

# CHAPTER 1

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## NUTRITION AND DIET

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To sustain a captive population of Asian small-clawed otters, the nutritional needs of the species must be met. Developing appropriate dietary guidelines requires consideration of: (1) feeding ecology, (2) target dietary nutrient values, (3) food items available to zoos, and (4) information collected from diets offered by institutions successfully maintaining/breeding Asian small-clawed otters. This chapter will address these nutritional issues in order to develop dietary guidelines for captive Asian small-clawed otters. It also provides an overview of the information that was gathered from the survey conducted during the fall of 1997 and spring of 1998.

### FEEDING ECOLOGY

The Asian small-clawed otter (*Aonyx cinerea*, hereafter **ASC otter**) is a member of the Mustelidae family. The otter is a carnivore in dietary habits because the diet of free-ranging Asian small-clawed otters includes: crabs, crustaceans, snails, mollusks, frogs, and fish (Table 1.1; Duplaix-Hall 1975; Foster-Turley 1985; Foster –Turley 1992; Engfer, 1986). Partridge and Jordan (1995) also indicated that octopus was consumed by free-ranging ASC otters.

#### *Nutrient Content of Diet*

Although many of the items in the diet of free-ranging otters are established, the nutrient content of those items remains unknown. Descriptions of the nutrient content of food items similar to those described in the diet of free-ranging otters (although sometimes in distinctly different forms) can be found in several

sources (NRC 1982, 1986; Pennington 1989). However complete nutrient information remains limited and should be used for estimations only.

## **TARGET DIETARY NUTRIENT VALUES**

Target dietary nutrient values for ASC otters are based on several sources. The cat is typically the model species used to establish nutrient guidelines for carnivorous animals. The NRC (1986), AAFCO (1994), and Waltham Center for Pet Nutrition (Earle and 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 requirements of another mustelid species. The target nutrient values presented herein (Table 1.4) are a range of values nutrient derived from these sources. In most cases, they reflect the highest values reported from the various references. As new information becomes available, these ranges will change to reflect knowledge gained.

## **FOOD ITEMS AVAILABLE TO ZOOS**

Historically, diets for captive ASC otters have revolved around meat products with additional supplements to compensate for any perceived nutrient shortfalls (Baer, et al 1994). Minced beef, fish, hard boiled eggs, locally available shellfish, crabs, etc. have all been included in diets reported for ASC otters (Timmins 1971; Lancaster 1975). To more closely match the apparent diet of free-ranging otters, locally obtained shellfish (crabs, clams, crayfish, etc.) and fish have increased in prevalence as part of the diet for captive ASC otters (See attached diet summary; Appendix 1.1).

## **ZOO DIET SUMMARY**

Information collected from diets offered by institutions holding ASC otters can be a useful tool in proposing dietary guidelines. Because of this, a nutrition section was included in the recent ASC otter survey. The resulting information showed that a number of different diets were fed to otters. Food items included can be categorized into: manufactured feeds, meat products, fish/seafood, insects, vegetables, and supplements. Manufactured feeds included: ZuPreem Canned Feline diet, Purina dog food, Nebraska Brand Feline diet, Purina Fit'n'Trim dog food, Nutrena dog food, Iams Less Active dog food, Cycle Lite, Wisconsin Meat Mix, and Nebraska Brand Bird of Prey (Manufacturer contact

information provided in Appendix 1.2). Meat products included horse liver and ribs. Seafood items included a wide variety of fish (capelin, smelt, mackerel, herring, goldfish, minnows, trout, cichlids), shellfish (clams), and other crustaceans (crayfish). Invertebrates included mealworms, crickets, and earthworms. A variety of vegetables have been offered as well (carrots, lettuce, green beans, lettuce, cucumber, collard greens, kale, and other assorted greens). Supplements included: Vitamin E, Corn Oil, Children's Vitamins, Thiamin, Vitamin E / Thiamin (in combination), Linatone, B complex, Vitasol (with vitamin E), Potassium Citrate Granules, and Chitin. In many cases, food items offered in the diet were measured either by weight or volume. Consumption also was measured institutions however this was by general visual appraisal.

While all food items offered are considered a part of a complete and balanced diet, several institutions noted that some food items were used as enrichment. It was noted that some of these items were used by other institutions as part of the "base diet" as well. Live food items used as enrichment included crayfish, crabs, fish, crickets, mealworms, etc. Mussels, clams, hard-boiled eggs, peanuts, etc. are also occasionally offered as well as various items frozen into ice cubes (crickets, fish, etc.).

Most seasonal variation in the diet offered occurs due to availability of food items. Institutions where otters are housed outdoors (or in areas with little temperature regulation) report experiencing an increase in consumption as temperatures decrease during the winter.

