



Otter
(*Lutrinae*)
CARE MANUAL

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

Otter (Lutrinae) Care Manual

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

This nutrition chapter is an excerpt
from the complete Animal Care
Manual available at the
Association of Zoos and Aquariums
(AZA)'s website:

[http://www.aza.org/animal-care-
manuals/](http://www.aza.org/animal-care-manuals/)

Further information about diets and
the nutrition of this and other species
can be found at the

AZA's Nutrition Advisory Group
(NAG)'s website:

<http://nagonline.net>

5.1 Nutritional Requirements

A formal nutrition program is recommended to meet the behavioral and nutritional needs of all animals (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of veterinarians as well as AZA Taxon Advisory Groups, Species Survival Plans®, and Nutrition Advisory Groups (www.nagonline.net/feeding_guidelines.htm).

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.

Diet formulation criteria should address the otters' nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

The target nutritional values for otters are based on several sources. The cat is typically used to establish nutrient guidelines for carnivorous animals. The National Research Council (NRC) (1986, 2006), Association of American Feed Control Officials (AAFCO) (1994), and Waltham Center for Pet Nutrition (Earle & Smith 1993) have provided recommendations for cats. A limited amount of information is provided by the NRC publication for mink and foxes (1982), which represents the requirements of another mustelid species. The target nutrient values presented (Maslanka & Crissey 1998) are a range of values reported from various references. As new information becomes available, these ranges will change to reflect knowledge gained. Table 5.1.1 lists dietary nutrient ranges for otters.

Table 5.1.2 contains updated information on feline nutritional requirements based on NRC recommendations published in 2006. The original target values have been retained for comparison. See Dierenfeld et al. (2002) for information on nutrient composition of whole vertebrate prey. Appendix H provides a description of the nutrients listed in these tables.

Diet formulation should account for animal preferences, body weight, exercise, physical condition, environmental/seasonal changes, behavioral considerations, diet item availability, gastrointestinal tract morphology, and actual nutrient requirements.

Primarily piscivorous, otters have high metabolic rates, rapid digestion, and have been found to spend 41-60% of their time involved in feeding or foraging activities (Hoover & Tyler 1986; Davis et al. 1992; Kruuk 1995; J.Reed-Smith, unpublished data). Duplaix-Hall (1975) found that otters (unidentified species) in the wild rarely ate more than about 500 g of food at a time and that they consumed approximately 20% of their own body weight daily. Kruuk (1995) reviewed his and other study results indicating that *ex situ* populations of *Lutra lutra* consuming between 11.9-15% of their body weight maintained a healthy weight. Ben-David et al. (2000, 2001a and b) reported success using 10% of a *L. canadensis* (*ex situ* population) body weight as a guide for the basis of their maintenance diet. See section 5.2 for sample diets for the various otter species.

Table 5.1.1: Target dietary nutrient ranges for otters (dry matter basis).

Item	Target nutrient range*
Energy, kcal/g	3.6-4.0
Crude Protein, %	24-32.5
Fat, %	15-30**
Vitamin A, IU/g	3.3-10***
Vitamin D, IU/g	0.5-1.0
Vitamin E, mg/kg	30-120 ^a
Thiamin, mg/kg	1-5 ^a
Riboflavin, mg/kg	3.7-4.0
Pantothenic Acid, mg/kg	5-7.4
Niacin mg/kg	9.6-40
Pyridoxine, mg/kg	1.8-4.0
Folic acid, mg/kg	0.2-1.3
Biotin, mg/kg	0.07-0.08
Vitamin B-12, mg/kg	0.02-0.025
Choline, mg/kg	1000-3000
Calcium, %	0.6-0.8 ^b
Phosphorus %	0.6 ^b
Potassium, %	0.2-0.4
Sodium, %	0.04-0.06
Magnesium, %	0.04-0.07
Zinc, %	50-94
Copper, mg/kg	5-6.25
Manganese, mg/kg	5.0-9.0
Iron, mg/kg	80-114
Iodine, mg/kg	1.4-4.0

* Target nutrient ranges expressed on a dry matter basis derived from requirements for domestic cats (NCR 1986), AAFCO recommendations (1994), Waltham Center for Pet Nutrition recommendations (Earle & Smith 1993), and requirements for mink and foxes (NCR 1982).

** The fat content of fish commercially available in N.A. typically ranges from 5–40% (Maslanka & Crissey 1998), and N.A. river otters have been maintained on diets containing 24-30% fat (Reed-Smith 1994), thus an appropriate range for fat appears to fall between 15-30%.

*** The vitamin A requirement for cats is 10 IU/g (dry matter basis; NRC 1986), which represents the upper bound of the range. However, free-ranging N.A. otters consume a higher proportion of fish and may have a higher tolerance for vitamin A due to the high levels, which occur in their natural diet.

^a When mostly fish diets are offered, the presence of unsaturated fatty acids and thiaminases causes the breakdown of these vitamins. Thus, dietary levels of 400 IU vitamin E/kg of dry diet and 100-120 mg thiamin/kg of dry diet or 25-30 mg thiamine/kg fresh weight as fed basis are recommended (Engelhardt & Geraci 1978; Bernard & Allen 1997).

^b The recommended Ca:P ration is between 1:1 and 2:1

Table 5.1.2: Target nutrient ranges for carnivorous species (dry matter basis)

	NRC 1986 Cat ¹	NRC 2006 Cat ²		Arctic fox ³	Mink ⁴	Carniv ⁵	
Nutrient	Maintenance	Growth	Maintenance	Gestation Lactation	Maintenance	Maintenance	All
Protein (%)	24-30	22.5	20	21.3-30	19.7-29.6	21.8-26	19.7-30
Fat (%)	9.0-10.5	9.0	9.0	15.0	--	--	9-15
Linoleic Acid (mg/kg)	0.5	0.55	0.55	0.55	--	--	0.5-0.55
Vitamin A (IU/g)	3.3-9.0	3.55	3.55	7.5	2.44	5.9	2.44-9
Vitamin D (IU/g)	0.5-0.75	0.25	0.25	0.25	--	--	0.25-0.75
Vitamin E (mg/kg)	27-30	38.0	38.0	38.0	--	27.0	27-38
Vitamin K (mg/kg)	0.1	1.0	1.0	1.0	--	--	0.1-1
Thiamin (mg/kg)	5.0	5.5	5.6	5.5	1.0	1.3	1-5.6
Riboflavin (mg/kg)	3.9-4.0	4.25	4.25	4.25	3.7	1.6	1.6-4.25
Niacin (mg/kg)	40-60	42.5	42.5	42.5	9.6	20.0	9.6-60
Pyridoxine (mg/kg)	4.0	2.5	2.5	2.5	1.8	1.6	1.6-4
Folacin (mg/kg)	0.79-0.8	0.75	0.75	0.75	0.2	0.5	0.2-0.8
Biotin (mg/kg)	0.07-0.08	0.075	0.075	0.075	--	0.12	0.07-0.12
Vitamin B ₁₂ (mg/kg)	0.02	0.022	0.022	0.022	--	0.032	0.02-0.032
Pantothenic acid (mg/kg)	5.0	6.25	6.25	6.25	7.4	8.0	5-8
Choline (mg/kg)	2400	2550	2550	2550	--	--	2400-2550
Calcium (%)	0.8-1.0	0.8	0.29	1.08	0.6	0.3-0.4	0.29-1.08
Phosphorus (%)	0.6-0.8	0.72	0.26	0.76	0.6	0.3-0.4	0.26-0.8
Magnesium (%)	0.03-0.08	0.04	0.04	0.06	--	--	0.03-0.08
Potassium (%)	0.4-0.6	0.4	0.52	0.52	--	--	0.4-0.6
Sodium (%)	0.05-0.2	0.14	0.068	0.132	--	--	0.05-0.2
Iron (mg/kg)	80.0	80.0	80.0	80.0	--	--	80
Zinc (mg/kg)	50-75	75.0	75.0	60.0	--	--	50-75
Copper (mg/kg)	5.0	8.4	5.0	8.8	--	--	5-8.8
Manganese (mg/kg)	5.0	4.8	4.8	7.2	--	--	4.8-7.2
Iodine (mg/kg)	0.35-0.42	2.2	2.2	2.2	--	--	0.35-2.2
Selenium (mg/kg)	0.1	0.4	0.4	0.4	--	--	0.1-0.4

¹ NRC (1986), Legrand-Defretin and Munday (1993), AAFCO (1994). All numbers are based on requirement set for maintenance.

² Dog and Cat NRC (2006).

³ NRC (1982). Protein is range of growth and maintenance; vitamins are for growth, and minerals for growth and maintenance.

⁴ NRC (1982). Protein is for maintenance, vitamins are for weaning to 13 weeks and minerals are a range of growing and maintenance.

