Urine/trapping lures
- Bath & Body Works lotions & sprays
- Diluted extracts
- Perfume pages from magazines
- Paper, paint, stickers on outside of window
- Sun catcher outside enclosure
- Diluted Eucalyptus oil (5 drops/gal. water)
- Diluted essential oils
- Mirror mobile outside exhibit
- Audio tapes
- Baby mirrors (unbreakable)
- Hooves (monitor)
- Feathers (frozen for 30 days)
- Non-toxic bubbles
- Herbs, spices
- Camel hair/wool (frozen for 30 days)
- Squirrel call
- Hand held or box fan (outside of exhibit)
- Pinwheels outside exhibit
- Disco ball outside exhibit

Foods and feeding

- Cardboard box with
- Food inside
- Buster food cube
- Pinecone
- Egg carton puzzle feeder
- Small bones
- Wax worms in a feeder
- Bones (monitor)
- Crazy ball feeder
- Feed bag with diet (remove liners)
- Hay or leaves
- Boomer ball puzzle feeder
- PVC bug feeder
- Piñatas
- Frozen fruit pops
- Nyla bones/Healthy edibles
- Kong toy with diet
- Carved pumpkin with diet
- Burlap bag with insects
- Live fish in water tub
- Applesauce smears
- Coconut feeder
- Peanut butter smears

Manipulative items/toys

- Balls with/without bells inside
- Kong toy
- Antlers
- Seashells
- Paper materials to shred
- Cardboard boxes/tubes
- Tennis ball
- Small boomer ball
- Pine cones
- Burlap pillows
- Phone books
- Wiggly giggly ball
- Fire hose
- Furry mouse cat toy - supervised
- Small stuffed animals with detachable parts
- Ferret ball

Physical environment

- Exercise inside/outside with supervision
- Straw bedding
- Large cardboard tubes to crawl through
- Exercise ball to crawl through
- 5” PVC pipe to crawl through
- Articles of clothing (sleeves, pant leg)
- Pool with small amount of water (supervised)
- Shredded paper
- Ferret hammock
- Varied substrate, soil
- mulch, etc.
- Snow, sod, sand
- Large hamster ball
- Linen bed sheets
- Frisbee swing suspended with twine

Behavioral/social

- Training programs
- View of decoy animals
- Taken around the zoo to see other animals
- Shredded paper for bedding

Fisher

Sensory
- Bison fur
- Scents
- Feathers
- Sheep wool

Foods and feeding
- Tuna-sicles
- HB eggs
- Mice
- Cylinder feeder
- Quail

Manipulative items/toys
- Pumpkins
- Cardboard boxes
- Paper leaf bags
- Rope toys

Physical environment
- Pine trees
- Antlers
- Box of straw
- PVC tubes

Skunk

Sensory
- Crickets in escape proof container
- Snake sheds
- Scents
- Urine/trapping lures
- Bath & Body Works lotions & sprays
- Diluted extracts
- Perfume pages from magazines
- Audio tapes
- Mirror (unbreakable)
- Hooves (monitor)
- Feathers (frozen 30 days)
- Squirrel call
- Sun catcher outside enclosure
- Diluted essential oils
- Hand-held or box fan outside of exhibit
- Pinwheels outside exhibit
- Bird calls
- Mirror mobile outside exhibit
- Non-toxic bubbles
- Herbs, spices
- Camel hair/wool (frozen 30 days)

Foods and feeding
- Cardboard box, ball, feeders with diet
- Buster food cube
- Pinecone
- Egg carton puzzle feeder
- Crazy ball feeder
- Feed bag with diet (liner removed)
- Peanut butter smears
- PVC insect feeder
- Piñatas
- Nyla bones/healthy edibles
- Kong toy with diet
- Carved pumpkins with diet
- Burlap bags with insects
- Live fish in tub
- Applesauce smears
- Coconut feeder

Manipulative items/toys
- Kong toy
- Small stuffed animals with detachable parts
- Antlers
- Paper bags, paper to shred
- Tennis balls
- Small boomer ball
- Ferret ball
- Pine cones
- Burlap pillows
- Cardboard boxes/tubes
- Phone books
- Wiggle giggly ball
- Fire hose
- Klinker ball