#### *Feeding Schedule/Interval*

Most institutions represented in this survey offer food twice daily (morning and evening). Several institutions offer food more often (3 to 15 times) per day. Food items are offered on and off exhibit depending on the item(s) and the desired presentation.

#### *Water Presentation*

Most exhibits have potable water provided via running water and/or pools. Some institutions offer water in separate tubs for drinking. Most of the institutions reported that pool water was not heated and was maintained at a temperature of between 65° F and 80° F.

### *Determination of Nutrient Content of Total Diets*

Several institutions have had their diets analyzed via lab assays and/or computer programs. The ingredients of these diets are listed in Table 1.2 and the nutrient content information is listed in Table 1.3. Two of the diets are fish based diets, and appear comparable in many nutrients.

### *Behavior Related to Feeding*

Most institutions have experienced some type of competition for food items offered. In some cases, this competition has manifested itself in the form of aggression for food. This has led to physically separating individuals for feeding or offering food items in separate areas of the exhibit. It has been reported that ASC otters adapt well to routines, learn the precise time of feeding on a daily basis, and, in many cases, will vocalize at feeding time. Several institutions have observed a begging behavior for food. Once fed, otters have been observed to wash their food. In mixed species exhibits, other animals have been observed stealing the otter's food and vice versa, but little interspecies aggression has been observed.

### *Alternative Diets*

Several institutions have employed alternative diets for special circumstances - lactating female diet (KMR and calcium carbonate added), weight loss diet, growing juvenile diet (Science Diet Growth Formula), maintenance diet (Science Diet Maintenance), possible calculi reduction, etc. Few details were provided regarding the specific situations when each diet was used.

## **RECOMMENDATIONS FOR FEEDING**

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. Thus, providing guidelines for nutrient content rather than specific food items in set quantities is appropriate (Table 1.4). This allows for flexibility in diet formulation while assuring that nutrient needs are met. Feeding mustelids at least 2 times/day is recommended due to a high metabolic rate and rapid digestion (Partridge and Jordan 1995).

### *Diets*

As mentioned previously, several basic diets (including fish and commercially available dry, canned, and frozen diets) have been used to maintain ASC otters in captivity (Baer, et al 1994). Meat based diets have been used in most institutions for growth, maintenance, and breeding of ASC otters. There are a variety of meat products upon which to base the diet. Table 1.5 briefly describes the nutrient content of some commonly used manufactured products/nutritionally complete items. Although no definitive cause-effect relationship has been established, many otters offered meat-based diets have developed renal calculi (see Reported Health Problems Associated with Diet and/or Health Chapter). It must be noted however, that most otters receive this type of diet and most have this problem, so the involvement of the diet remains unclear at this point.

With the observation that renal calculi are observed almost solely in captive ASC otters, a diet which more closely resembles the diet reported for free-ranging ASC otters has been developed as an attempt to reduce the incidence of renal calculi in captive otters. This fish based diet has been evaluated for 2-3 years at the Minnesota Zoo, and appears to offer some promise in reducing incidence and/or development of renal calculi (Petrini, et al 1996). Alternatively, some institutions have historically offered ASC otters all fish diets with little, if any, reduction in the incidence of renal calculi (Petrini, pers. comm.). Common fish species and marine products, and their nutrient contents that could be included in an “all fish diet” are listed in Table 1.6. It should be noted that supplementation of vitamin E, thiamin, and possibly multivitamin are especially important when offering a diet comprised of mostly fish (see Nutrient Supplementation section).

Also, offering bones or some hard diet item, regardless of the rest of the diet, is recommended to maintain dental health.

Additional thoughts for experimental diets/items have been discussed in the Future Research Section. Use of potassium citrate has offered some promise in minimizing the incidence of renal Calculi composed of calcium and oxalate in dogs and cats via alkalization of the urine, however its benefit to ASC otters has not been proven. Additionally, chitin, which potentially may bind dietary calcium, has been used as a possible way to minimize the incidence and/or development of renal calculi, but results have been disappointing.

### *Nutrient Supplementation*

Vitamin E, Thiamin. Diets which contain high levels of marine products may predispose individuals to vitamin E deficiency if not adequately supplemented (Engberg, et al 1993). Marine products contain high levels of poly- and mono-unsaturated fatty acids. Because vitamin E functions as an antioxidant, the breakdown of these oils during storage causes vitamin E destruction. Thiamin deficiency may arise from feeding fish-based diets due to thiaminases present in some types of fish. If fish is offered as a major component of the total diet, supplementation with thiamin and vitamin E is recommended due to degradation of the two vitamins during the storage period (see Target Nutrient Values). These considerations should be addressed during the diet formulation process.