⁵ Combination of cat, mink, and fox

Changing Nutrient Requirements – Age: An animal's diet should be developed to maintain optimal weight or weight gain and normal physical development for a young animal. Diets for young or senescent adults should take into account their activity level, dental development and/or condition.

***P. brasiliensis*:** In an *ex situ* population study, Carter and Rosas (1997) determined that an adult consumed roughly 10% (range 6-16%) of their body weight daily and a sub-adult consumed 13.4% (range 8-18.9%). Earlier studies (Zeller 1960; Best 1985) reported similar findings with adults and sub-adults daily consuming 7-9.6% and 12.9% of their body weight, respectively. Amounts eaten can vary with air temperature and activity level changes, but if food is refused for one day, this could be a sign of sickness. Excess weight gain or loss and daily amounts and food types eaten should be monitored and recorded (Sykes-Gatz 2005).

Changing Nutrient Requirements – Reproduction: There is an increased need for energy during lactation. Tumanov & Sorina (1997) supported the use of high-energy diets for lactating female mustelids. Fat is the most concentrated source of energy in the diet. For lactating females, fat levels in the diet may be increased to support lactation (see below for exceptions) and also to provide increased energy to minimize mobilization of body stores and metabolic stress associated with milk production. Diet increases for lactating otters should be based on past experiences with individual otters and/or observed body weight loss (mobilization of tissue to support lactation). To date, institutions have typically increased the amount of fish offered a lactating female versus simply increasing the fat content by switching the type of food offered. An increase of 10-30% is the accepted rule.

P. brasiliensis: Hagenbeck and Wünnemann (1992) reported that lactating females at the Hagenbeck Tierpark generally increased their food consumption from 4.41-6.61 lb/day to 13.23 lb/day (2-3 kg/day to 6 kg/day). They also reported increasing vitamin supplements during pregnancy/lactation and calcium supplementation during lactation (Sykes-Gatz 2005).

The energy requirements of a pair of otters, including a pregnant female, at the Institution U also increased during pregnancy and lactation. At this time, the energy intake of the pair increased to 246 kcal/kg BW^{0.75} (~2.75 kg fish/animal fed at a ratio of 1:2 low- to high-fat fish). Fifty days postpartum and with one surviving pup, the intake of the pair was 236kcal/kg BW^{0.75} (~3kg fish/animal fed at a ratio of 1:4 low- to high-fat fish). The female exhibited a preference for herring, trout, and catfish (K.Lengel, personal communication). It appears that feeding behaviors of *ex situ* populations of reproductive *P. brasiliensis* mimic those of their wild counterparts. Rosas et al. (1999) found that during the birthing season, the diet of wild otters included a higher proportion of fish in the order Siluriformes (catfishes), which are higher in fat (37-41% fat DMB – Silva 1993) than fish in the order Percoidei (perch) (22-31% fat DMB – Twibell & Brown 2000), which are commonly fed on in the wild. Siluriformes are also higher in fat than Cichlidae (tilapia) (21-32% fat DMB – Toddes 2005-2006 analysis), which are the low-fat fish commonly fed to otters at Institution U.

Due to the giant otters requirement of “fish higher in fat during gestation and pup rearing, [Institution U feeds] gestational diets 3xBMR in the last month of pregnancy” which appears to support the dam’s requirements (B. Toddes personal communication). Toddes further reports: “Although dry matter intake increases during late gestation and lactation, it does not increase proportionately with energy need. The addition of high fat fish such as herring and catfish greatly increases the percentage of fat (energy) in the diet, without drastically increasing the amount of fish the animal needs to consume. The dam when given the choice between high and low fat fish consumes high-fat fish preferentially (personal communication).”

Toddes points out that “quantifying the needs of a reproductive group – especially one with multiple litters – is difficult. The specific needs of an individual reproductive animal will vary with exhibit size and temperature as well as with the dynamics of the group.” She further states that once a female giant otter has produced a litter she will likely always be in a stage of gestation or lactation. As a guide, she offers the following chart; however, this should be adjusted for the needs of the specific individual.

Table 5.1.3: Energy Guide for feeding adult female giant otters

Energy Guide for feeding adult female giant otters, BMR is calculated using Klieber’s equation $70 \times (BW_{kg})^{0.75}$ B. Toddes			
Life Stage	Estimated Energy Need	Target BW (kg)	Energy Need (kcal)
Maintenance	2 – 2.5 x BMR	25	1565 – 1957
Late Gestation	3 x BMR	29	2624
Lactation	3.0 – 7 x BMR	29	2624 – 6123

In general, dam and pups are fed ad lib. Typically, pups will begin sampling the group’s food as early as 3 months of age; this needs to be accounted for in amounts offered. Typically, the Institution U includes the pups’ needs within the dam’s allotment until they are ~9 months old (B. Toddes personal communication). Thereafter, the pups daily diet allotment is calculated separately (on paper only, they are fed as a group). It also is important that the high energy needs of the sire (as much as 5.5 x BMR during pup rearing) and older siblings is accounted for. For this reason the group always should be closely monitored to ensure that enough energy is provided for all group members (B. Toddes personal communication).

Table 5.1.4: Energy guidelines for post-weaning giant otters

Energy guidelines for Post-weaning otters, BMR is calculated using Klieber’s equation $70 \times (BW_{kg})^{0.75}$ B. Toddes			
Age	Estimated Energy Need	Typical BW (kg)	Energy Need (kcal)
9 – 12 months	5 x BMR	15 – 20	2667 – 3310
Juvenile (12 – 18 months)	4 x BMR	18 – 22	2446 – 2844
Young adult (18 – 24 months)	2.25 – 2.5 x BMR	20 – 24	1489 – 1897
Adult maintenance (24+ months)	2 – 2.25 x BMR	24 – 28	1518 – 2130

Seasonal Changes in Nutritional Needs: An animal's weight should be monitored regularly and diets adjusted accordingly. Some institutions report seasonal changes in appetite of some otters, but not in the majority of animals. Further research in this area is required. An animal's weight should be regularly monitored and diets adjusted accordingly. At this time, further research into seasonal nutritional requirements is required.

***P. brasiliensis*:** The energy needs of *P. brasiliensis* are very dependent on their life stage, social grouping, and the ambient temperature of the environment. At Institution U, an average energy intake of 173 kcal/kg BW^{0.75} (~2 kg of fish fed at a ratio of 3:1 low- to high-fat fish) was adequate to maintain a single adult otter within a target weight range during the warmer months of the year (K.Lengel, personal experience).

When maintained with a mate, the same animal required an increased energy intake from 173 kcal/kg to 201 kcal/kg BW^{0.75} (2.75 kg of fish fed at a ratio of 3:1 low- to high-fat fish) during warmer months and went as high as 243 kcal/kg BW^{0.75} (2.75 kg of fish fed at a ratio of 2:1 low- to high-fat fish) during cooler months (K.Lengel, personal experience).

A group of two adults, an 18-month old juvenile male, and three 6-month-old pups were successfully maintained during the summer season on an average energy allotment for the group of 545 kcal/kg BW^{0.75} (~6 kg fish/animal fed at a ratio of 1.25:1 low- to high-fat fish). This energy allotment exceeded that of previous intake studies by almost double. However, the group was extremely active and primarily comprised of growing adolescent animals.

Weight Loss: While otters should carry some body fat and not be kept artificially thin, they are prone to gaining excessive weight in zoos and aquariums. Tarasoff (1974) reported subcutaneous fat deposits primarily at the base of the tail and caudally on the rear legs, with smaller deposits around the genitalia and in the axillary regions. There are several ways to approach formulating a weight loss diet for otters. Depending on the food items available, the feeding situation (fed alone or in a group), and the amount of weight loss desired, one or more of the following approaches may be appropriate.

Feed less total food: By reducing the amount of total food offered, weight loss may occur. This practice is confounded by the aggression observed in most otters, and particularly *A. cinereus* and *P. brasiliensis* groups, around feeding time and the potential for this to increase when less food is offered.

Add more water to the diet: By providing a diet that contains more moisture, the total calories in the diet are diluted and this may allow for weight loss. The otter can consume the same amount of total diet, but will actually be consuming fewer calories.

Increase the "bulk" of the diet: By adding indigestible or lower calorie items to the diet, the total "bulk" of the diet can be increased, effectively diluting the calories in the diet. The otter can consume the same amount of total diet, but will actually be consuming fewer calories.

Offer lower calorie items: Lower calorie items can be substituted in the diet. For example, fish varies in energy content from species to species. If weight loss is desired, a leaner fish, such as Pollock, could be substituted for a fattier fish, such as herring or capelin, to reduce total calories in the diet. This would be the preferred method for all otter species fed fish.

