ASSOCIATION OF ZOOS & AQUARIUMS

RED PANDA
(*Ailurus fulgens*)
CARE MANUAL

CREATED BY THE
AZA Red Panda Species Survival Plan®
IN ASSOCIATION WITH THE
AZA Small Carnivore Taxon Advisory Group

Red Panda (*Ailurus fulgens*) Care Manual

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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/

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

Chapter 5. Nutrition

5.1 Nutritional Requirements

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

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.

Feeding Ecology and Digestive System Morphology & Physiology: Red pandas are in the order Carnivora and are the only species in the family Ailuridae. Red pandas have a simple stomach, with no cecum and a short gastrointestinal tract (Stevens & Hume, 1995). These are adaptations for easily digestible foods that usually form the diet of carnivores (i.e., meat). However in the wild, red pandas have specialized in a diet of bamboo leaves and shoots that could account for ~95% of the total food consumed. In autumn, the diet of *in situ* red pandas also contains fruits, acorns, and mushrooms (Wei & Zhang, 2011; Wei, 2000; Wei, 1999). *In situ*, in order to thrive it is suggested the red panda selects high-quality portions of the bamboo like the tender leaves and shoots. However due to a rapid passage rate, they have to ingest large quantities (1.5 kg [3.3 lb] of leaves and 4 kg [8.8 lb] of shoots, as fed) to maximize nutrient intake and absorption (Wei & Zhang, 2011; Wei, 1999). The simple structure of their digestive system limits the ability to process this high fibrous diet. However, to cope with it, red pandas have developed several morphological, physiological, and behavioral strategies: 1) skull and teeth adaptations for effective mastication, 2) ability to select the most nutritious parts of bamboo, 3) daily consumption of large amounts of food and rapid passage time of digesta to maximize the rate of energy intake, and 4) low metabolic rate that reduces energy requirements (Wei, 1999).

Energy: Animals require energy for basal metabolic functions—(vital cell activity, respiration, cardiovascular distribution of the blood), in a resting, unstressed, post-absorptive state, in a thermoneutral environment (no shivering or special activity to maintain body temperature). Basal energy expenditure is related to body surface; Kleiber (1975) concluded fasting homeotherms produce 1,000 kcal of heat per square meter body surface. Kleiber (1975) used previously published research to establish the equation 70BWkg0.75 to express kilocalories needed per day for basal metabolic functions.

Red pandas vary their intake of shoots and leaves relative to seasonal changes both in the wild and in zoos. It was noted by McNab (1988) that the red panda have a low rate of metabolism, which is only 39% of the value predicted by the Kleiber equation at ambient temperature of 25–30 °C (77–86 °F). Red pandas have a higher energy requirement in the winter months and probably also in late gestation, during lactation and especially during growth. During these times the animals should always be fed enough so as to have at least 3% of the total food offered is left uneaten (Nijboer & Dierenfeld, 2011).

Seasonal Influence: Increased or decreased requirements for illness, thermoregulation, or activity can be met by offering diets *ad lib.* and monitoring body condition. In general diets should be offered so that a small amount of food is remaining at the end of the feeding period.

Body Condition: Wild red panda (*Ailurus fulgens*) weights range between 3–5 kg (6.6–11 lbs) (Nowak, 1999; Macdonald, 1999). Adult *A. fulgens* (in zoos) with a body weight of between 5–6 kg (11–13 lbs) have been found to consume between 145–200 g of nutritionally complete biscuits (as fed) each day. This represents intake of animals in a maintenance situation, (e.g., when the animals were under little stress from the weather, not pregnant or lactating, and in the absence of any other food item) (Nijboer & Dierenfeld, 2011). Due to their dense hair coat and body shape, it is difficult to determine a standard body condition score for red pandas. Periodic photos taken in the same position, over time, may be helpful to pair with weights, as an assessment of body condition.

Target Nutrients: Target nutrient levels for red pandas are listed in Table 5. These are adapted from Fulton et al. (1989) and based on National Research Council (NRC) requirements for non-human primates (2003) and cats (2006) with American Association of Feed Control Officials (AAFCO) requirements for cats (2011) (AAFCO, 2011; Fulton et al., 1989; NRC Cats, 2006; NRC Nonhuman Primates, 2003). These nutrient ranges represent the best-studied domestic animals, which match most closely the foraging ecology and gastrointestinal tract morphology of the red panda.

Table 5: Target Nutrient Ranges for red panda (dry matter basis)

Nutrient	Recommended Target Range[1]
Crude Protein, %	15–30
Fat, %	5–8.5
Linoleic Acid	0.5–2.0
Acid detergent fiber (ADF), %	5–15
Calcium, %	0.30–1.2
Phosphorous, %	0.30–1.0
Sodium, %	0.04–0.3
Potassium, %	0.40–0.60
Magnesium, %	0.04–0.10
Iron, mg/kg	20–100
Iodine, mg/kg	0.35–1.5
Copper, mg/kg	6.0–20.0
Manganese, mg/kg	5.0–40.0
Selenium, mg/kg	0.11–0.35
Zinc, mg/kg	20–120
Thiamin, mg/kg	1.0–3.0
Riboflavin, mg/kg	2.2–10.5
Pyridoxine, mg/kg	1.0–4.0
Vitamin B12, mg/kg	0.01–0.035
Niacin, mg/kg	11.4–30.0
Folate, mg/kg	0.18–4.0
Biotin, mg/kg	0.10–0.2
Choline, mg/kg	750–1700
Pantothenate, mg/kg	10.0–15.0
Vitamin A, IU/g	0.5–8.0
Vitamin E, mg/kg	30.0–100
Vitamin D, IU/g	0.5–2.5

[1]Nutrient requirements are based on Fulton et al., (1989), NRC Cats (2006), NRC Nonhuman Primates (2003), and AACFO requirements for cats (2011).

Provision of Variability in Food Type and Presentation: Based on SSP nutrition research from the late 1980's and current feeding ecology information, red pandas should be offered a large quantity of bamboo and provided with a nutritionally balanced diet of good quality nutritionally complete primate leaf eater biscuits (nutrient profile of: protein 23%, fat 5–6.5%, crude fiber 10–12%, acid detergent fiber 13–16%)(Eriksson, 2010; Pradhan, 2001; Wei, 1999; Wei, 2000). Bamboo should be offered ad libitum *Pseudosomas*, *Phyllostachys* and/or *Pseudosasa spp,* among others (Fulton, 1989). Some red pandas will self-limit intake of leaf eater biscuits; others will become obese if fed biscuits ad lib. Red pandas can be easily trained to climb on to platform scales and frequent weighing and adjustment of the biscuit portion of the diet is recommended based on weight, condition, intake, and behavioral observations.