*Multivitamin.* In many cases, if a fish based diet is used, supplementation with a multivitamin is recommended. Nutritional deficiencies have been reported in commercially farmed mustelids (NRC, 1982). Fish composition can change based on species, season of harvest, duration of storage, etc. and addition of a multivitamin may provide some consistency in the nutrients contained in the diet. However, the diet should be analyzed to determine nutrient levels prior to supplementation in order to minimize the chance of over-supplementation and toxicity's particularly of fat-soluble vitamins.

### **HAND-REARING / INFANT DIET**

The AZA Infant Diet Notebook provides some insight into hand-rearing mustelid species (Burnette 1994). Table 1.7 describes the milk composition of several mustelid species. According to Burnette (1994) the formula of choice appears to be Esbilac Dog Milk Replacer. This notebook is in the process of revision by the AZA Nutrition Advisory Group and should provide updated guidelines.

If hand rearing is necessary, and formula is offered via a bottle, a transition from 100% water to 100% formula should be gradual over a period of several feedings. This will allow for the infant to become used to the nipple or other feeding implement, thus minimizing the risk of fluid aspiration. It also will minimize the potential for diarrhea caused by a sudden dietary change.

Newborn and/or weakened cubs should be fed every 2-3 hours around the clock. After 10 days, feedings can be reduced to every 3-4 hours, and overnight feeding may still be necessary. As the animals grow, frequency of feedings can be continually reduced to 3-4 feedings per day until weaning (Burnette 1994).

Amounts to offer depend on size, age, and health. The recommended amount to offer as noted in the infant diet care notebook is described: “feed until the stomach is full but not taut or over-extended.” It should be noted that the concept that an infant will correctly control its own intake if milk is offered ad lib has been proven incorrect by numerous reports of diarrhea, vomiting, listlessness, potbellies, labored breathing, anorexia, and death (Robbins 1993). Thus, ad libitum feeding is discouraged. It is best to establish moderate guidelines at the start of the hand-rearing period and adjust them based on consumption and observed growth.

## **ALTERNATIVE DIETS**

### *Lactation Diet*

There is an increased need for energy during lactation. Tumarov and Sorina (1997) have 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 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 the individual otters and/or observed body weight loss (mobilization of tissue to support lactation).

### *Weight Loss Diet*

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 approaches may be appropriate.

1. Feed less total food. By simply reducing the amount of total food offered, weight loss may occur. This practice is confounded by the aggression observed in group fed ASC otters

around feeding time and the potential that this may be increased when less total food is offered.

2. 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 weight loss. The otter can consume the same amount of total diet, but will actually be consuming fewer calories.
3. 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.
4. 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 could be substituted for a fatter fish to reduce total calories in the diet.

### **REPORTED HEALTH PROBLEMS ASSOCIATED WITH THE DIET**

In 1985, the single major husbandry problem as reported in the regional studbook was urinary stones (calculi; Foster-Turley 1985). At the time, calculi appeared to exist regardless of the diet offered (meat mixes, commercial diets for cats or dogs, thawed fish, table scraps, etc.). In 1988, when the ASC otter SSP program was detailed, calculi were reported as the primary cause of death in the North American population (Foster-Turley and Engfer 1988). That same year, calculi were observed in over 75% of the captive population (Calle 1988) and are still apparently prevalent today (current survey). Eight out of nineteen survey institutions reported no nutritionally related disorders with their otters. Of the institutions that reported nutritional disorders, they all reported renal calculi (or “renal problems”). To this end, work has been

performed to determine the cause of renal calculi in ASC otters and possible management techniques to minimize incidence and/or development of calculi (Petrini 1996). This research has led to the philosophy that calculi formation in these otters is caused by a multitude of complex and inter-related factors. Several dietary adjustments have been attempted (all fish diets, potassium citrate addition, chitin addition, special prescription diets), however few have been examined within the parameters of a defined study lasting for a period of time necessary to strongly conclude their efficacy or lack thereof.



## **FUTURE RESEARCH NEEDS**

Studies examining the efficacy of all fish diets in reducing incidence/growth of renal calculi have been ongoing for several years with mixed results. Work performed at the Minnesota Zoo (Petrini, et al 1996) has shown some promise, however otters there have been on an all fish diet for slightly over 3 years and it will be important to observe those otters over the next few years as well. With this in mind, we have several considerations to direct our future efforts:

- (1) Between 70-80% of ASC otters offered a variety of diets have developed renal calculi.
- (2) Although some otters offered an all fish diet have developed calculi, the young otters at Minnesota have not exhibited calculi after being on the diet for 3 years or more.
- (3) Several “new” diet items have been introduced that may assist in reducing incidence of renal calculi, but have yet to be adequately tested - potassium citrate, chitin, Hill’s Feline c/d<sup>o</sup>, etc. Collaborative efforts among holding institutions may allow for systematic evaluation of the abilities of these items to reduce incidence/development of calculi.
- (4) Several young otters (assumed calculi free at this point) in the North American population may allow for the evaluation of a selected diet throughout their lives.