5.2 Diets

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

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

If browse plants are used within the animal's diet or for enrichment, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants

AZA Accreditation Standard

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

AZA Accreditation Standard

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

AZA Accreditation Standard

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

are safe for the species. If otters have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available. Before any plants are placed in or near otter exhibits, they should be vetted through relevant management staff (e.g. curator, veterinarian, grounds keeper, county poison control officer, etc.). Plants considered toxic to humans or other animals should be considered toxic to otters. Loquat (Weber and Garner 2002) consumption has proven fatal to Asian small-clawed otters (see useful Veterinary References). Otters are obligate carnivores but they will eat some vegetative matter such as berries and/or consume vegetation or other foreign material out of boredom or while exploring their environment.

Sample Diets: The one best diet for any of the otters of *ex situ* populations has not been found and requires further research. However, current recommendations for all but *A. cinereus* are that a variety of fish species should be offered 3-4 times a week, preferably daily. Currently the AZA Otter SSP recommends a specific diet for *A. cinereus* (see below) and that *P. brasiliensis* should be offered fish daily as their main diet. The AZA Small Carnivore TAG chair should be contacted for specifics regarding the *A. cinereus* diet.

A. cinereus: The following food items represent the recommended daily diet per animal for *A. cinereus* (AZA Otter SSP recommendation 2006). The items are given as percentage of diet fed:

- 54.5% commercial canned diet designed to meet the nutrient requirements for domestic cats and control occurrence of calcium oxalate uroliths (e.g., Hill's x/d[®], IAMS Moderate pH/O[®]).
- 2.5% commercial dry food to meet nutrient requirements for domestic cats and control occurrence of calcium oxalate uroliths (e.g., Hill's x/s[®], IAMS Moderate pH/O[®]).
- 17.4% capelin
- 24.6% lake smelt
- 1% cricket and meal worms
- 100 IU vitamin E per kg of fish offered
- 25-35 mg thiamin per kg of fish offered

A. capensis: The following food items represent a sample daily diet per animal for *A. capensis* in *ex situ* environments.

- 182 g Dallas Crown Carnivore Diet
- 908 g fish (herring, capelin, sardines, two choices daily)
- 1.5 dozen large crayfish a week
- 30 g lamb & rice dry dog food
- 90 IU vitamin E
- 6.25 mg thiamin

L. canadensis: The amounts of food items in the sample diet below are based on achieving a target weight for otters. The diet should be fed at least three times a day and 4-5 times if possible. These additional feedings can consist of the fish, rib bones, and enrichment/training feeds.

- 155 g commercially prepared feline diet, 2 x day, 7 days a week
- 112 g capelin, 1 x day
- 120 g smelt, 1 x day
- 135 g trout, 1 x day
- ½ medium carrot, 1 x day scattered
- 2 rib bones, ox tail, or similar 3 x week
- 25-35 mg thiamin per kg of fish offered
- 100 IU vitamin E per kg of fish

Only good quality, mostly fresh water fish, low in thiaminase and fat should be offered (Wünnemann 1995a). The fish source(s) and/or vendor(s) should be examined closely to assess their handling practices, ensure that HACCP guidelines are being met, and that the fish is considered human grade. Historical use of a type of fish by zoos and aquariums does not ensure it is an adequate diet ingredient, and only careful inspection of handling practices and the fish itself ensures consistent safety and quality. Most diets currently include horsemeat products, or alternative beef-based products which are available in addition to nutritionally complete dry and wet cat foods. The following sample diet is recommended for *L. canadensis*:

- 13.5% capelin
- 14.5% smelt
- 16.3% herring
- 18.2% carrots

- 37.5% nutritionally complete cat food or beef-based product (IAMS® cat food used for analysis)
- 2 bones, 3 per week (rib, ox/horse tail, or similar)
- 25-35 mg thiamin and 100 IU vitamin E per kg of fish fed

L. maculicollis: The following food items represent a sample daily diet per animal for *L. maculicollis*. The animals should be fed at least twice per day:

- 50 g Iams® Less Active Cat Kibble
- 150 g Natural Balance zoo carnivore diet
- 150 g trout (3 x week)
- 120 g squid (3 x week)
- Yams and carrots offered in small amounts.

P. brasiliensis: A variety of good quality, fresh-water fish low in thiaminase and fat should be offered as the main diet (Wünnemann 1995a). Saltwater fish, high in fat, should only be offered occasionally. Institution U reports that the feeding of high quality fish species similar to those the giant otter has evolved to predate has “proven to be both well received and to maintain the animals in excellent condition”. This species should be fed 3-5 times daily. Some institutions feed 4 to 8 times or more daily and never less than 4 times per day (Institution T) as fewer feedings increases agitation, undesirable vocalizations, and decreases focus on the trainers. Typically, 2-3 kg (4.4-6.6 lb) of fish should be fed daily to each adult. Results of a survey of facilities housing this species indicate that all of these institutions offer fish daily (thawed, frozen, live, and/or freshly caught) as the main diet. Fish species offered include the following: rainbow trout* (*Salmo gairdneri*), carp (*Cyprinus carpio*), river fish (unidentified), tilapia, redeye (*Rutilus rutilus*), common bream (*Abramis brama*), herring* (*Culpea harengus*), mackerel* (*Scomber scombrus*), felchen (*Coregonus albula*), and channel catfish (*Ictalurus punctatus*). Fish species marked with an asterisk (*) can be used as a training reward or for vitamin delivery; other species used occasionally for rewards are catfish and small tilapia (Institution T). If thawed frozen fish constitute the bulk of the diet the otters should be given supplementary B₁ (thiamine) and vitamin E. Supplements should be fed separately from the main feedings by at least 2 hours (Sykes-Gatz 2005). This delay in feeding of supplements may not be necessary and is not practiced by all institutions (Institution T).

For all otters: Fish types containing high thiaminase and/or high polyunsaturated fat levels should be avoided as they can cause malnutrition, sickness, and even death (Merck 1986). Diets containing fish high in thiaminase can lead to thiamin (vitamin B₁) deficiency in the otters fed this diet (Merck 1986). The process of fish storage (freezing), thawing, and preparation, can lead to fish nutrient loss, particularly vitamins B₁ and E, and especially in fish with high fat and/or high thiaminase content (Crissey 1998; Merck 1986). Vitamin supplements, especially vitamin B₁ (thiamin), vitamin E, and a multivitamin, should be added when fish is the main diet. The recommended vitamin supplementation regime for fish eating animals is as follows:

- Thiamin: 25-30 mg/kg fish fed, fresh weight as fed basis (Bernard & Allen 1997)
- Vitamin E: 400 IU/kg dry weight basis (Engelhardt & Geraci 1978)

Based on the information above, the following food items represent a sample diet for giant otters (Sykes-Gatz 2005):

- 2-3 kg (4.4-6.6lb) fish/day/adult
- 400 IU vitamin E daily
- 100 mg vitamin B₁ daily
- Multi-vitamin/mineral supplement 3 x week
- Note: Other institutions (Institution T) offer Vitamin E 3 x week; Vitamin B₁ daily and Multivitamin daily

Feeding Schedule: Due to their naturally nutrient dense diet, reliance on fat as a source of energy, rapid transit time of food through the intestinal tract, feeding style of frequent, small amounts, and generally high activity level – it is recommended that otters be fed at least twice a day and preferably three or more times daily (including enrichment or training feeds). *P. brasiliensis* should be fed 3-5 times per day. Frequent feeding prevents consumption of spoiled food, accommodates their rapid digestion (Ormseth & Ben-David 2000), and can stimulate increased activity in these generally active and curious species.

In addition to feeding smaller amounts frequently, it is recommended that a portion of the daily diet be fed as part of enrichment or husbandry training activities. At least one of the daily feedings, or part of a feeding, should be scattered to encourage foraging (except for giant otter). Timing of foraging

opportunities and items offered should be varied to prevent habituation. All uneaten food should be removed before it spoils; this may be daily or more frequent in warm climates or seasons.

P. brasiliensis: Sykes-Gatz recommends that food for *P. brasiliensis* should not be scatter fed, as they do not forage on land and non-living food left uneaten in pools can be difficult to find. However, some institutions report that they frequently scatter feed without a problem. Fish is hidden in enrichment devices on land and in the water (Institution T). A portion of the daily diet can be used for daily training sessions with this species.

Food Variability: Otters should routinely be offered a variety of fish either as part of their diet or as enrichment. Reliance on multiple fish species, versus one or two, will prevent animals from developing strong preferences and help in switching them over to new sources if one fish type becomes unavailable.