Dietary ingredients should be fresh and of good quality. Fresh water should always be available. Every effort should be taken to avoid spoilage of the food during warm weather and freezing during cold. Offering bamboo with a dry biscuit should help eliminate these kinds of problems. To further reduce this problem it is suggested that the animals are fed at least twice per day; at these times fresh food should be provided and the old food removed (Nijboer & Dierenfeld, 2011). This will help minimize the impacts of desiccation, by keeping fresh, hydrated product available through the day. When animals are housed together it may be important to offer food in more than one bowl and in several locations. This will ensure that all animals will have access to the same food items and will help prevent one animal from potentially dominating the food situation and excluding others from the more nutritious components of the diet (Roberts & Glatston, 1994).

Red pandas that are "off" their food (this can occur in varying circumstances) can be tempted to eat by soaking their biscuit in water or apple juice, making a sweetened gruel or by smearing their biscuits

with a sweet product. It is important that the sweetener/gruel is withdrawn from the diet as soon as possible to avoid dental problems (Nijboer & Dierenfeld, 2011).

Bamboo: Fresh bamboo should be offered *ad lib*. Red pandas readily consume many species of bamboo. In 2010 a survey was completed by the AZA Red Panda SSP on what species of bamboo was offered and consumed. Forty-five institutions responded and the list of bamboo offered is in Table 6 in order of most commonly provided, the most common species being *Phyllostachys aureosulcata*. Although it is not recommended to offer a diet without bamboo if bamboo is unavailable, or only seasonally available, then fiber should be incorporated into the diet as the nutritionally complete biscuit (Nijboer & Dierenfeld, 2011). If fresh bamboo is not readily available in your area, please contact the AZA Red Panda SSP for information on where to purchase bamboo.

Table 6: Bamboo species fed to red panda in order of most commonly offered

Phyllostachys aureosulcata
P. aurea
P. japonica
P. bissetii
P. nuda
P. decora
P. nigra "Henon"
P. angusta
P. nidularia
P. heteroclada
P. nigra
P. bambustoides
P. edulis
P. dulcis
P. ventricosa
P. vivex
P. purpurata
Fargesia sp.
Indocalamus tessellates
Sasaella masamuneana 'albostriata'
Semiarundinaria okuboi
Arundinarea gigantean
Sasa pygmaea
Bambusa chungii
Bambusa vulgaris

Fruit: These are not important nutritionally to the diet of the red panda. In fact, they can be harmful especially if offered in large quantities, as they will dilute the nutrients in the biscuit thus lowering the nutrient content of the diet (Fulton, 1987; Nijboer & Dierenfeld, 2011). In addition, fruits provide readily fermentable carbohydrate and little fiber, which is not appropriate for the gastrointestinal health of the red panda.

Fruit can be useful in small amounts as a training reward or when providing medications to the animals as undesirable substances can be presented in a palatable form (Nijboer & Dierenfeld, 2011). Many red pandas readily accept apples and bananas, but all produce should be fed very sparingly as it can cause the animals to become overweight.

Provision of Food and Water: Fresh water needs to be available to all animals at all times of day. Care should be taken so that sufficient water is available and freezing is avoided. Where there is no fresh potable water available in the exhibit, sturdy bowls that are not easily inverted are usually suitable for providing water. Animals with restricted water intake will also decrease food intake so the availability of fresh water is very important. All food and water containers should be cleaned and disinfected daily.

In general, only foods that can easily be contaminated by dirt (e.g., moist foods or fruit) should be placed in containers, the rest can be scattered or hidden for the animals to find. Dry foods, or foods that can be left whole, can be scattered or hidden around the exhibit. Bamboo should be placed in holders that are attached to the trees and/or structures so the long stalks of bamboo reaches higher parts of the exhibit. Smaller branches can also be placed on the ground for variety (AZA Small Carnivore TAG, 2010).

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.

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.

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. The appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established for the taxa or species specified. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. Remove food within a maximum of 24 hours of being offered unless state or federal regulations specify otherwise and dispose of per USDA guidelines.

AZA Accreditation Standard

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

If browse plants are used within the animal's diet or for enrichment, all plants must be identified and assessed for safety. The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the red pandas. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available. (Cheeke, 1985; Kingsbury, 1964)

AZA Accreditation Standard

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

Diet Composition: All red panda diets should contain bamboo and a dry biscuit with very little fruit. The recommended composition of red panda diet is shown in Table 7.

Table 7: Recommended red panda diet ratio

Food Type	% In Diet
Bamboo	65%–75%
Nutritionally Complete Leafeater Biscuit	23%–33%
Produce	2%
Total	100%

Listed below in Table 8 are sample diets for red panda. Both subspecies are represented in Table 8 to show different quantities based on the fact that *refulgens (styani)* are larger bodied animals than *fulgens*. Tables 9 &10 outline the nutrient analysis from those diets.

Table 8: Sample diets from successful red panda holding and/or breeding institutions