Due to the limitations of the current research on renal calculi and the association, if any, with the diet in Asian small-clawed otters, it is recommended that all young otters be thoroughly evaluated initially and periodically. This evaluation should include radiographs. Since the number of animals is relatively small, collaborative investigation is a necessity. This collaboration should involve standardized protocols and management guidelines, and should test a uniform diet (such as fish and specific supplements) among all participating institutions.

**Table 1.1 . Prey items listed in order of frequency of occurrence in the scat of ASC otters.\***

Prey Item*
Invertebrates (general)
Crab
Fish (general)
Gobiodei (mudskippers)
Anabantidae (specific fish family)
Snakes (general)
Trichogaster spp. (fish spp.)
Anabis testudineus
Amphibians (general)
Rattus spp.
Snail
Clarias spp. (fish spp.)

\* From Foster-Turley, 1992.

**Table 1.2. Percent distribution of food items included in the representative diets of captive ASC otters (as fed: 1997/98 survey results).**

Audubon Zoo	Brookfield Zoo	WCS (Bronx)	Minnesota - Fish*	Minnesota - Meat*
53% Capelin	58% Otter Mix <sup>2</sup>	50% FelineDiet <sup>4</sup>	28.6% Capelin	100%FelineDiet <sup>4</sup>
33% Smelt	30% Fish <sup>3</sup>	18% Capelin	28.6% Mackerel	
7.1% Mackerel	8% Ribs	18% Carrot/Yam	28.6% Herring	
6.4% Herring	2% Dog food	14% Greens	14.3% Smelt	
0.2% Corn Oil	2% Invertebrates	Thiamin/E	1.9% Corn Oil	
0.1% Multivitamin <sup>1</sup>			0.2% Thiamin/E	
0.1% Vitamin E			Multivitamin <sup>1</sup>	
0.1% Thiamin				

\* Two experimental diets have been used at the Minnesota Zoo: a fish based diet and meat based diet. These diets have been used to examine the incidence of renal calculi (Petrini, et al. 1996).

<sup>1</sup> Multivitamin was a Children's Multivitamin (Audubon) and A-Z Multivitamin (Minnesota).

<sup>2</sup> Otter mix contains 30% low calorie dog food, 27.6% Nebraska ground horsemeat, 14.9% ground beef heart, 12.3% water, 9.1% ground cat food, 2.7% poultry fat, 2.1% beet pulp, 0.58% CaCO<sub>3</sub>, 0.44% oil, 0.3% theralin substitute, 0.0001% Rovimix-E.

<sup>3</sup> Fish includes capelin, smelt, and herring.

<sup>4</sup> Feline diet is the Nebraska Brand Feline Diet (see manufacturer contacts, Appendix 2).

**Table 1.3. Analyzed nutrient content of representative diets offered to captive ASC otters (dry matter basis).\***

Nutrient	Audubon Zoo Diet	Brookfield Zoo Diet	WCS (Bronx) Diet	Minnesota Fish Diet	Minnesota Meat Diet
Dry Matter, %	25.3	56.0	60.6	24.8	39.3
Crude Protein%	66.6	42.9	53.7	68.1	47.8
Fat, %	24.1	18.4	36.6	18.95	37.9
Fiber, %	1.02	4.5	-	1.2	2.8
Ash, %	9.56	6.2	-	10.4	6.5
Na, %	0.43	0.27	-	0.79	0.32
Ca, %	3.26	0.82	1.3	1.56	0.96
P, %	1.14	0.55	1.1	1.67	0.78
K, %	1.44	0.90	-	1.5	0.88
Mg, %	0.18	0.12	-	0.16	0.1
Zn, mg/kg	57.3	54.7	-	78.8	73.5
Cu, mg/kg	2.18	7.36	-	3.34	7.9
Mn, mg/kg	-	6.8	-	4.69	18.6
Fe, mg/kg	70.8	154.1	-	103.5	483

\*Diets were analyzed at multiple sites (based on institution affiliation and/or preference).

- Indicates unknown value.