With the exception of *P. brasiliensis* (see below), otters will sample a variety of food groups, especially if introduced to them at an early age; cat kibble, worms, crickets, vegetables, berries, mice, chicks, etc., can all be added to the diet as enrichment. Due to the possible formation of uroliths, foods high in calcium oxalates should be avoided (e.g., beans, celery, leafy greens, sweet potato, berries, peanuts, among others), particularly for *A. cinereus*. The use of these items for enrichment scatter feeds for North American river otter is acceptable on a limited basis, but the overall nutrient and caloric intake, body weight of the animal(s), and condition of the animal(s) should be taken into consideration.

All otters will benefit from receiving live fish/crayfish (from approved sources), at least as enrichment on a weekly basis. Whole fish should be the sole dietary item offered to *P. brasiliensis* and should comprise a portion of the daily diet of all other species.

A. cinereus: The AZA Otter SSP has specific diet recommendations for this species that should be obtained from the AZA Otter SSP Chair

A. capensis, *L. canadensis*, and *L. maculicollis*: It is recommended that fish constitute at least a portion of the daily diet offered these species. Hard dietary items should be routinely incorporated for dental health. These can include: hard kibble, crayfish, crabs, chicken necks, ox/horse tails, partially frozen fish, bony fish, day-old chicks, mice, rib bones, canine dental bones, or similar items.

P. brasiliensis: Staib (2002) reports that wild giant otters almost exclusively eat fish. In the wild, fish from the suborders Characoidei (characins), Percoidei (perch), and Siluroidei (catfish) make up the majority of the giant otter diet (Carter & Rosas 1997). A variety of good quality, fresh-water fish low in thiaminase and fat should be offered as their main diet (Wünnemann 1995a). Saltwater fish, high in fat, should only be offered occasionally. Gravid fish have caused diarrhea and appetite loss, and fish eggs should be removed before feeding (V.Gatz, personal observation). This species should be fed 3-5 times daily (typically 2-3 kg [4.4-6.6 lb] fish/day/adult) (Sykes-Gatz 2005). A small amount of left over food is common and desirable to ensure all members of the group receive their portion and to avoid fights over fish. Uneaten fish should be regularly removed to prevent the otters from consuming spoiled food (Sykes-Gatz 2005). The strategy of feeding animals multiple times per day and using at least some feedings as training sessions has been successful at maintaining animal weights and maintaining low levels of food aggression in the group (Toddes 2005-2006). Institution T reports the feeding of live fish has promoted foraging and hunting skill use. They also have successfully used a "fish launcher" that sends fish into the deep pool.

Species-appropriate Foraging and Feeding: Live fish and crustaceans can and should be provided, if possible, on a regular basis. However, due to the risks of live fish or crayfish transmitting disease or parasites, policies regarding the feeding of live prey should be established by each facility. If these items are used, they should be obtained only from known, institutionally approved sources. Where live prey are used, provisions in the exhibit should be made to allow these prey species a place to hide from the otters, thus forcing the otters to use their hunting skills and extending the time of activity.

There also are a variety of puzzles and other feeding devices described in the literature that can be adapted for use in river otters. Alternatively, feeding tubes can be built into exhibits that randomly release live prey or food items into the exhibit. See Chapter 8, section 8.2 for other enrichment items used, including non-food items.

5.3 Nutritional Evaluations

The AZA Otter SSP is currently beginning work on a body-condition matrix that can be used to help assess proper weight and condition for otters (See Appendix O for working matrix draft). At this time there are no known tools for performing clinical nutritional evaluations of otters; this would be a useful area for future research.

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. Also, conception is not guaranteed.

At this time AI is not used in any otter species but semen collection techniques and preservation are being researched by Bateman et al. (2005, 2009).

7.3 Pregnancy and Parturition

It is extremely important to understand the physiological and behavioral changes that occur throughout an otter's pregnancy. This information is contained in Section 7.1.

7.4 Birthing Facilities

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is "baby-proofed." This information is contained in Section 7.1.

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.

Hand-rearing may be necessary for a variety of reasons: rejection by the parents, ill health of the mother, or weakness of the offspring. Careful consideration should be given as hand-rearing requires a great deal of time and commitment (Muir 2003). Before the decision to hand-rear is made, the potential for undesirable behavioral problems in a hand-reared adult should be carefully weighed (e.g., excessive aggression towards humans (rare in most otters), 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 to another facility, exposure to species-specific sounds, etc. At this time, the AZA Otter SSP is recommending hand-rearing of all otter species, if necessary.

Pups that have been abandoned by their mother should be removed as soon as possible to prevent infanticide. See Chapter 6, section 6.5 for a 'Neonatal Examination and Monitoring Protocol'. Offspring that are not receiving milk will be restless, possibly calling continuously, 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 a problem with her or the pups (Muir 2003). If it is necessary to remove offspring because of an exceptionally large litter, it is best to remove two of the largest pups. 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 on humans than if they have a conspecific to play with (Muir 2003). The AZA Otter SSP recommends that singleton pups being hand-reared be placed together, if at all possible. To date, fostering has been attempted once with otter pups and was successful. A pup was taken from a female with no milk and sent to another facility where their female was already nursing pups. In these cases, the AZA Otter SSP management team should be consulted first. Other institutions have been successful at supplement feeding pups left with their mother. Young otters removed for hand-rearing should not routinely be reintroduced to the parents with an expectation of acceptance. Introductions of hand-reared animals should follow procedures specified in the Introduction/Reintroduction section.

Physical Care Protocol: Incubators provide the best source of warmth. Heat lamps are too intense and can be dehydrating. In an emergency, hot water bottles wrapped in a towel may be placed in a box with the pups nestled next to it, or they can be warmed slowly by placing them next to your body (Muir 2003). Pups may feel more secure if wrapped in layers of towels; this also aids in keeping them warm (Muir 2003). Pups should be dried after feeding/bathing to prevent hypothermia until they are proficient at self-grooming. The normal body temperature for pups is unknown, but the animal should feel warm to the touch.

Altricial young are unable to self-regulate their body temperature during the early postnatal period and require an external source of warmth. If an incubator is not used, it may be necessary to place a heating pad, set on low, under the housing container until the pups are able to thermo regulate. Meier (1986) and Wallach & Boever (1983) recommend 29.4-32.2 °C (85-90 °F) and 50-60% humidity as the desired incubator setting for neonate mustelids. 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). Litters of pups are less likely to need additional ambient heat since huddling together may provide an adequate amount of warmth. External temperatures should be closely monitored to prevent hyperthermia.

Rapid and/or open-mouth breathing, restlessness, and hair loss are indication of an external environment that is too warm.

Pups should be stimulated to urinate and defecate at least 4-5 times each day for several weeks, generally before feeding. However, some animals may respond better to post-feeding stimulation. The genitals and anal area are rubbed gently with a finger, towel, or damp cotton to stimulate the pup to urinate and have a bowel movement. If pups do not urinate and/or defecate after two successive feedings, the formula should be reviewed and their health status evaluated immediately.

Specific environmental parameters, formula information, etc. for hand-rearing *L. canadensis* and *P. brasiliensis* pups can be found in the North American River Otter Husbandry Notebook, 2nd Edition (Reed-Smith 2001) and International Giant Otter Studbook Husbandry and Management Information and Guidelines (Sykes-Gatz 2005), respectively; these are available on the Otter Specialist Group web site (www.otterspecialistgroup.org). The hand-rearing of giant otters (*P. brasiliensis*) is somewhat different than that of other otter species, because their development is slower. Detailed information on the types of records needed, signs of illness, etc. are available in the Giant Otter Husbandry Manual (Sykes-Gatz 2005).

Feeding Amount and Frequency: 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. The artificial formula should be started at a diluted concentration, generally at a 1:4 ratio (mixed formula: water) for another 2-3 feedings. It generally takes about 72 hours to get the animal on full-strength formula by gradually offering higher concentrations. Depending on the species, 4-5 feedings of each concentration level (1:2, 1:1, 2:1, full-strength) are required to allow for adaptation and to minimize the onset of digestive problems, particularly diarrhea. During the initial phase (24-36 hours), 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 pups are not given full strength formula too soon (in less than 48 hours after pulling for hand-rearing) because the likelihood of diarrhea 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.

Pups should have a normal body temperature and be properly hydrated before starting them on formula. Young mammals require a specific amount of calories per day for optimum development and growth. A nutritionally dense milk formula will allow for fewer feedings than more dilute formulas that are low in fat or protein. A method for calculating the volume of food to be offered per meal as well as total daily amount is presented below.

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 thermo-neutral zone. This represents the amount of calories it needs to stay alive, without having to use energy to maintain normal body temperatures (Grant 2004). Mustelids have a higher metabolic rate per body weight than many other placental mammals. For that reason, Iversen's equation of $84.6 \times \text{body weight (in kg)}^{0.78}$ (Iversen 1972) is used rather than Kleiber's equation of $70 \times \text{body weight (in kg)}^{0.75}$ (Kleiber 1947) typically used for other species. Therefore, for a 200g river otter, the BER would be: $84.6 \times 0.2^{0.78} = \sim 24 \text{ kcal/day}$.