Subspecies	Institution	Food Item[1]	Grams/day	% in Diet
refulgens (styani)	A: adult male	Marion Leafeater biscuit	225	33.58
		Banana – peeled	104	15.52
		Vionate supplement	1	0.15
		Bamboo	340	50.75
		Total	670	100
	A: adult female	Mazuri Leafeater 5M02 biscuit	300	43.10
		Banana – peeled	55	7.90
		Vionate supplement	1	0.14
		Bamboo	340	48.85
		Total	696	100
	B: young female	Apple – every day	87	9.94
		Mazuri Leafeater 5M02 biscuit	288	32.97
		Bamboo	275	31.48
		Grapes – every day	67	7.65
		Papaya – 4x/wk	28	3.24
		Pear – 3x/wk	21	2.43
		Frozen Blueberries – 4x/wk	21	2.43
		Cantaloupe – 4x/wk	28	3.24
		Banana – 5x/wk	35	4.05
		Kale – 2x/wk	6	0.74
		Endive – 1x/wk	3	0.37
		Romaine – 1x/wk	3	0.37
		Spinach – 1x/wk	3	0.37
		Collards – 1x/wk	3	0.37
		Red Leaf Lettuce – 1x/wk	3	0.37
		Total	874	100
	B: young male	Apple – every day	80	11.02
		Mazuri Leafeater 5M02 biscuit	220	30.47
		Bamboo	275	38.09
		Grapes – every day	53	7.37
		Papaya – 4x/wk	15	2.02
		Pear – 3x/wk	11	1.51
		Frozen Blueberries – 4x/wk	11	1.51
		Cantaloupe – 4x/wk	15	2.02
		Banana – 5x/wk	18	2.52
		Kale – 2x/wk	7	0.99
		Endive – 1x/wk	4	0.49
		Romaine – 1x/wk	4	0.49
		Spinach – 1x/wk	4	0.49
		Collards – 1x/wk	4	0.49
		Red Leaf Lettuce – 1x/wk	4	0.49
		Total	722	100
	B: adult male	Apple – every day	39	4.09
		Mazuri Leafeater 5M02 biscuit	300	31.25
		Marion Leafeater	50	5.21
		Bamboo	275	28.65
		Grapes – every day	84	8.76
		Papaya – 4x/wk	39	4.09
		Pear – 3x/wk	29	3.07
		Frozen Blueberries – 4x/wk	29	3.07
		Cantaloupe – 4x/wk	39	4.09
		Banana – 5x/wk	49	5.12
		Kale – 2x/wk	7	0.74
		Endive – 1x/wk	4	0.37
		Romaine – 1x/wk	4	0.37
		Spinach – 1x/wk	4	0.37
		Collards – 1x/wk	4	0.37
		Red Leaf Lettuce – 1x/wk	4	0.37
		Total	960	100

Subspecies	Institution	Food Item[1]	Grams/day	% in Diet
Fulgens	C	Marion Leafeater	375	57.25
		Apple	30	4.58
		Pear	30	4.58
		Grapes	30	4.58
		Babyfood	42	6.41
		STAT supplement	60	9.16
		Bamboo	88	13.44
		Total	665	100
	D	Marion Leafeater biscuit	300	17.54
		Bamboo	1300	76.02
		Grapes	20	1.17
		Apple	90	5.26
		Total	1710	100
	E	Marion Leafeater biscuit	250	22.73
		Bamboo	800	72.73
		Grapes	25	2.27
		Apples	25	2.27
		Total	1100	100

[1]Marion Zoological 03 E. Center Circle, Plymouth, MN 55441, PMI Nutrition International (Mazuri), Grays Summit, MO 63039, STAT supplement PRN Pharmacal Pensacola, FL 32514, Vionate vitamin mineral powder Gimborn Pet Specialities Atlanta, GA 30340.

Table 9: Nutrient content of sample red panda sp. diets[1] (dry matter basis)

	refulgens (styani)	*refulgens (styani)*	*refulgens (styani)*	*refulgens (styani)*	*refulgens (styani)*	
Nutrient	Inst. A: Female	Inst. A: Male	Inst. B: Female	Inst. B: Male	Inst. B: Male	Target Nutrients[1]
Protein (%)	17.1	18.3	17.7	16.9	18.55	15–30
Fat, %	5.3	5.4	5.2	5.3	5.3	5–8.5
Essential n-6 Fatty Acids, %	1.3	1.9	1.9	1.7	2.0	0.5–2.0
ADF, %	25.9	26.4	23.8	25.6	23.0	5–15
Calcium (%)	0.73	0.77	0.74	0.70	0.78	0.30–1.2
Phosphorus (%)	0.45	0.49	0.47	0.44	0.50	0.30–1.0
Sodium (%)	0.17	0.18	0.18	0.17	0.19	0.04–0.3
Potassium (%)	0.91	1.01	1.0	1.01	1.08	0.40–0.60
Magnesium (%)	0.15	0.17	0.16	0.16	0.17	0.04–0.10
Iron (mg/kg)	143	407	390	371	409	20–100
Iodine (mg/kg)	0.032	1.14	1.1	1.0	1.1	0.35–1.5
Copper (mg/kg)	19.4	14.0	15.5	14.6	16.3	6.0–20.0
Manganese, mg/kg	44.1	89.9	87.2	81.7	92.3	5.0–40.0
Selenium (mg/kg)	0.23	0.16	0.15	0.14	0.17	0.11–0.35
Zinc (mg/kg)	76.7	104	100	94.4	106	20–120
Thiamin (mg/kg)	3.6	7.5	7.5	6.9	8.0	1.0–3.0
Riboflavin (mg/kg)	4.4	8.3	8.2	7.5	8.8	2.2–10.5
Pyridoxine (mg/kg)	4.5	8.1	8.1	7.4	8.7	1.0–4.0
Vitamin B12 (mg/kg)	0.02	0.03	0.03	0.03	0.04	0.01–0.035
Niacin (mg/kg)	29.8	75.1	74.4	68.4	79.7	11.4–30.0
Folacin (mg/kg)	0.5	7.4	7.3	6.7	7.8	0.18–4.0
Biotin (mg/kg)	0.11	0.2	0.19	0.18	0.20	0.10–0.2
Choline, mg/kg	2	1018	991	913	1059	750–1700
Pantothenic acid (mg/kg)	12.3	40.9	40.2	36.9	42.9	10.0–15.0
Vitamin A (IU/g)	5.4	13.8	18.2	17.2	19.5	0.5–8.0
Vitamin E (mg/kg)	145	129	129	119	138	30.0–100
Vitamin D (IU/g)	1.15	2.0	1.9	1.8	2.1	0.5–2.5

Table 10: Nutrient content of sample red panda sp. diets[1] (dry matter basis)