Physical environment
- Exercised inside/outside with supervision
- Large drain pipe to crawl through
- Pool with small amount of water (supervised)
- Varied substrate – sand, shredded paper, sod, etc.
- Visual barrier
- Hammock

Behavioral/social
- Training programs
- View of decoy animals
- Taken around the zoo to see other animals

Wolverine

Sensory

- Bengay ointment in a boomer ball
- Logs from other exhibits
- Urine scents, lures
- Spices and extracts
- Burlap bags with scented straw
- Bison, pronghorn, moose, elephant feces
- Deodorant spray
- Feathers
- Pig ears, cow hooves
- Reindeer antlers
- Pronghorn sheaths
- Hair from other species
- Education animals allowed to use exhibit while wolverines are in holding, then allowed back into exhibit after the animals has been removed

Foods and feeding

- Frozen mice, rats, fish hidden around exhibit
- Liver
- Rats and mice (dead)
- Rabbit (dead)
- Knuckle, shank & rib bones
- Super worms & crickets
- Live crayfish & fish
- Pumpkins, apples, grapes, HB eggs
- Rat/Mouse sickles
- Blood popsicles
- Anchovy (fish) paste
- Tuna fish
- Beef heart
- Clams and krill
- Hot dogs and chunk meat

Manipulative items/toys

- Paper towel/toilet paper rolls with food inside
- Paper bags with food inside
- Cardboard boxes with food inside
- Burlap bags with straw or treats
- Cornstalks
- Sod
- Snow piles
- Ice cubes
- Sleeping platforms
- Logs to climb on
- Wood box filled with stones/sod/straw to search for treats in
- Yellow pages, paper to shred
- Shredded paper, wood wool for bedding
- Hay from hoofstock exhibits
- Water tubs

Physical environment

- Sleeping platforms with bedding
- Digging boxes/pits
- Climbing structures
- Rock piles
- Deep dirt to tunnel in
- Hollow logs
- Stone piles
- Mud wallows

Behavioral/social

- Training programs
- Visual access to other species
- Climbing and digging opportunities

Appendix M: Common Diseases Affecting Mustelids

This table is intended as a list of diseases observed in mustelids and associated clinical signs; it is not intended as a comprehensive table. For proper treatment and management the reader is referred to more extensive medicine texts such as: Fernandez-Moran (2003),[1] Lewington (2007),[4] and Oglesbee (2006).[6] For an extensive review on the infectious disease agents that affect NARO and may affect other mustelids refer to Kimber and Kollias (2000).[2]
The last column lists the species in which the disease has been reported; other species may also be susceptible. Adapted from Fernandez Moran (2003).[1]

Viral Diseases	**Transmission**	**Clinical signs**	**Diagnosis**	**Species reported**
Rabies	Contact of infected saliva with mucosal surface or open wound	In ferrets signs are usually mild and non-specific: anxiety, lethargy and posterior paresis. Should be considered in any animal with outdoor access with neurologic signs.	Can only be diagnosed definitively post mortem. Histopath on brain.	All warm blooded animals are susceptible
Canine Distemper	Aerosol exposure or direct contact with conjunctiva, nasal exudates, urine or feces	Anorexia, vomiting, diarrhea, weight loss, hyperemia of face and ears, hyperkeratosis of nasal planum and footpads, oculonasal discharge, neurologic signs	Immunofluorescent antibody test or PCR of conjunctival swab. Histopath exam of affected tissue. 100% fatal to ferrets	Domestic ferret, BFF, badgers, weasels, skunks minks, martens, Eurasian otter
Influenza (type A)	Inhalation of aerosolized droplets	Sneezing, conjunctivitis, otitis (unilateral), fever, photophobia, naso-ocular discharge	Clinical signs and presence of HI antibodies (hemo-agglutination inhibition test)	Domestic ferret and mink. Also one Stone marten reported to have been infected with H5N1.[3]
Aleutian Disease (*Parvoviridae*)	Infected	Weight loss, hypergamma-globulinemia, reproductive failure, hemorrhagic enteritis and immune mediated glomeruloeohritis.	Gammaglobulin >20% serum total protein, IFA test.	Mink, ferret, striped skunk (typically of farmed mink)
Ferret kit disease (*Rotavirus*)	Affects kits. Can become enzootic at a facility.	Watery diarrhea, anorexia and lethargy.	Identification of viral particles in fresh feces	Ferret
Infectious peritonitis (*Coronavirus*)	Unknown, recently reported disease	Diarrhea, granulomatous lesions	Biopsy, immunohistochemistry	Ferret[5]