**Table 1.4. Target nutrient ranges on a dry matter basis for Asian Small-Clawed 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( $\alpha$ )
Thiamin, mg/kg	1-5( $\alpha$ )
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
Folic Acid, mg/kg	0.2-1.3
Biotin, mg/kg	0.07-0.08
Vitamin B12, mg/kg	0.02-0.025
Choline, mg/kg	1000-3000
Calcium, %	0.6-0.8( $\beta$ )
Phosphorus, %	0.6( $\beta$ )
Potassium, %	0.2-0.4
Sodium, %	0.04-0.6
Magnesium, %	0.04-0.07
Zinc, mg/kg	50-94
Copper, mg/kg	5.0-6.25
Manganese, mg/kg	5-9
Iron, mg/kg	80 -114
Iodine, mg/kg	1.4-4.0

\* Target nutrient ranges on a dry matter basis derived from requirements for domestic cats (NRC 1986), AAFCO recommendations (1994), Waltham Center for Pet Nutrition recommendations (Earle and Smith 1993), requirements for mink and foxes (NRC 1982), and literature describing the foraging behavior of ASC otters.

\*\* The fat content of fish commercially available in North America typically ranges from 5-40%, and ASC otters have been maintained on diets containing between 15-40% fat (see table 2), 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 1985), which represents the upper bound of the range. However, free-ranging ASC otters may consume a diet of mostly fish (Foster-Turley 1992), thus may have a higher tolerance for vitamin A due to the high levels which may occur in their natural diet.

(α) 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 are recommended (Engelhardt and Geraci 1978).

(β) The recommended Ca:P ratio is between 1:1 and 2:1.

**Table 1.5. Nutrient content of several commonly used meat/nutritionally complete food items (dry matter basis).\***

Nutrient	Ground Horsemeat	Nebraska Feline®	Nutrena River Run Dog Food®	Purina Fit 'n' Trim Dog Food®
Crude Protein, %	51.7	50.0	23.9	18.2
Fat, %	19.7	31.6	9.1	5.7
Vitamin A, IU/g	-	97.1	5.7	20.1
Vitamin D, IU/g	-	1.2	5.7	2.0
Vitamin E, mg/kg	-	42.4	56.8	12.5
Ca, %	-	1.6	1.7	1.1
P, %	-	1.3	1.1	0.9
Mg, %	-	0.05	0.05	0.2

\* Values from manufacturer guaranteed analysis and analyses performed at or for Brookfield Zoo. See manufacturer contacts in Appendix 2.

**Table 1.6. Nutrient content of several commercially available fish species and marine products (dry matter basis).\***

Nutrient	Capelin	Herring	Oystershell	Shrimp***	Smelt	Trout
Dry Matter, %	18.8	27.7	100	24.1	22.7	23.7
Energy, kcal/g	5.5	6.3	-	2.3	7.0	6.5
Crude Protein, %	59.8	45.3	0	20.5-44.2	70.4	55.8
Fat, %	14.8	34.0	0	1.8-4.3	16.6	34.5
Vitamin A, IU/g	44	56	0	-	-	58
Vitamin E, IU/g	0.024	0.034	0	-	-	0.32
Ca, %	1.7	1.7	38.0	10.8	1.4	2.1
P, %	0.37(1.2-1.4**)	0.39	0.07	2.1	1.6	1.5

\* Analyses from Bernard and Ullrey (1989), Minnesota Zoo, Brookfield Zoo unless otherwise noted.

\*\* Unpublished data from the Brookfield Zoo and Minnesota Zoo indicates value may be closer to 1.2-1.4.

\*\*\* From NRC (1982), shrimp meal process residue, and Pennington (1989), whole raw shrimp.

**Table 1.7. Milk composition of several mustelid species.\***

Species	% Water	% Solids	% of Solids		
			Fat	Protein	Carbohydrate
N.A. River Otter	62.0	38.0	63.0	28.9	0.3
Sea Otter	69.9	30.1	65.0	31.2	2.6

Mink	78.3	21.7	33.0	26.0	21.0
	68.9	31.1	30.1	29.6	-
Badger	81.4	18.6	33.9	38.7	18.8
Ferret	76.5	23.5	34.0	25.5	16.2
Hog-nose Skunk	65.4	34.6	31.2	31.2	7.8
Striped Skunk	69.4	30.6	45.0	32.0	10.0

\* From Burnette (1994); Robbins (1993).

## **Appendix 1.1. ASC Otter Diets**

1997-98 SSP Survey Results

Reported Diet per Otter

### **Abbreviations:**

ALT - alternating

App - approximately

BE - behavioral enrichment

eod - every other day

ex - on exhibit

0.1 - female

1.0 - male

occ - occasionally

pcs - pieces

SMTWHFS - days of the week

X - quantity not listed

x/w - times per week

w/a - when available

### **Footnotes to Appendix 1.1:**

\* 1 can Iams Less Active for Cats (Fish and Rice), ½tbsp MirraCoat Daily Care, 1/8 cup Bran. Makes 5 ½meatballs.