Nutrient	*fulgens* Inst. C	*fulgens* Inst. D: Female	*fulgens* Inst. E	Target Nutrients[2]
Protein (%)	21.2	13.0	15.3	15–30
Fat, %	10.8	5.5	7.5	5–8.5
Essential n-6 Fatty Acids, %	1.9	0.78	0.92	0.5–2.0
ADF, %	15.9	34.3	32.7	5–15
Calcium (%)	0.94	0.50	0.43	0.30–1.2
Phosphorus (%)	0.60	0.29	0.28	0.30–1.0
Sodium (%)	0.25	0.10	0.12	0.04–0.3
Potassium (%)	0.85	0.79	0.37	0.40–0.60
Magnesium (%)	0.17	0.11	0.08	0.04–0.10
Iron (mg/kg)	138	143	59.3	20–100
Iodine (mg/kg)	2	2	2	0.35–1.5
Copper (mg/kg)	25.6	12.9	11.8	6.0–20.0
Manganese, mg/kg	55.8	31.9	25.6	5.0–40.0
Selenium (mg/kg)	0.33	0.13	0.16	0.11–0.35
Zinc (mg/kg)	102	51.7	47.3	20–120
Thiamin (mg/kg)	5.7	2.0	2.4	1.0–3.0
Riboflavin (mg/kg)	6.6	2.4	2.8	2.2–10.5
Pyridoxine (mg/kg)	5.1	1.7	2.0	1.0–4.0
Vitamin B12 (mg/kg)	0.02	0.01	0.01	0.01–0.035
Niacin (mg/kg)	48.9	16.8	19.8	11.4–30.0
Folacin (mg/kg)	0.82	0.27	0.32	0.18–4.0
Biotin (mg/kg)	0.17	0.07	0.08	0.10–0.2
Choline, mg/kg	2	2	2	750–1700
Pantothenic acid (mg/kg)	20.7	6.7	7.92	10.0–15.0
Vitamin A (IU/g)	9.1	2.91	3.4	0.5–8.0
Vitamin E (mg/kg)	221	83.9	98.9	30.0–100
Vitamin D (IU/g) 3	1.7	0.65	0.77	0.5–2.5

[1]Nutrient requirements are based on Fulton et al., (1989), NRC Cats (2006), NRC Nonhuman Primates (2003), and AACFO requirements for cats (2011).
[2]There is no value for iodine or choline for the Marion Leafeater biscuit.

5.3 Nutritional Evaluations

Diets should be formulated taking into account an animal's size, activity level, age, and over-all health. Target weights should be set for each animal and diets formulated to maintain that weight. Red pandas have been noted to become obese from overfeeding, lack of exercise, or a combination of the two. "Goal weights" for individuals should be established (ideally, general, and seasonal), and body weight checked frequently, so that diet adjustments can be made in a timely fashion to avoid over or under-condition.

The AZA Red Panda SSP has collected the weights of red pandas in the North American population for the past several years (2008–2011) and based on the pairs that have bred, a correlation can be made that red pandas do not breed when obese. Careful weight management of breeding pairs, the females in particular, is very important. Red pandas have been noted to easily gain weight in zoos and aquariums. This can be managed by regularly monitoring their weight and adjusting diets as needed. See Appendix I for weight calculation chart.

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

Analysis of weight fluctuations can be a valuable tool for managing individuals and populations. Weight changes can reflect nutritional problems (e.g., obesity and under-conditioning), illness (e.g., cancer, organ failure, etc.), other medical conditions (e.g., intestinal blockage, etc.), changes in reproductive condition (e.g., pregnancy or weight loss during lactation), and hormonally or environmentally induced changes in metabolism (e.g., prior to dormancy and the onset of the breeding season). Correlating weight changes with key life history parameters will enable animals to be managed much more effectively and efficiently (AZA Small Carnivore TAG, 2010).

The other type of dam/cub management is to lock the dam into her nest area in mid-May and keep her and the cubs inside until the cubs are 2–3 months old. Considerations for this type of management would be to make sure the denning area is air conditioned and that the male, if he is outside on exhibit, has access to other nest areas. Also, the denning area needs to consist of more than one nest box to give the dam choice of nesting areas. When the dam/cubs are released out on exhibit, the depth of any water features will still need to be considered to avoid any drowning possibilities.

Combinations of these two management styles may also be considered. The personality of the dam will determine which management style of combination works best.

Female with cubs on exhibit – Sarah Glass

Example of nest area – Mary Noell

7.5 Assisted Rearing

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

Poor milk production has also been known to occur in some red panda mothers. If the cubs do not appear to be receiving any or enough milk, they can be pulled for hand rearing, or if the mother's personality allows, they can be supplement fed while remaining with their mother.

Due to a powerful sucking response that could result in aspiration of liquid, animals should be fed initially by stomach tube (size 7–10 French, depending on animal size). A measured volume is delivered by syringe. The procedure is simple and easily taught to handlers by veterinary staff. Attempts at bottle-feeding should be delayed until animals are well stabilized to milk formula (one week or longer, depending on animal age and condition). Initial bottle-feeding attempts should utilize a sterile solution of 5% dextrose and 0.9% NaCl in case of aspiration. For young red pandas the small teats

Two month old cub being hand fed – Mary Noell

Example of feeding tube – Mary Noell

designed for premature human infants may be appropriate. Bottle-feeding can be adopted when controlled sucking is obtained. The size of the hole in the teat is important for regulation of milk flow rate and should be monitored periodically to avoid excessive milk flow.

The milk formula generally used is a solution of powdered Esbilac® (Borden, Inc.) in boiled water to which a lactase enzyme preparation is added at rate of 1 drop per 100 g formula. The formula should be predigested with the enzyme for 24 hours in a refrigerator or for 90 minutes at 32–35° C (90–95° F) (e.g., in a water bath). Due to possible bacterial contamination use the 24-hour formula for one day only (discard at 48 hours after initial preparation). 90-minute formula is kept for only 12 hours prior to being discarded. Formula is kept refrigerated after the pre-digestion period and only the amount required for each feed is warmed prior to feeding. Please see Appendix K for the feeding chart. (Esbilac® is a product from Borden, Inc. Lacteeze, Gelda Scientific 6320 Northwest Drive, Mississauga, Ontario, Canada, L4V 1J7, phone (905) 673-9320 fax (905) 673-8114 (toll free: 1-866-673-9320), email: gelda@globalserve.net; web: www.gelda.com). In order to aid the development of a new milk substitute, any zoo which has to sedate a lactating panda is asked to obtain a milk sample for analysis.

For the first few feeds the formula should be very dilute (7% Esbilac® by weight, e.g., 7 g Esbilac®, 93 g boiled water, one drop Lactaid or Lacteeze [make sure to check expiration dates]) to allow acclimation to formula constituents. Formula concentration is gradually increased in stepwise fashion (10%, 12%, 15%, 18%, 20% Esbilac®) according to animal performance and age. Thus the formula concentration might reach 15% strength in one week and 20% in three weeks. Formula is kept at this strength until weaning. In some instances pediatric vitamins (ABDEC, Parke-Davis, Morris Plains, N.J. 07950) or iron supplements have been given to hand reared red pandas but these may not be necessary in most cases as Esbilac contains generous levels of these nutrients.