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 pups that have a higher metabolism and are developing and growing, the BER is multiplied by 3 or 4 (Evans 1985), depending on the species and other factors.

The stomach capacity for most placental mammals is 5-7% of the total body weight (Meehan 1994). Convert the body weight into grams to find the stomach volume in ml (cc). To calculate the stomach capacity in ounces, convert body weight into grams (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 an infant can comfortably consume at one feeding. Offering much more than this value may lead to overfilling, stomach distension, and bloat. It also prevents complete emptying of the stomach before the next feeding, and promotes the overgrowth of potentially pathogenic bacteria, diarrhea, and enteritis (Evans 1985).

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.

- Calculate Maintenance Energy Requirement: $84.6 \times \text{body wt (kg)}^{0.78} \times 3$.
- Determine stomach capacity (amount that can be fed at each meal): $\text{Body weight (in grams)} \times 0.05$.
- Divide Maintenance Energy Requirement (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 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 offer per day.
- Divide 24 hours by the number of feedings/day to find the time interval between feedings.
- See Table 7.5.1.

Table 7.5.1: Calculations for formula volume and feeding frequency for neonate with an approximate birth weight of 135g (MER = Maintenance Energy Requirement)

Step 1: calculate MER	$84.6 \times 0.135 \text{ kg}^{0.78} \times 3$	~53 kcal/day
Step 2: determine stomach capacity	135 g x 0.05 (stomach capacity of 5% body weight)	~7g ml per feeding
Step 3: calculate daily volume fed	$\frac{53 \text{ kcal/day (MER)}}{1.78 \text{ kcal/ml (formula contents)}}$	~30 ml/day
Step 4: number of feedings	$\frac{30 \text{ ml/day (total volume fed)}}{7 \text{ ml/feeding (stomach capacity)}}$	4.2 feedings/day (=5)
Step 5: feeding schedule	24 hrs/5 feedings	Every 5 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 infants is 5-8% increase of body wt/day while on formula feeding and 8-10% body wt increase/day on weaning diet (Grant 2005). Since neonates being hand-reared (less than one week of age) are typically severely compromised, they should be given smaller, more frequent feedings than calculated until roughly 2-4 weeks of age.

As a general rule, animals should have an overnight break between feedings that are no longer than twice the time period between daytime feedings (equivalent to missing one feeding). For example, if they are being fed every three hours during the day, they can go six hours at night without food. When they are eating every four hours, they can go eight hours at night. It is not advisable to go more than eight hours between feedings with species that typically nurse throughout the day when mother-raised. Intervals between feeding also will depend on how healthy or strong the infants are. Very weak neonates will probably need feedings every few hours even through the night; typically this is necessary for only a few days to a week. The AZA Otter SSP recommends that neonates be fed every two hours around the clock initially. Depending on how the animal is doing, these feedings may be stretched to every three hours after the first few weeks.

Otter pups should only be fed if the pup is hungry and suckling vigorously. Weak infants 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 (i.e., warm, not hot, to the touch). Electrolytes can be offered orally if the pup is suckling, or subcutaneously if it is too weak; 2.5-5% dextrose can also be given to raise the pup's glucose level. More research is required to determine body temperature norms for young of all the otter species. This information should be collected by all facilities hand-rearing otter pups and submitted to the AZA Otter SSP. Young animals will be hungry at some feedings, less at others, but this is quite normal (Muir 2003). However, refusal of two feedings is a sign of trouble in young otters. Pups will not die from being slightly underfed, but overfeeding may result in gastrointestinal disease, which is potentially fatal.

If any animal's formula is changed abruptly, it is likely to cause diarrhea, which can dehydrate the pup quickly. Any formula changes should be made slowly, by combining the formulas and gradually changing the ratio from more of the first to more of the second. If an animal develops diarrhea or becomes constipated with no change having been made in the formula, consult the veterinarian. In general, adjusting the formula ratios should be attempted before medicating the animal. For diarrhea, increase the ratio of water to all the other ingredients. Be sure the water has been boiled or sterilized well, and the bottle is clean. Subcutaneous fluids (e.g., lactated ringers) may be needed if the infant dehydrates significantly.

Feeding Techniques: To bottle feed, hold the pup in the correct nursing position; sternally recumbent (abdomen down, not on its back), with the head up. Place the hand holding the bottle in such a way that it provides a surface for the pup to push against with its front feet. If milk comes through their nose, the nipple hole may be too large or the pup may be trying to eat too quickly. Make sure there is consistency with who is feeding the pups. Note any changes in feeding immediately. Decreased appetite, chewing on the nipple instead of sucking, or gulping food down too quickly can be signs of a problem (Blum 2004).

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 pup may tire and refuse to nurse.

If an animal aspirates fluids the recommended protocol is to hold the infant with head and chest lower than the hind end. A rubber bulb syringe should be used to suck out as much fluid from the nostrils and the back of the throat as possible. If aspiration is suspected, or if fluid is heard in the lungs, the veterinarian should be contacted immediately; drugs should not be administered without the veterinarian's involvement. Body temperature should be closely monitored 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, and 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.

Pups will need to be stimulated to urinate and defecate for the first six weeks of life, either immediately before or after feeding. Parent-reared giant otters of *ex situ* populations are reported to have required stimulation by their parents to urinate or defecate for up to 10 weeks of age. In at least one case, a hand-reared individual needed to be stimulated to urinate/defecate until it was 2.5-3 months old (Sykes-Gatz 1999-2006). In other cases (Corredor & Muñoz 2004), pups were reported using latrines on their own at 9 weeks of age. Some pups also may require "burping" to prevent gas build-up in the abdomen.

***P. brasiliensis*:** One of the most reliable methods of determining if the young are nursing successfully is monitoring for what Sykes-Gatz (2005) calls the "nursing hum", which pups make when they are suckling. This hum is a somewhat higher pitched and faster vocalization than the contact hum described by Duplaix (1980), which has a twittering quality to it. The nursing hum is performed when a pup is nursing from the mother or a bottle. Sykes-Gatz (2005) also reports this call, when given by a caregiver, can encourage pups to feed. From birth, the pups also display "tail wagging" when they nurse, wagging their tails rather quickly and repeatedly from side-to-side. Some individuals may require "burping" to prevent gas build-up in the abdomen. For more detailed information refer to Sykes-Gatz (2005).

***A. cinereus*:** Pups may be slow to learn how to suckle from a bottle, in one case taking eight days before suckling without aspirating (Webb 2008). Care should be taken to ensure that the nipple's hole is not too large and that pups are fed slowly at the beginning. For additional information see Webb 2008 (also available online at (www.otterspecialistgroup.org/Library/TaskForces/OCT.html)).

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. Table 7.5.2 provides information on the nutritional content of otter milk, and Table 7.5.3 provides information on the nutritional composition of selected substitute milk formulas/replacers.

Table 7.5.2: Otter (*Lutra spp.*) Milk Nutrition Composition on As Fed (AFB) and Dry Matter Basis (DMB) (Ben Shaul 1962; Jenness & Sloan 1970)

Species	Solids %	Kcal (ml)	Fat %	Protein %	Carb. %
Otter	38.0	2.6 (AFB)	24.0 (AFB)	11.0 (AFB)	0.1 (AFB)
			63.2(DMB)	28.9(DMB)	0.3 (DMB)

Esbilac® (or Milk-Matrix® 33/40) is preferred as the base for milk formulas offered to otters and provides good pup growth. The addition of Multi-Milk® (or Milk-Matrix® 30/55) increases the total fat and protein content without adding substantially to the carbohydrate content of the formula. The maternal milk composition of otter milk only has a trace amount of milk sugars, so this component of the substitute formula should be kept as low as possible to prevent gastric upset and diarrhea. See Table 7.5.3 on the following next page.