\*\* 1 ½cans ZuPreem Feline, ½tbsp MirraCoat, 1/8 cup Bran. Makes 6 ½meatballs.

\*\*\* 30.0 % Purina Fit'n'Trim, 27.6% Ground Nebraska Horse Meat, 14.9% Ground Beef Heart, 12.3% water, 9.08% Ground Nutrena Cat Chow, 2.66% poultry fat, 2.06% Beet Pulp, 0.58% CaCO<sub>3</sub>, 0.44% Nutriderm Oil, 0.3% Theralin Substitute, 0.0001% Rovimix E-125.

	Audubon	Bermuda Aquarium	Birmingham Zoo	Bronx Zoo
<b>Manufactured Feeds</b>				
Commercial Cat Food	-	-	-	-
Commercial Dog Food	-	-	Purina 1cup	-
Hills ZuPreem Canned Feline	-	85g	-	-
Nebraska Canine	-	-	-	-
Nebraska Feline	-	-	1cup	225g
Nebraska Bird of Prey	-	-	-	-
Purina Fit'n'Trim	-	-	-	-
Otter Mix	-	-	-	-
Science Diet	-	-	-	-
Other	-	110g Buckeye Dog Kibble	-	-
<b>Meats</b>				
Horsemeat	-	-	1"x2" slice-1x/w Liver	-
Hard Boiled Egg	-	0.5	-	-
Other	-	-	-	-
<b>Fish/Seafood</b>				
Capelin	370g/d	-	-	60g
Crayfish	-	12g-2x/w	-	-
Smelt	230g/d	95g	4	-
Trout	-	-	-	-
Mackerel	50g/d	-	-	-
Herring	45g/d	92g	-	-
Goldfish	-	16g-w/a BE	-	-
Minnnows (Golden roaches)	-	-	-	-
Other	-	-	-	-
<b>Insects</b>				
Crickets	-	-	2-3x/w BE	App 10-20
Mealworms	-	handful w/a	2-3x/w BE	App 10-20
Other	-	Earthworms wild-in ex.	-	-
<b>Vegetables</b>				
Apple	-	-	-	-
Carrot	-	20g	0.5	50g
Lettuce	-	20g	-	-
Sweet Potato	-	-	-	-
Green Beans	-	-	2 1/2 beans	-
Assorted Greens	-	-	-	50g
Other	-	-	-	-
<b>Supplements</b>				
Vitamin E Supplement	65 IU	-	-	-
Corn Oil	2cc	-	-	-
Children's Vitamin	1/3 tablet	-	-	-
Stuart Thiamin-E	-	1g/kg fish	-	-
Linatone	-	1/2 tbsp	-	-
Vionate	-	-	-	-



B1	-	-	-	-
Chitin	-	-	-	-
Cod Liver Oil	-	-	-	-
Other	25mg Thiamin	-	1/2 tab B-Complex	X Vit-a-sol with Vit E

	Brookfield	Cleveland Metroparks	Columbus Zoo	Cheyenne Mt. Zoo
<b>Manufactured Feeds</b>				
Commercial Cat Food	-	50g IAMS Less Active	-	-
Commercial Dog Food	-	-	-	-
Hills ZuPreem Canned Feline	-	-	-	-
Nebraska Canine	-	-	-	-
Nebraska Feline	-	-	-	57g
Nebraska Bird of Prey	-	-	-	-
Purina Fit'n'Trim	10 g	-	2/3 cup	-
Otter Mix	-	-	-	-
Science Diet	-	-	-	-
Other	99g/f-162g/m Otter Mix***	-	4pcs Cycle Lite	-
<b>Meats</b>				
Horsemeat	Rib 120-140g 1x/w	-	-	-
Hard Boiled Egg	-	-	-	-
Other	-	-	227g Wisconsin	-
<b>Fish/Seafood</b>				
Capelin	65g,1x/w	30-60g	114g STHS	9-12g/d or
Crayfish	rarely - Tropic group	-	BE	-
Smelt	100g,1x/w	30-60g	114g Lake MWF	12-18g/d or
Trout	50g,1x/w	-	295g	-
Mackerel	-	-	-	-
Herring	68g,1x/w	-	-	12-18g/d
Goldfish	-	-	-	-
Minnows (Golden roaches)	App 25g/w	-	-	-
Other	-	-	Clams -BE	-
<b>Insects</b>				
Crickets	20g/w	-	occasionally	-
Mealworms	-	-	occasionally	-
Other	-	-	-	-
<b>Vegetables</b>				
Apple	-	-	-	-
Carrot	-	-	-	0.125
Lettuce	200 g/w - Tropic group	-	-	-
Sweet Potato	-	-	114g	-
Green Beans	-	-	6	-
Assorted Greens	-	-	-	1 leaf
Other	App 100 g/w cucumber	-	-	-
<b>Supplements</b>				
Vitamin E Supplement	-	-	-	-
Corn Oil	-	-	-	-
Children's Vitamin	-	-	-	-