Bottles used to hand-feed cubs – Mary Noell

Animals are initially fed at 3-hour intervals (8x per day). As the animals stabilize and get stronger the interval can be increased to 4 hours (6x per day). The amount fed per day is based on body weight; therefore it is essential to weigh the animals each day. A typical regimen for the first week would be 25–30% of body weight distributed over 8 feeds (3.1–3.8% of body weight per feed). The amount to feed is recalculated at 3–4 days intervals based on body weight changes. As the animal ages the percentage of body weight fed per day is gradually reduced, (e.g., at about 1 month old, the panda is fed 20–25% of its body weight per day, at 2 months old 16–18% per day, and at 3 months old about 15% per day). These amounts are modeled after milk intakes of mother-reared carnivores; small (undersized) animals should be fed at the upper end of these percentage ranges.

Weaning red panda cub – Sandy Helliker

Weaning in bottle-raised red pandas is begun at approximately 4 months, which can include offering panda gruel, or formula soaked biscuits in a bowl, in addition to the formula. The animals should be taught to consume formula from a bowl, which can prove difficult. A spoon can be used over the bowl at first, slowly lowering the spoon until the panda is prompted to eat from the bowl. In one case the teat had to be placed in the bowl of formula to initiate feeding. The amount of gruel or softened biscuits added is gradually increased then changed to hard biscuits such that animals may be fully weaned by 5 to 6 months. Fruit can be added gradually after hard biscuits are being readily eaten or to entice the cubs to eat the hard biscuits. Red pandas resist rapid dietary change. Bamboo can be offered separately from about 70–90 days to allow manipulation and investigation; they may not be eaten at first. Water should be made available as solids are introduced.

The gruel to which animals are weaned is a mixture of red panda formula and crushed leaf eater biscuits. The amount of biscuit added to the formula is gradually increased until cubs are ready to transition to formula softened biscuits, then to water softened biscuits then to the adult diet of hard biscuits and bamboo.

Young red pandas are initially kept in an incubator or warm box at 29.4–32.2 °C (85–90 °F). As they mature, they are prone to heat stress. Fans can help in hot weather.

Hand reared red pandas gain weight at a rate equal to or above that of mother-reared young. Weights of hand-reared animals are provided below. Early weights of animals pulled due to small size are excluded (i.e., animals much smaller than those below are underweight). For both subspecies, an average weight gain of 7–10 g per day is healthy.

Cub being weighed – Sandy Helliker

A. fulgens

Birth ca. 100 g	10 weeks 0.9–1.4 kg
2 weeks 160–210 g	3 months 1.3–1.9 kg
4 weeks 260–360 g	4 months 1.8–2.6 kg
6 weeks 460–650 9	5 months 2.4–3.7 kg
8 weeks 650–960 g	6 months 3.2–4.8 kg

A. refulgens (styani)

Birth	110–169 g		
2 weeks	213–359 g	3 months	2.8–3.1 kg
4 weeks	447–592 g	4 months	4.2–5.2 kg
6 weeks	685–1.01 kg	5 months	5.7–7.4 kg
8 weeks	1.1–1.5 kg	6 months	6.9–7.6 kg

Additional Considerations: Animals should be reared as a group if at all possible to prevent abnormal socialization as they mature. If you are hand rearing a single red panda cub, contact the SSP to see if a

peer rearing opportunity exists. Since young animals tend to suck on each other, they may need to be housed separately for an initial period.

Stimulate young animals to induce elimination. Stimulate anal and urethra separately to avoid urinary tract infections. Lubricants are not necessary and may contribute to infections. Diaper cream (Desitin®) can be used for irritation. Older cubs may develop soreness in the anal region from frequent scent marking (anal rubbing) of objects in the enclosure.

Nails will require periodic trimming, even so it may be necessary to wrap older cubs in a towel for feeding to avoid scratches. Handlers will need heavy trousers when animals start to climb on them (this behavior should be discouraged and not inadvertently positively trained in any way).

Urethra being stimulated in two month old panda cub– Mary Noell

Example of a brooder – Mary Noell

Myconium: The first stool a baby passes after birth looks different than normal stool and is one way to tell if a baby has nursed. Red panda cubs typically do not pass myconium until they have nursed. There may be the odd time they will pass myconium in utero or during labor, however when this happens it can cause respiratory distress after the birth.

The normal range for rectal temperature appears to be 35.2–36.6 °C (95.4–98 °F). Rectal temperatures above 37.2–37.7 °C (99–100 °F) may indicate a medical problem. Rectal temperature should be monitored once or twice a day in young animals.

References

Association of American Feed Control Officials (AAFCO). (2011). Dog and Cat Nutrient Profiles. (pp. 146–162). Oxford, IN: The Association of American Feed Control Officials.

AZA SCTAG. (2010). Procyonid Care Manual (pp. 33–46, 57–69). Silver Spring, MD: Association of Zoos and Aquariums,

AZA SCTAG (2009). Small Carnivore Taxon Advisory Group Regional Collection Plan 3rd Edition (pg. 34). Silver Spring, MD: Association of Zoos and Aquariums,

Bitgood, S., Patterson, D., & Benefield, A. (1986). Understanding your visitors: ten factors that influence visitor behavior. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 726–743).

Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior. *Environment and Behavior*, *20*(4), 474–491.

Cheeke, P. (1985). Natural toxicants in feeds and poisonous plants. Westport, CT: The AVI Publishing Company.

Churchman, D. (1985). How and what do recreational visitors learn at zoos? *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp.160–167).

Conway, W. (1995). Wild and zoo animal interactive management and habitat conservation. *Biodiversity and Conservation*, *4*, 573–594.

Davison, V.M., McMahon, L., Skinner, T.L., Horton, C.M., & Parks, B.J. (1993). Animals as actors: take 2. Annual Proceedings of the American Association of Zoological Parks and Aquariums (pp. 150–155).

Eriksson, P, J Zidar, D. White, J. Westander, M Andersson. 2010. Current husbandry of red pandas (*Ailruus fulgens*) in Zoos. Zoo boil 29:1-9.

Fulton, K.J., Crissey, S., Oftedal, O.T., & Ullrey, D.E. (1987). Fiber utilization in the red panda. Proceedings of the 7th Dr. Scholl Conference on the Nutrition of Captive Wild Animals.