Bacterial Disease	Transmission	Clinical Signs	Diagnosis	Species reported
Salmonellosis (*Salmonella spp*)	Associated with feeding uncooked meat. Can be found in some clinically normal animals	Hemorrhagic enteritis, dehydration, weight loss, fever, lethargy	Culture of fresh feces	Many species
Tuberculosis *(M. tuberculosis)*	Inhalation of aerosolized particles, ingestion of contaminated tissues	Weight loss, enlarged lymph nodes, chronic respiratory disease.	PCR, direct examination of tissue and culture	Usually only a problem in free-ranging badgers from the UK and in from free ranging ferrets in New Zealand.
Campylobacteriosis (*Campylobacter jejuni, C. coli*)	Raw meat diets carry some risk of infection, ferrets may be asymptomatic carriers	Diarrhea, tenesmus, fever anorexia vomiting, leukocytosis, abortion	Fecal culture	Ferret and mink
Botulism (*C. botulinum*)	Ingestion of contaminated food. Associated with capture stress in wild otters	Death, paralysis and dyspnea before dying. Enerotoxemia, acute gastric distension, cyanosis	Fecal Gram stain and toxin assay	Otter and black footed ferret.
Pneumonia (*various agents*)	Due to a number of organisms, concurrent infection with calici and picornavirus can predispose.	Thick yellowish nasal discharge, labored breathing, dyspea, cyanosis, fever, lethargy, anorexia	Increased lung sounds, complete blood count results, culture, cytology.	Most mustelids

Fungal Disease	Transmission	Clinical Signs	Diagnosis	Species reported
Dermatomycosis	Direct contact or fomite transmission. Exposure to cats	Lesions resemble those seen in other species (Young animals most at risk. Skin is thickened itchy and scaly). Ferrets are not prone to skin mycotic disease, but some species of dermatophytes could present a zoonotic risk.	Definitive diagnosis is done by culture.	Most species

Parasitic Disease	Transmission	Clinical Signs	Diagnosis	Species reported
Toxoplasmosis	Exposure to sporulated oocysts, ingestion of intermediate host or ingestion of uncooked infected meat.	Anorexia, lethargy, fever, lymphadenitis, spenomegaly, corneal edema, myocarditis, hepatitis, pneumonitis	Antibody titers	BFF highly susceptible. NARO reported to have had titers.
Coccidiosis (*Isospora, Eimeria spp*)	Fecal oral	Often asymptomatic. If affected lethargy, diarrhea, dehaydration, weight loss	Fecal examination	European otter,[7] Ferret, mink.[4]
Lungworm	Transmission can be direct, by ingestion of L1 in feces or sputum of infected animals or indirect by ingestion of the intermediate host depending on the species of lungworm involved.	Cachexia, anemia, coughing, dyspnea, hyperpnea, nasal discharge, neurological signs.	First stage infective larva in fecal exam	Mink, skunk, sable, Eurasian badger, otter, ermine.
Kidney worm	Lifecycle is complex and not completely known. Involves annelids as first intermediate host and freshwater crustaceans, mollusks and fish as second intermediate hosts.	Weight loss hematuria, polyuria and other signs associated with renal failure	Necropsy finding- usually in the right kidney	Mink, otter, weasel, ermine, marten, fisher, and grison.
Tapeworms and roundworms.	Mustelids may be susceptible to them, usually not a problem in *ex situ* situations with a regular endoparasite control program in place.		Fecal exams (sedimentation and floatation)	
Microfliaria spp	Bite from infected mosquito	Respiratory and cardiac signs. Not all microfilaria infections develop into clinical disease	Clinical signs, finding microfilaria in blood smears.	River otters
Sarcoptic mange	Exposure to infected animals	Scabs around head and neck, tail, feet.	Finding the mites in skin scrapings or biopsy	Most mustelids
Fleas	Fleas can transfer from other animals. Although fleas tend to prefer their specific host.	Signs may vary from asymptomatic to flea bite allergy. Pruritus, inflammation. In young or sick animals with heavy infestation also anemia. May what?	Finding fleas or flea dirt in the coat,	Most mustelids
Ticks	As with other mammals	Itching, May transmit other diseases.	Finding ticks on animals. Others in group may be affected	Many