Table 7.5.3: Nutritional analysis of commercial animal milk replacers

Product	Solids %	Fat %	Protein %	Carbohydrates %	Ash %	Energy (KCAL/ML)
Esbilac						
Undiluted powder	95.00	40.00	33.00	15.80	6.00	6.20
Diluted 1:3*	15.00	6.00	4.95	2.38	0.90	0.93
Diluted 1:1.5*	30.00	12.00	9.90	4.76	1.80	1.86
Liquid product	15.00	6.00	4.95	2.38	0.90	0.93
KMR						
Undiluted powder	95.00	25.00	42.00	26.00	7.00	5.77
Diluted 1:3*	18.00	4.50	7.56	4.68	1.26	1.04
Diluted 1:1.5*	36.00	9.00	15.12	9.36	2.52	2.07
Liquid product	18.00	4.50	7.56	4.68	1.26	1.04
Multi-Milk						
Undiluted powder	97.50	53.00	34.50	0	6.63	6.85
Diluted 1:1*	22.70	12.00	7.83	0	1.51	1.55
Diluted 1:1.5*	36.00	19.59	12.75	0	2.54	2.47
Evaporated Milk						
Undiluted product	22.00	7.00	7.90	9.70	0.70	1.49
Multi-Milk:KMR+						
1:1*	22.81	8.93	8.71	3.20	1.55	1.45
3:1*	22.90	10.97	8.63	1.54	1.59	1.57
4:1*	22.90	10.90	8.27	1.17	1.50	1.51
1:3*	22.70	7.28	9.10	4.39	2.30	1.37
1:4*	22.60	6.95	9.16	4.68	1.57	1.36
Multi-Milk:KMR++						
1:1*	34.22	13.40	13.07	4.80	2.33	2.18
3:1*	34.55	16.46	13.03	2.31	2.39	2.36
4:1*	34.55	16.35	12.41	1.76	2.25	2.28
1:3*	34.05	10.92	13.65	6.59	3.45	2.06
1:4*	33.90	10.43	13.74	7.02	2.36	2.04
Multi-Milk:Esbilac+						
1:1*	22.81	10.63	7.70	1.78	1.44	1.49
3:1*	22.93	11.63	8.00	0.89	1.52	1.56
4:1*	22.90	11.60	7.86	0.71	1.49	1.55
1:3*	22.70	9.81	8.75	2.67	2.13	1.51
1:4*	22.60	9.65	7.54	2.84	1.39	1.43
Multi-Milk:Esbilac++						
1:1*	34.22	15.95	11.55	2.67	2.16	2.24
3:1*	34.40	17.45	12.00	1.34	2.28	2.33
4:1*	34.35	17.40	11.79	1.07	2.24	2.33
1:3*	34.05	14.72	13.13	4.01	3.20	2.28
1:4*	33.90	14.48	11.31	4.26	2.09	2.15

* Ratio of powder to water; + Ratio of powder-to-powder, diluted 1 part powder to 1 part water; ++ Ratio of powder-to-powder, diluted 1.5 parts powder to 1 part water (Evans 1985)

The addition of an anti-gas build-up product to the formula should be considered (milk sugars can cause the build-up of gas). Lact-aid® is an enzyme that has been used successfully with many species. Add two drops of Lact-aid® to 100 ml of mixed formula. The formula then should be refrigerated for 24 hours prior to feeding for the enzyme to perform correctly (Grant 2005). *Lactobacillus* spp., in Bene-bac® or Probios®, is a group of beneficial gut bacteria that also break down milk sugars in the digestive tract. Follow label instructions for these products.

Table 7.5.4: Substitute milk formulas for otters. Values taken from product composition documents available from PetAg™ (K.Grant, personal communication)

Formula	% Solids	% Fat	% Protein	% Carb	Kcal/ml
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Formula #1

1 part Esbilac® or Milk Matrix® 33/40	30.9	15.6	10.5	2.7	1.78
1 part Multi-Milk® or Milk Matrix® 30/55					
2 parts water					

Formula #2

1 part Multi-Milk® or Milk Matrix 30/55®	31.3	17.8	10.4	1.1	1.91
1 part water					

***L. Canadensis*:** At this time, the preferred formula is canned Esbilac® due to palatability and good pup growth. Milk Matrix® based formulas also are nutritionally suitable but some facilities have had pups refuse this formula (Blum 2004) while others have had good success.

Weaning: Some of the following recommendations do not apply to *P. brasiliensis* (e.g. offering food in a bowl). The weaning process should be started when the pup shows interest in solid food, generally at about eight weeks of age. If the pup is not gaining enough weight on formula alone, solid food can be added at six weeks of age (this may need to be pureed or chopped). To begin, formula can be mixed with AD diet (canned cat food or similar), baby food, mashed up fish, rice cereal, or ground meat. New food can be added to the bottle; feed this mixture with a syringe, baby bottle, or offer it in a bowl. Milk formula in a bowl should not be provided to giant otters, as they tend to inhale liquids into the nose until they become proficient at eating solid foods (McTurk & Spelman 2005). Only one new food component should be added to their diet every couple of days until they are eating solids well. It is best to be creative, flexible, and not to rush the weaning process. In the case of problems, try different approaches, try them multiple times, and try foods in new ways like bottles, syringes, suction bulbs, bowls, etc. Do not cut back on bottle-feeding to make the pup “hungry”. Offer new food at the beginning of the feeding and finish with the bottle (Blum 2004). Situations to watch for during the weaning process include (Blum 2004): weight loss, diarrhea and sucking behavior. If sucking on tails, feet, genitals, etc. is observed between feedings, an additional bottle-feeding should be offered for a few days. R. Green of the Vincent Wildlife Trust recommends putting orange oil on the genitals to discourage sucking; this worked well with *Lutra lutra* and is not harmful to the otter (G.Yoxon, personal communication).

Swimming, Terrestrial Activities, and Behavioral Stimulation: Otter pups are not born knowing how to swim and may even be scared of the water. They will usually start to take interest in the water at 4-8 weeks of age. The pups should be started off in shallow pools and watched carefully; once comfortable, they can gradually be introduced to deeper water. Pups should be dried off completely and warmed after their swim.

Enrichment is crucial to the development of the pups; toddler safe toys, grooming materials, dens, climbing structures, live food, etc. have all been used successfully. The more items that are introduced to otters at an early age, the more they will interact with as they age. All toys should be safe and approved by the veterinary staff. The suitability of toys should be regularly re-evaluated, as some may no longer be safe as the otter grows. Due to the tendency of all otters to take things into the water, the use of cardboard or other paper-type items, especially for young animals, is not recommended. Cases of these items becoming water logged and congealing in an animal's mouth or over their nose have been reported.

Pup Development: The following information provides a summary of pup development. More specific information can be found in the Otter Husbandry Manuals (Lombardi et al. 1998; Reed-Smith 2001; Sykes-Gatz 2005). See Appendix I for pup weight charts.

***A. cinereus*:**

- Eyes begin opening at between 17 and 28 days, fully open by day 45
- Teeth begin erupting about day 20 and canines erupting ~ day 91 (Webb 2008)
- Thermo regulating well on their own about day 38 (Webb 2008)
- Moving on their own between day 39 and day 50
- Urinating and defecating on their own (hand reared animals) by day 59 (Webb 2008)
- Generally born with mostly grayish fur, darkens by 6-7 weeks
- Solid food 7-8 weeks; weaned 82-120 days
- Hand reared animals eating solid well by day 92 and weaned on day 130 at a weight of 2336 grams (Webb 2008)

***A. capensis*:** At this time there is no information available on pup development. More research is required.

L. maculicollis: Pups are born with white on their lips. After a few days, patches of white/orangish colored hair develop on their chest or groin area. These patches change to an orange color, before changing back to cream or white as the pups reach full growth or maturity. The age at which these color changes occur appears to be highly variable and is currently being documented (D.Benza, personal communication; R.Willison, personal communication).

- First spots seen ~6 days, whitish but turned orange in a few days. More orange spots developed by day 42
- Eyes open at 34-46 days
- First crawling at about 20 days, crawling well 42 days
- First teeth erupting at 23-29 days, all teeth in ~78 days
- Walking well at ~ 37 days, running 59 days
- Leaving den on own at about 57 days
- Playing in water bowl ~ 61 days
- First going in to water on their own at about 57-91 days; variation comes from water tub versus pool exploration
- First pool swimming lessons ~ 86 days (timing may be due to when family is allowed into the exhibit)
- First eat solids at about 60-73 days

L. canadensis: Consult the North American River Otter Husbandry Notebook 1st & 2nd editions for more detailed information (Reed-Smith 1994, 2001).