Fulton, K.J., Roberts, M.S., Oftedal, O.T., Baer, D.J., Allen, M., & Crissey, S. (1989). The Red Panda SSP Diet Evaluation Project. Proceedings of the 8th Dr. Scholl Conference on the Nutrition of Captive Wild Animals.

Johnston, R.J. (1998). Exogenous factors and visitor behavior: a regression analysis of exhibit viewing time. *Environment and Behavior*, *30*(3), 322–347.

IUCN 2011. *IUCN Red List of Threatened Species. Version 2011.2*. <http://www.iucnredlist.org>. Downloaded on 8/15/2011.

Kingsbury, J.M. (1964). Poisonous Plants of the United States and Canada. Englewood Cliffs, NJ: Prentice Hall, Inc.

Kleiber, M. (1975). The Fire of Life: An Introduction to Animal Energetics (2nd ed.), Melbourne, FL: Kreiger.

Macdonald, D. (Ed.). (1999). The Encyclopedia of Mammals. Barnes & Nobel, Inc.

MacMillen, O. (1994). Zoomobile effectiveness: sixth graders learning vertebrate classification. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 181–183).

McMillan, G., Drummer, L., Widner, K., & Glass, S. (2002). Establishing a Behavioral Management Program for the red panda (*Ailurus fulgens*). Knoxville Zoological Gardens. Red Panda SSP Keeper Workshop, Knoxville Zoological Gardens, October 18 – 20, 2002.

McMillan, G., Glass, S., (1995) Red Panda Keeper training Manual, Knoxville Zoological Gardens, 2004 Red Panda SSP Keeper Workshop, Knoxville Zoological Gardens, USA.

McNab, B.K. (1988). Energy conservation in the tree kangaroo (*Dendrlolagus matschiei*) and the red panda (*Ailurus fulgens*). *Physiological Zoology*, *61*, 280–292.

Morgan, J.M., & Hodgkinson, M. (1999). The motivation and social orientation of visitors attending a contemporary zoological park. *Environment and Behavior*, *31*(2), 227–239.

National Research Council (NRC). (2003). Nutrient Requirements of Nonhuman Primates. Washington, D.C.: National Academy Press.

National Research Council (NRC). (2006). Nutrient Requirements of Cats and Dogs. Washington, D.C.: National Academy Press.

Nijboer, J., & Dierenfeld, E.S. (2011). Red panda nutrition: how to feed a vegetarian carnivore. A.R. Glatson, (Ed.). *Red panda: biology and conservation of the first panda* (pp. 257–270). San Diego, CA: Academic Press.

Nowak, R.M. (1999). Walkers Mammals of the Wild, (6th ed.). Baltimore, MA: The Johns Hopkins University Press.

Povey, K.D. (2002). Close encounters: the benefits of using education program animals. *Annual Proceedings of the Association of Zoos and Aquariums* (pp. 117–121).

Povey, K.D., & Rios, J. (2002). Using interpretive animals to deliver affective messages in zoos. *Journal of Interpretation Research*, *7*, 19–28.

Pradhan, S., G.K. Saha, J.A., Khan. 2001. Ecology of the red panda (*Ailruus fulgens*) in the Singhalila National Park, Darjeeling, India. *Biology of Conservation, 98*:11.

Roberts, M.S. (1980). Breeding the red panda (Ailurus fulgens) at the National Zoological Park. *Zoologischer Garten*, *1980*, 253–263.

Roberts, M.S. & Gittleman, J., (1984). *Ailurus fulgens*. *Mammalian Species*, *222*, 1–8.

Roberts, M. & Glatston, A. (1994) Management and Husbandry Guidelines for red panda. As adopted by the AZA Red Panda SSP, Red panda Studbook, and International Red panda Management Group. National Zoological Park, Washington, D.C.

Roberts, M. (2002). Biology of the red panda General Summary. Red panda SSP Keeper Training Workshop, Knoxville Zoological Gardens, October 18 – 20, 2002.

Sherwood, K.P., Rallis, S.F., & Stone, J. (1989). Effects of live animals vs. preserved specimens on student learning. *Zoo Biology*, *8*, 99–104.

Stevens, C.E., & Hume, I.D. (1995). Comparative Physiology of the Vertebrate Digestive System (2nd ed.) New York, NY: Cambridge University Press.

Wei, F., & Zhang, Z. (2011). Red panda ecology. A.R. Glatson, (Ed.). Red panda: biology and conservation of the first panda (pp. 193–212). San Diego, CA: Academic Press.

Wei, F., Feng, Z., Wang, Z., Zhou, A., & Hu, J. (1999). Use of the nutrients in bamboo by red panda (*Ailurus fulgens*). *Journal of Zoology, London, 248*(4), 535–541.

Wei, F., Wang, Z., Feng, Z., Li, M., & Zhou, A. (2000). Seasonal energy utilization in bamboo by the red panda (*Ailurus fulgens*). *Zoo Biology*, *19*(1), 27–33.

Wolf, R.L., & Tymitz, B.L. (1981). Studying visitor perceptions of zoo environments: a naturalistic view. P.J.S. Olney (Ed.). *International Zoo Yearbook* (pp.49–53). Dorchester: The Zoological Society of London.

Yerke, R., & Burns, A. (1991). Measuring the impact of animal shows on visitor attitudes. Annual Proceedings of the American Association of Zoological Parks and Aquariums (pp. 532–534).

Yerke, R., & Burns, A. (1993). Evaluation of the educational effectiveness of an animal show outreach program for schools. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 366–368).

Personal Communications:

del Campo, Garcia A.L. Madrid Zoo, 1988

Glass, Sarah. Knoxville Zoo. 1990

Kohn, Frank. Smithsonian National Zoo, 1990

Monsalve, Liliana S. Madrid Zoo, 1988

Appendix H: Instructions for Measuring Body Size in Relation to Weight

To calculate "ideal" red panda weights:

First get your panda's body length measurement: Measure from the tip of the nose to the base of the tail. What you do is get a measuring tape, start at the nose then run the tape with your hand over the head then down the spine to the base of the tail (the easiest way to judge the base of the tail is to lift the tail straight up then place the measuring tape at the 90 degree curve point). See Figure A below.

Second get your panda's girth measurement: wrap the measuring tape around the torso just behind the front legs, tighten the tape until the fur is flattened but not any tighter. See Figure B below.