Non-infectious Disease	Risk factors	Clinical Signs	Diagnosis	Species reported
Excertional myopathy	Recent stressful, capture,immobilization, transport of wild animals	May vary. Elevated temperature, dark colored urine (myoglobinuria), ataxia, weakness, depression, elevated muscle enzymes in serum.	Urinalysis, blood chemistry, physical exam.	Badger, otter, black footed ferret.
Teeth abscesses	Cage trauma (biting), tartar and calculus build-up	Decreased appetite, facial swelling, weight loss,	Radiographs, physical examination	Otters
Urolithiasis	Diet and genetics may play a role. Sterile urolithiasis, more common in domestic ferret, but UTI may predispose. Most common: struvite, cystine.	Signs depend on location, number, and size of urolith and may include asymptomatic, polakyuria, dysuria, hematuria, staining of perineal area, urine dribbling, signs of pain when obstructed	Abdominal radiographs, urinalysis (pyuria, hematuria, changes in pH),	Small-clawed otter is particularly susceptible. Also reported in mink, ferret, Eurasian otter, domestic ferrets
Amyloidosis	Was reported in a relatively large number of black footed ferrets and may point toward a genetic predisposition.	Relate to specific site of amyloidosis accumulation. Can include anorexia, lethargy, sign of renal disease	Histologic evaluation of tissues submitted	Black-footed ferrets
Thiamine (Vit B1) deficiency	Thiaminase present in some fish	Anorexia, salivation, ataxia, papillary dilation, sluggish reflexes	Response to treatment	Piscivorous species (mink on raw fish diet)
Post-estrous anemia	Estrus that persists for over one month	Non-regenerative anemia, ecchimoses, bleeding,	CBC- aplastic anemia, vulvar discharge	Ferrets
Pancreatic cancer (insulinoma)	High incidence in domestic ferrets.	Hind leg weakness, blank look, staring drooling, nausea, as the disease progresses seizures as well	Blood tests for fasting low blood sugar. See texts referenced above for test details and risks	Ferrets
Adrenal neoplasia (adrenocortical carcinoma).	High incidence in America ferrets	Alopecia, pruritus, vulvar swelling in sterilized jills, sexual behavior (aggression in males), weight loss,	Clinical signs, ultrasound, sometimes palpation is possible, abdominal exploratory surgery. Dexamethasone suppression test ACTH stimulation test not reliable in ferrets.	Ferrets
Lymphoma	Unknown, potentially viral origin	Lymphadenopathy, respiratory distress (if ay organs in the chest cavity are involved)	Histopathology of enlarged lymph nodes or other affected organs biopsied, cytology of fine needle aspirate of enlarged organs may be of limited value.	Ferrets

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Appendix N: SCTAG General Necropsy Protocol and Forms

Small Carnivore TAG Necropsy Protocol

I. Recommended Fixed tissues. In addition collect a sample of any lesion. Fix in 10 parts10% neutral buffered formalin to 1 part tissues, samples should be no thicker than 1 cm, and should be fixed for at least 72 hrs 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 - **marrow must be exposed**)
27. Thyroids/parathyroids
28. Brain (if possible whole)
29. Pituitary
30. Both eyes

II. 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)

Small Carnivore SSP Necropsy Form

Institution\Owner

_____

Address

_____

City_____State_____Zip

Country

_____

Veterinarian

_____

Pathologist/Prosector _____

Phone# ( ) _____

Fax# ( ) _____

I. Historical Data (Attach additional sheets as needed & attach pertinent medical records.)

Species: _____

Stud Book#	ISIS#		
Age/Birth date: _____ (Circle) Actual or Estimated	Sex (Circle) M F	Weight: _____Kg (Circle) Actual or Estimated	Acquisition: (Circle) Captive Born or Wild Captured
Date & Time of Death_____ post mortem interval _____hrs Site/Enclosure_____			
1. Was animal euthanized? (Circle) Y or N If so, what method? _____ 3. Member of Group? (Circle) Y or N Number in Group_____ # Sick_____ # Dead _____ 4. Vaccinations: _____			
Additional History: (Signs, stress factors, previous disease, treatments, pertinent feed or feed additives, time period animal was on premises, clinical lab results).			

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).