- Birth weight: 120-135g
- Born blind with dark brown fur
- External ears are flat against the head, and claws and toe webbing are well formed.
- Deciduous upper and lower canines erupt at about 12 days
- Eyes fully open at 28-35 days
- Walking at about 35-42 days, first swimming lesson generally at 28-56 days
- Beginning to play ~25-42 days
- Leaving nest box on their own ~49 days
- Pelt change 28-56 days, born with all dark fur
- First solid food taken at 42-56 days
- Localized latrine use ~49 days
- Pups should be weaned by 3-4 months of age

P. brasiliensis: Because this species requires complete isolation and privacy (particularly primiparous pairs), detailed information on pup development is taken from video and audio recordings. Note: Institution U does not believe in complete isolation but recommends maintaining the normal routine; this approach should be tailored to the individual female and situation. Sykes-Gatz (2005) provides more detail on pup rearing and development. McTurk & Spelman (2005) also provide information on hand-rearing and rehabilitation of orphaned giant otters. An outline of giant otter pup development is provided below (Wünnemann 1990, 1995a,b; McTurk & Spelman 2005; Sykes-Gatz 2005, 1999-2006; V.Gatz, personal communication; N.Duplaix, personal communication):

- Weight at birth – 150-265 g
- Birth pelt is grayish in color and darkens by 6-7 weeks of age
- Eyes begin opening at ~28 days and are fully open by ~45 days
- Pups should be moving on their own by 39-50 days
- First leave the nest box on their own at 63-67 days
- First swimming lessons at 20-60 days, or as early as 11 days
- Pups can be reliably sexed at 10 weeks
- Pups swim on their own for the first time at 63-67 days
- Pups will begin playing with solid food at roughly 56 days, but generally do not consume any until about 70-90 days.
- Pups will begin weaning at roughly 4 months of age, but can nurse insignificant amounts (this provides little nutritional value) at 6.5 to 8 months of age.
- Fish should first be offered pups at 2.5-4 months of age
- 100% of their required caloric intake should be offered in formula/mother's milk form until roughly 2.5 months of age
- Pups should be weaned from formula between 6.5-10 months of age

- Pups should be weaned on a fish based diet; rice cereal has been used successfully as a dietary addition for hand-reared pups. Formula should not be offered in a bowl, as giant otters tend to inhale liquids into the nose until they are proficient at eating solid foods.
- Pups are approximately $\frac{3}{4}$ the size of adults at 10 months of age, although this will vary

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 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 otters are outlined below. More details on products, application, and ordering information can be found on the Institution E 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 (Munson 2006). Other progestins (e.g., Depo-Provera[®], Ovaban[®]) are likely to have the same deleterious effects. C.Osmann (personal communication) specifically recommends against using progestins in *P. brasiliensis* for the reasons mentioned above and because these side effects may compromise future breedings. For carnivores, one institution now recommends GnRH agonists, e.g., Suprelorin[®] (deslorelin) implants or Lupron Depot[®] (leuprolide acetate), as safer alternatives. Although GnRH agonists appear 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 African clawless otters, North American river otters, Asian small clawed otters and sea otters.

Gonadotropin Releasing Hormone (GnRH) Agonists: GnRH agonists (e.g., 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). 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 otters 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, they are more commonly used in females. This is because monitoring efficacy by suppression of estrous behavior or cyclic gonadal steroids in feces is usually easier than ensuring continued absence of sperm in males, since most institutions cannot perform regular semen collections. Suprelorin[®] 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

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Appendix H: Description of Nutrients

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.

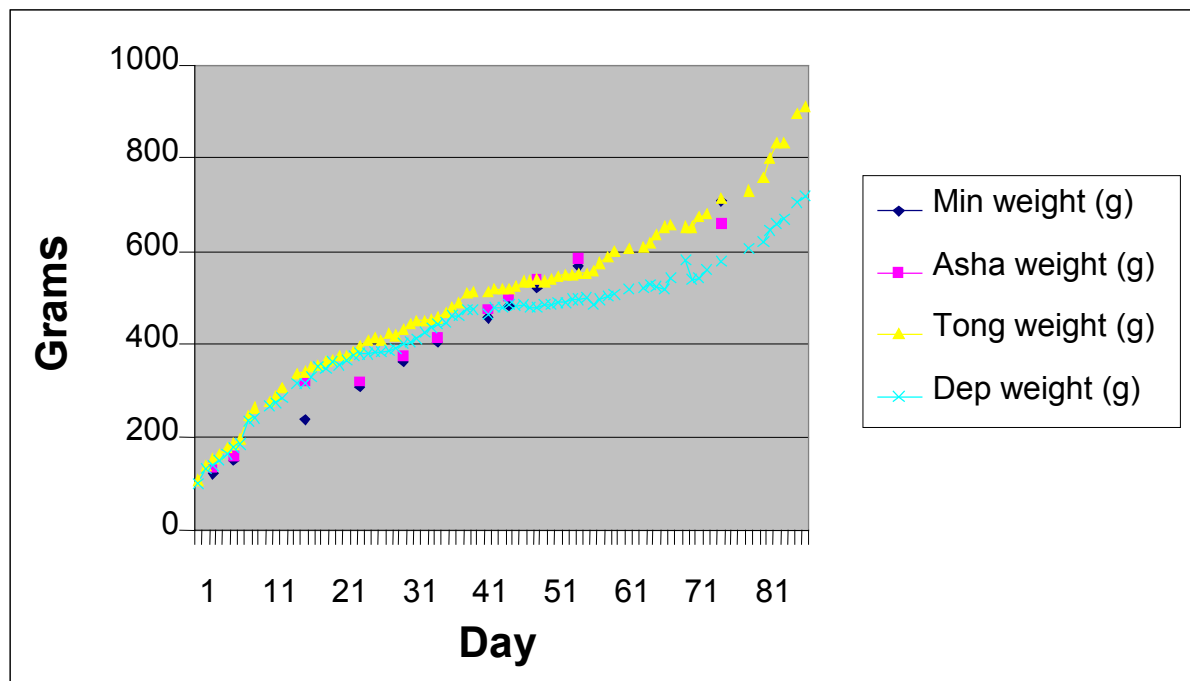
Selenium: Selenium is an essential trace element. It is an integral part of enzymes, which are critical for the control of the numerous chemical reactions involved in brain and body functions. Selenium has a variety of functions. The main one is its role as an antioxidant in the enzyme selenium-glutathione-peroxidase. 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.

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Appendix I: Pup Weights of *Ex situ* Population Bred Otters

Asian-small clawed otter (*A. cinereus*) pup weights (mother-reared) at Institution F (N = 1.3)



Spotted-necked otter (*L. maculicollis*) pup weights (mother-reared) at Institution M N=1.0

Age in days	Weight (kg)	Age in days	Weight (kg)
28	0.75	98	1.9
35	0.95	107	1.9
42	1.2	113	1.95
49	1.4	120	2.1
56	1.5	127	2.7(after eating)
65	1.6	134	2.5
72	1.65	140	2.6
77	1.8	148	2.5
84	1.75	155	2.45
91	1.9	-	-

North American river otter (*L. canadensis*) pup weights (mother-reared). Data taken from AAZK Zoo Infant Development Notebook 1994, Institution N, Institution O, Institution P.

Males (N = 9)				Females (N = 8)			
Age/days	Weight (g)	Age/days	Weight (kg)	Age/days	Weight (g)	Age/days	Weight (kg)
1	110-170	32	0.992-1.03	1	170	32	0.971
2	177-184	33	0.998-1.09	2	177	33	-
3	193-220	34	1.08-1.11	3	198	34	1.01
4	204-241	35	1.11-1.14	4	213	35	1.05-1.15
5	241-276	36	1.13-1.19	5	248	36	1.06
6	249-298	37	1.16-1.18	6	262	37	1.09-1.23
7	266-333	38	1.20-1.25	7	298	38	1.13
8	280-354	39	1.23-1.28	8	333	39	1.15-1.30
9	325-376	40	1.28-1.34	9	347	40	1.23
10	353-404	41	1.35-1.36	10	383	41	1.28
11	364-425	42	1.32-1.41	11	397	42	1.25-1.35
12	398-453	43	1.35-1.39	12	411	43	1.28
13	414-475	44	1.40-1.43	13	439	44	1.35
14	496	45	1.45-1.57	14	454	45	1.39
15	531-539	46	1.52-1.62	15	489	46	1.43
16	499-574	47	1.43-1.62	16	517	47	1.34-1.48
17	595	48	1.59-1.69	17	546	48	1.46-1.60
18	617-624	49	1.59-1.67	18	560	49	1.58
19	624-645	50	1.69-1.79	19	609-685	50	1.62
20	666-680	51	1.62-1.74	20	637	51	1.56
21	687	52	1.67-1.87	21	652	52	1.53
22	765-780	53	1.74-1.88	22	660-730	53	1.62
23	780-808	54	1.74-1.92	23	723	54	1.64
24	810-843	55	1.71-1.96	24	758-850	55	1.66-1.81
25	822-858	56	1.54-1.68	25	720-795	56	-
26	829-872	57	1.71-2.03	26	772	57	1.93
27	850-872	58	1.87-2.10	27	794	58	1.76
28	865-910	59	1.90-2.06	28	815-900	59	1.80
29	907-921	60	1.52-2.12	29	872	60	1.86-1.70
30	935-978	61	1.97-2.15	30	907	61	1.84-2.33
31	971-1000	62	1.96-2.24	31	928-1060	62	1.88

Appendix K: Enrichment Items Commonly Provided to Otters

The table below lists items used at various North American facilities for behavioral and environmental enrichment of otters.