With these measurements, calculate the volume of a cylinder:

Circumference = 2 π r
π = 3.14
Volume = πr^2 x length

<u>Example</u> Panda Weight Calculation:

Girth (circumference) – 33 cm
Length (tip of nose to base of tail) – 65 cm

Calculate the radius by solving for "r
33 cm = 2(3.14)r
33 cm = (6.28)r
33 cm/6.28 = r
r = 5.25 cm

Then plug "r" into the volume formula:
Volume = $(3.14)(5.25)^2(65.cm)$
= 5625

Take the volume number and then plug it into the Figure C "Red Panda Body Condition; Relationship between Body Volume and Mass" into the "volume (cc)" horizontal line and go up the chart until you reach the straight diagonal line, go across to the mass (g) line to get an estimate of your panda's best weight. This is an estimate only and should be tempered with common sense and your experience with red pandas and what is a good weight for them.

You can also plug in the length measurement into Figure D "Relationship between body length and mass" to find "ideal" weight, but the masses obtained using only length and not girth may not be as accurate as the method using both length and girth.

Figure A. Red panda body length measurement
Photo Credit: Sandy Helliker

Figure B: Red panda body girth measurement
Photo Credit: Sandy Helliker

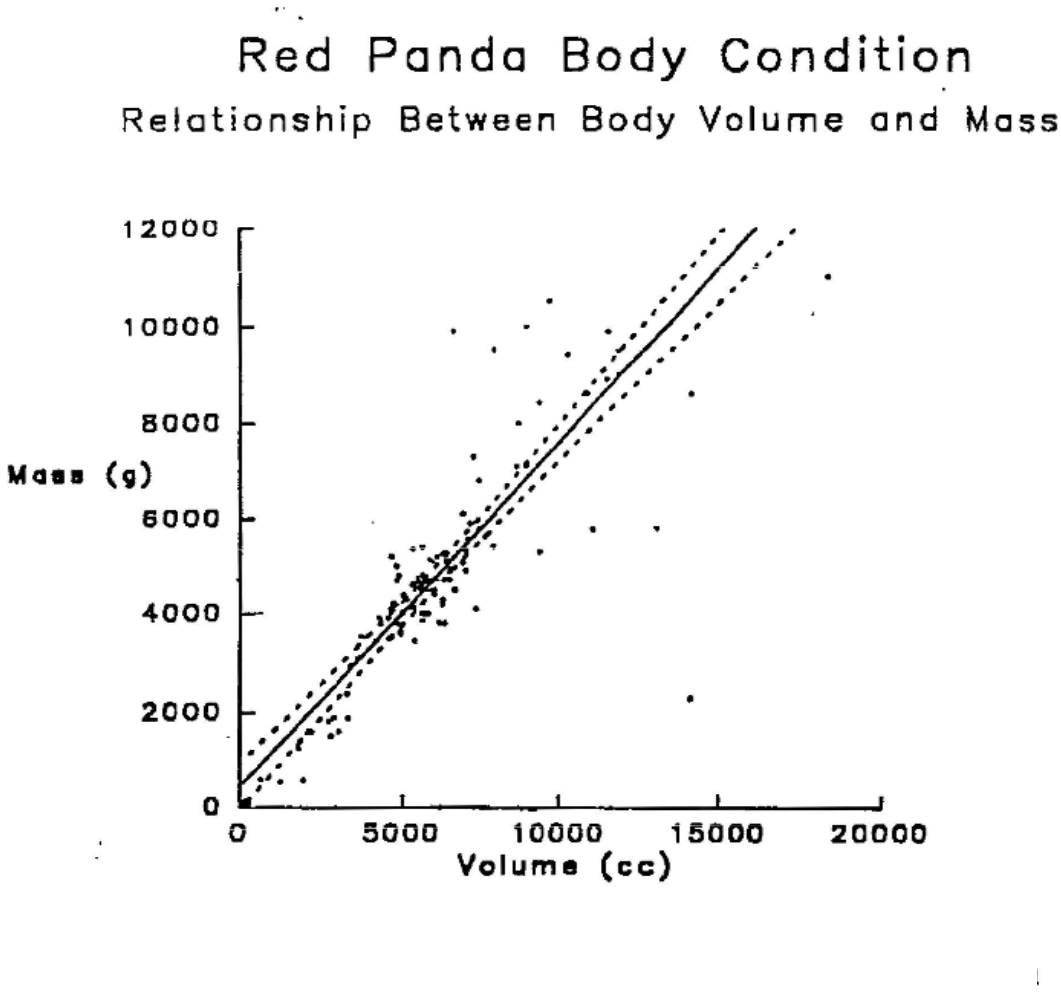

Figure C. Relationship between body volume and mass. (Glass and Kohn, unpublished)