Stuart Thiamin-E	-	-	-	-
Linatone	-	-	-	-
Vionate	-	-	-	1/4 tsp
B1	-	-	-	25mg
Chitin	-	-	Chitin	-
Cod Liver Oil	-	-	-	-
Other	-	300 mg K Citrate Granules	-	-

	Henry Doorly Zoo	Kansas City	Miami Metrozoo	Minnesota Zoo	National Zoo (group1)
<b>Manufactured Feeds</b>					
Commercial Cat Food	-	-	-	-	-
Commercial Dog Food	-	-	75g Wayne Bites	-	-
Hills ZuPreem Canned Feline	-	-	-	-	-
Nebraska Canine	100g	-	-	-	-
Nebraska Feline	30g	-	150g	-	-
Nebraska Bird of Prey	-	100g	-	-	-
Purina Fit'n'Trim	-	-	-	-	-
Otter Mix	-	-	-	-	-
Science Diet	-	T/D 2cups	-	-	-
Other	-	-	-	-	1IAMS-Meatball*
	-			-	1Zu-Prem Feline-Meatball**
<b>Meats</b>					
Horsemeat	-	-	-	-	2 Tail Bones S
Hard Boiled Egg	-	-	60g	-	-
Other	-	-	-	-	-
<b>Fish/Seafood</b>					
Capelin	60g	2-3x/w	-	60g	-
Crayfish	BE	daily-BE	-	-	1 HF
Smelt	-	-	-	30g	-
Trout	BE	-	-	-	-
Mackerel	-	-	-	60g	-
Herring	-	daily	-	60g	-
Goldfish	-	-	-	-	-
Minnows (Golden roaches)	-	eod-BE	-	App 20/w	-
Other	-	-	Cichlids 4/d	-	1 Fishpop MWS
<b>Insects</b>					
Crickets	-	-	20/d	-	1 T
Mealworms	-	-	25/d	-	-
Other	-	-	-	-	-
<b>Vegetables</b>					
Apple	-	-	-	-	-
Carrot	30g	-	30g	-	-
Lettuce	-	-	-	-	-
Sweet Potato	-	-	-	-	-

Green Beans	-	-	-	-	-
Assorted Greens	kale 70g	-	-	-	-
Other	-	-	-	-	-
<b>Supplements</b>					
Vitamin E Supplement	-	4 (E-400IU)	-	-	-
Corn Oil	-	-	-	4ml	-
Children's Vitamin	-	-	-	1/10 tablet	-
Stuart Thiamin-E	-	-	-	0.5ml	-
Linatone	-	-	3/4 tsp	-	-
Vionate	-	-	3/4 tsp	-	-
B1	-	4(100mg)	-	-	-
Chitin	Chitin 15g	-	-	-	-
Cod Liver Oil	-	-	3/4 tsp	-	-
Other	Polyvisol 3dps	-	-	-	-

	National Zoo (group2)	Reid Park	Santa Fe	Sea World- Ohio
<b>Manufactured Feeds</b>				
Commercial Cat Food	-	-	-	-
Commercial Dog Food	-	20 Parner	FRM chunks 30g	-
Hills ZuPreem Canned Feline	1/3 can	-	-	-
Nebraska Canine	-	-	112.5g	-
Nebraska Feline	-	454g	-	-
Nebraska Bird of Prey	-	-	-	-
Purina Fit'n'Trim	-	-	-	-
Otter Mix	-	-	-	-
Science Diet	-	-	-	85g
Other	1tbsp Bran	8 Zu-Preem Monkey Chow	-	-
<b>Meats</b>				
Horsemeat	-	-	-	-
Hard Boiled Egg	-	-	1/w	X - BE
Other	2 Chicks TH	-	Yogurt 6 tbsp	Tadpoles -BE
	5 Mice WS	-	-	-
	1 joint Ox tail S	-	-	-
<b>Fish/Seafood</b>				
Capelin	-	-	-	400g
Crayfish	-	-	every other month	BE
Smelt	10-15 MF	-	1	285g
Trout	-	-	-	varies - BE
Mackerel	-	-	-	-
Herring	-	-	-	-
Goldfish	-	-	-	BE
Minnnows (Golden roaches)	-	-	-	-
Other	-	5 Silversides MWF	crabs-eod	-
<b>Insects</b>				
Crickets	-	-	-	-
Mealworms	-	-	-	-
Other	-	-	-	-
<b>Vegetables</b>				