Natural	Exhibit Furniture	Non-edible manmade	Live Food	Edibles
<ul style="list-style-type: none"> - Soil, sand, mulch - Grass, wheat grass, sedges, etc. - Trees - Vines "vine hoops" - Aquatic plants - Hay, straw, grass, leaves, wood wools as bedding - Grass piles - Leaf piles - Rocks, all sizes for play and manipulation - Knot holes - Bark sheets - Pine Cones - Mud - Sod - Bank over-hangs - Floating wood - Blocks - Pine needles - Other animal urines - Powdered scents and herbs - Fresh herbs - Extracts, i.e., vanilla, etc. - Grapevine balls - Shells - Turkey feathers - Corn stalks - Blowing bubbles into exhibit - Kudzu vines - Cow hooves 	<ul style="list-style-type: none"> - Climbing areas (available in all exhibits, i.e., cliffs, ledges) - Logs (on land, submerged, floating; hollow and/or solid) - Rocks (not artificial) - Stream - Sticks - Browse (leafy branches on land and/or floating) - Slides - Tunnels - Stream bed - Running water - Holts - Jacuzzi-like jets in pool - Islands in pool - Bridges made from logs, etc. - Stumps - Natural fiber mat - Movable sand box - Logs brought from other exhibits - Log ladder - Non-sprayed evergreen trees - Moving soil pots - Hanging logs with holes for food - Snow piles - Piles of ice cubes 	<ul style="list-style-type: none"> - Boomer balls and other products like the "spoolie", "bobbin" & "ice cube". - Ice blocks, cubes, pops. - Snow & ice - PVC cricket feeder - Buckets - Blankets, burlap, non-fraying rags, towels - Barrels of water - Frisbees - Tubs of water - Carpet over board - Rubber-coated heating pad* - Astro turf - Floating plastic toys - Phone books - Swim through plastic ring - Kids puzzle balls, billiard balls, hard balls - Pieces of PVC pipe and fittings - Kong chews - Metal bowls and pans - Plastic tubs and bottles - Bread tray - Plastic slide, house - Stock tank - Hanging tub* - Warm water hose - Vari-kennel tubs with substrates - PVC tube hung for climbing in 	<ul style="list-style-type: none"> - Fish (smelt, shiners, goldfish, trout, mackerel, tilapia salmon)* - Crayfish - Crickets - Giant mealworms - Earthworms - Freshwater clams - Mussels - Krill - Eels- naturally found - Shrimp - Aquatic insects - naturally found - Mice- naturally found - Frogs – naturally found - Grubs - Chub - Minnows - Bluegill - Clams - Mud minnows 	<ul style="list-style-type: none"> - Ice blocks w/fish, fish-sicles, fish cubes, etc. - Krill cubes, clam cubes, etc. - Frozen or thawed sand eels - Fish pieces - Chicken necks - Mice - Whole-fish -frozen or thawed - Whole apples/oranges - Fruit & berries incl. grapes, blueberries, strawberries - Small pumpkins and squash - Omnivore biscuits - Monkey chow - Pigs ears - Frozen blood blocks, cubes, etc. - Hard-boiled eggs - Day-old chicks - Crabs - Melons - Coconuts - Frozen feline balls - Milk bones - Screw pine nuts, unsalted peanuts - Krill patties - Hamster ball w/ treat - Gelatin Jigglers - Corn on the cob - Yogurt with fish - Unsalted ham

* These items should be monitored for safety.

The following list provides more examples of enrichment initiatives offered to otters at the Institution J and Institution L:

Institution J – ASC otter

Non-food items

- Boomer balls & Jolly balls
- Bowling pins
- Brushes
- Bucket lids
- Beer kegs, feed barrels & trash cans
- Feed bags
- Clover clumps
- Milk crates, Plastic wagons & Plastic logs
- Water cooler bottles
- Grass flats/clumps
- Hang paper maché figures
- Hollow coconut shells
- Oscillating fan, wind chimes, & bubble machine (outside of enclosure)
- Large logs, rearrange furniture, etc.
- Leaves, sand, and rock piles
- PVC tubes
- Towels, clothes, blankets
- Cardboard boxes and tubes (caution needed when using paper products that can become wet)
- Laser pointer
- Nature tapes
- Perfume/body sprays & Glad scented sprays

- Traffic cones
- Hummus
- Ice piles
- Rose petals
- Burlap sacs
- Straw piles
- Reindeer antlers
- Varied of feeding devices & times
- Nyla bones
- Spices and extracts
- Mirror

Food items

- Honey smears
- Blood popsicles
- Cooked chicken
- Crickets
- Horse meat
- Meal worms
- Peanut butter
- Pinkies
- Dry cat food
- Milk bones
- Tuna

Institution L – N. A. river otter/ASC otter

Non-food items

- Bobbin with smelt rubbed on it
- Whole coconuts to roll around
- Yellow pages
- Bengay™ ointment inside a boomer ball
- Log switching between animal exhibits
- Regular Alka Seltzer® in PVC tube (very small holes in PVC)
- Corn stalks
- Blocks of recycled plastic with holes drilled in them to dig food items out
- Crickets in PVC tube feeder
- PVC shaker toys
- Milk crates, cardboard box, use with caution
- Pinecone soaked in scents
- Extracts – vanilla, almond, lemon & spices
- Elephant manure
- Deodorant spray
- Reindeer antlers & pronghorn sheaths
- Paper maché

- Pig ears and cow hooves
- Painting
- Mustard or tomato sauce
- Large black kong toy
- Floating PVC tube to swim through

Food items

- Liver
- Anchovy paste
- Hard boiled eggs, apples, pumpkins, carrots, blueberries
- Gelatin jigglers
- Live crawdads, live trout in pool, crickets
- Frozen smelt ice blocks
- Blood popsicles
- Knuckles
- Beef hearts
- Mice and rats

Appendix M: Missouri Fish and Wildlife Otter Stomach Contents

(Missouri Fish and Wildlife (www.mdc.mo.gov/conmag/1999/11/40) MDC Online November 1999, Vol. 60, Issue 11. D. Hamilton

Otter Stomachs containing identifiable fall prey items

Type	Percent
Crayfish	61
Fish	51
Frogs	17
Muskrats	3
Ducks	1
Empty	4

Ozark otter stomachs containing identifiable fish species

Species	percent
Bass (sunfish family)	39
Suckers and Carp	31
Minnows	14
Shad	11
Pike (chain pickerel)	6
Trout	3
Catfish	3
Drum	3
Unidentified Fish	19

Age of Game Fish in Ozark Otter Stomachs

Age	Percent
1-3 years	40
4-6 years	40
7-9 years	20

Appendix P: Otter Body Condition Matrix

Cheryl Dikeman, NAG Advisor, 2009

5 Matrix is still in development, photos of each body condition are being sought.

SCORE	1 Emaciated	2 Poor	3 Ideal	4 Solid	5 Obese
Photo/Drawing					
General Condition	No obvious fat and loss of muscle mass. Lumbar vertebrae all visible, ribs visible, obvious abdominal tuck. Iliac wings pronounced. Poor coat.	Lean, minimal muscle mass	Optimum body fat and muscle tone, well proportioned, ideal coat condition.	Noticeable fat deposits throughout body.	Obvious fatty deposits, no definition between shoulder, stomach and pelvic regions
Neck and Shoulders	Pronounced scapula and lack of muscle over the shoulders, Noticeable shoulder skeletal region.	Visible scapula with little muscle over the shoulders, thin neck. Visible delineation behind shoulders.	Smooth lines over shoulders and scapula. Slight delineation behind shoulder region.	Smooth lines over shoulders and scapula. No delineation behind shoulder region.	No definition, very thickened neck region. Obvious fat deposits over top of shoulders and in neck region.
Abdomen and Waist	Very pronounced waist and severe abdominal tuck	Visible waist behind the ribs. No visible abdominal fat present.	No visible abdominal tuck. Some distinguishable abdominal fat present; however, not obvious.	Some rounding in the abdominal region. Noticeable abdominal fat. Waist is not visible.	Obvious abdominal fat deposits and large protruding waist region. Abdominal fat pad drops below the rib cage.
Hindquarter	Pronounced and very obvious hip and iliac region.	Pelvic bones visible.	Hips and pelvis slightly visible and palpable but not obvious.	No skeletal visibility in hindquarter. Smooth lines over entire quarter.	Fat deposits obvious over hind limbs. Fat pad obvious on tailhead.
Vertebrae and Rib Cage	All vertebrae visible. Visible ribs.	Tops of lumbar and thoracic vertebrae and ribs slightly visible and definitely palpable.	Smooth lines over topline and throughout body. No visible ribs or vertebrae.	Some fat evident over vertebral bodies and/or ribs	Extreme fat pad over rib cage region. Heavy fat deposits over vertebrae.