Apple	-	-	127.5g eod-ALT	-
Carrot	1tbsp-grated	-	120g eod-ALT	-
Lettuce	-	-	-	-
Sweet Potato	-	-	-	-
Green Beans	-	-	-	-
Assorted Greens	-	-	1.4 cup	-
Other	-	-	WhPotato 127.5g	-
<b>Supplements</b>				
Vitamin E Supplement	-	0.2cc	-	-
Corn Oil	-	-	-	-
Children's Vitamin	-	-	-	-
Stuart Thiamin-E	-	-	-	-
Linatone	-	-	1/4 tsp	-
Vionate	-	-	-	-
B1	-	-	-	-
Chitin	-	-	-	-
Cod Liver Oil	-	-	Cod liver oil 1/4 tsp	-
Other	-	-	-	-

	Sea World-Texas	Topeka	Zoo Atlanta
<b>Manufactured Feeds</b>			
Commercial Cat Food	-	-	-
Commercial Dog Food	-	-	-
Hills ZuPreem Canned Feline	-	-	-
Nebraska Canine	-	-	-
Nebraska Feline	-	-	113g
Nebraska Bird of Prey	-	-	-
Purina Fit'n'Trim	-	-	-
Otter Mix	-	-	-
Science Diet	112-148g	-	-
<b>Meats</b>			
Horsemeat	-	-	-
Hard Boiled Egg	-	-	-
Other	-	-	Bouillon cubes -BE
<b>Fish/Seafood</b>			
Capelin	420-644g	-	-
Crayfish	-	-	-
Smelt	-	-	-
Trout	-	-	occ treat
Mackerel	-	-	-
Herring	-	-	-
Goldfish	-	-	-
Minnnows (Golden roaches)	-	-	-
Other	-	-	silversides 75.7g
<b>Insects</b>			
Crickets	wild	-	10g STHS + Cricket cubes -BE
Mealworms	-	-	6.7g MWF
Other	-	-	-

<b>Vegetables</b>			
Apple	-	-	-
Carrot	-	-	-
Lettuce	-	-	-
Sweet Potato	-	-	-
Green Beans	-	-	-
Assorted Greens	-	-	-
Other	-	-	91g corn+celery+turnip root (MTH)
	-	-	91g whpotato+swpotato+carrot (SWFS)
	-	-	Celery
<b>Supplements</b>			
Vitamin E Supplement	-	-	0.12cc Emcelle
Corn Oil	-	-	-
Children's Vitamin	-	-	-
Stuart Thiamin-E	-	-	-
Linatone	-	-	-
Vionate	-	-	-
B1	-	-	-
Chitin	-	-	-
Cod Liver Oil	-	-	-
Other	Hi Vits	-	-

### **Appendix 1.2. Manufacturer Contacts.**

ABDEC Baby Vitamin Drops (liquid baby vitamins)

Parke-Davis  
 Division of Warner-Lambert Company  
 201 Tabor Road  
 Morris Plains, NJ

Animal Spectrum, Inc. (Nebraska Brand Feline, Canine, and Bird of Prey diets, horsemeat).

P.O. Box 721  
 North Platte, Nebraska 69103-0721

Hill's Pet Products (Prescription diets, ZuPreem Canned and Dry Foods)

P.O. Box 148  
 Topeka, KS 66601

Iams Co. (Iams Less Active Dog Food)

7250 Poe Ave  
 Dayton, OH 45414  
 800-525-4267

Nutrena Feeds (River Run Dog Food)

2101 Terminal Road

Fort Worth, TX 76106

Lambert Kay, Inc. (Linatone)  
Division of Carter-Wallace, Inc.  
Cranbury, NJ 08512-0187

Landco, Division of Golden Crown Corp. (Potassium Citrate Crystals)  
Post Falls, ID 83854

Pet Ag, Inc. (Mirracoat)  
261 Keyes Ave.  
Hampshire, IL 60140  
800-323-6878

Ralston Purina Co. (Fit'n'Trim Dog Food)  
St. Louis, MO 63164  
317-962-8547

Roche, Inc. (Rovimix-E)  
Animal Feed Division  
Nutley, NJ 07110-1199

SmithKline-Beecham Animal Health (Nutriderm)  
West Chester, PA 19380  
800-733-5500

Stuart Products, Inc. (Thiamin-E Paste)  
Bedford, TX 76021

Sundown Vitamins (Multivitamins)  
Boca Raton, FL 33487  
800-327-0908