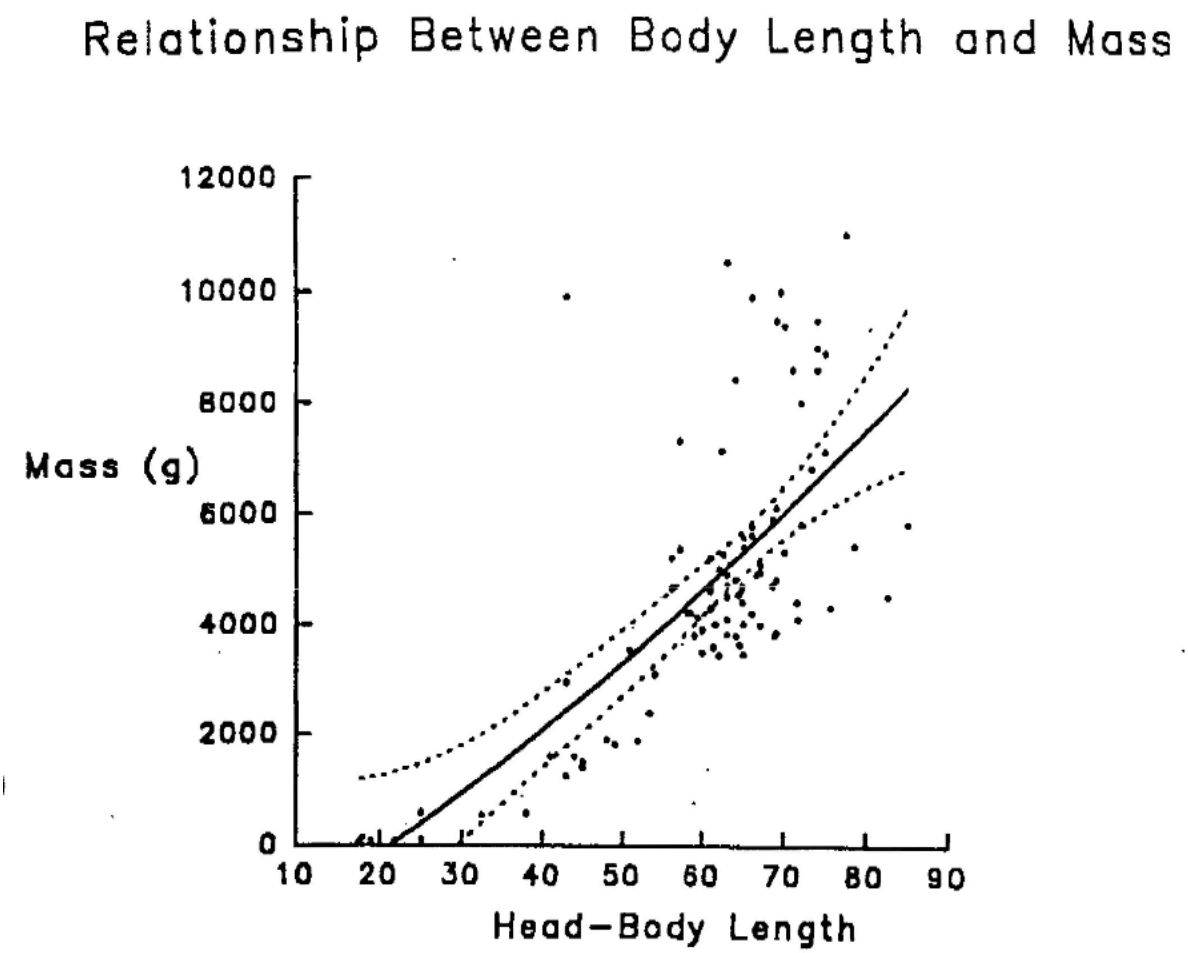

Figure D. Relationship between body length and mass. (Glass and Kohn, unpublished)

Appendix I: Cub Feeding Chart

Red Panda Cub Hand Rearing Feeding Schedule (Glass, unpublished)

Days from Birth	% of Body Wt. To Feed	Formula Concentration	Feedings per Day	Notes
1 to 4	30%	7%	8 x daily	
5 to 8	30%	10%	8 x daily	
9 to 14	30%	12%	7 to 8 x daily	
15 to 20	25%	15%	7 x daily	
21 to 27	25%	18%	6-7 x daily	Feeding every 4 hours
28 to 36	25%	20%	5-6 x daily	Discontinued night feedings at 31 days
39 to 58	20%	20%	4-5 x daily	Feedings begin 7 am continue every 3 hours until 5 pm
59 to 89	16%	20%	3 x daily	
90...	16%	20%	3 x daily	Begin weaning, feed from dish

Daily Feeding Quantities Based on a Percentage of Red Panda Body Weight

Body Weight	Daily Feeding Quantities (mL) Based on % of Body Weight				
(grams)	10% of body wt.	16% of body wt.	20% of body wt.	25% of body wt.	30% of body wt.
80	8	12.8	16	20	24
120	12	19.2	24	30	36
160	16	25.6	32	40	48
200	20	32	40	50	60
240	24	38.4	48	60	72
280	28	44.8	56	70	84
320	32	51.2	64	80	96
360	36	57.6	72	90	108
400	40	64	80	100	120
440	44	70.4	88	110	132
480	48	76.8	96	120	144
520	52	83.2	104	130	156
560	56	89.6	112	140	168
600	60	96	120	150	180
640	64	102.4	128	160	192
680	68	108.8	136	170	204
720	72	115.2	144	180	216
760	76	121.6	152	190	228

Daily Feeding Quantities Based on a Percentage of Red Panda Body Weight

Body Weight	Daily Feeding Quantities (mL) Based on % of Body Weight				
(grams)	10% of body wt.	16% of body wt.	20% of body wt.	25% of body wt.	30% of body wt.
800	80	128	160	200	240
840	84	134.4	168	210	252
880	88	140.8	176	220	264
920	92	147.2	184	230	276
960	96	153.6	192	240	288
1000	100	160	200	250	300
1040	104	166.4	208	260	312
1080	108	172.8	216	270	324
1120	112	179.2	224	280	336
1160	116	185.6	232	290	348
1200	120	192	240	300	360
1240	124	198.4	248	310	372
1280	128	204.8	256	320	384
1320	132	211.2	264	330	396
1360	136	217.6	272	340	408
1400	140	224	280	350	420
1440	144	230.4	288	360	432
1480	148	236.8	296	370	444
1520	152	243.2	304	380	456
1560	156	249.6	312	390	468
1600	160	256	320	400	480
1640	164	262.4	328	410	492
1680	168	268.8	336	420	504
1720	172	275.2	344	430	516
1760	176	281.6	352	440	528
1800	180	288	360	450	540
1840	184	294.4	368	460	552
1880	188	300.8	376	470	564
1920	192	307.2	384	480	576
1960	196	313.6	392	490	588
2000	200	320	400	500	600
2040	204	326.4	408	510	612
2080	208	332.8	416	520	624
2120	212	339.2	424	530	636
2160	216	345.6	432	540	648
2200	220	352	440	550	660
2240	224	358.4	448	560	672
2280	228	364.8	456	570	684

Daily Feeding Quantities Based on a Percentage of Red Panda Body Weight

Body Weight	Daily Feeding Quantities (mL) Based on % of Body Weight				
(grams)	10% of body wt.	16% of body wt.	20% of body wt.	25% of body wt.	30% of body wt.
2320	232	371.2	464	580	696
2360	236	377.6	472	590	708
2400	240	384	480	600	720
2440	244	390.4	488	610	732
2480	248	396.8	496	620	744
2520	252	403.2	504	630	756
2560	256	409.6	512	640	768
2600	260	416	520	650	780
2640	264	422.4	528	660	792
2680	268	428.8	536	670	804
2720	272	435.2	544	680	816
2760	276	441.6	552	690	828
2800	280	448	560	700	840
2840	284	454.4	568	710	852
2880	288	460.8	576	720	864
2920	292	467.2	584	730	876
2960	296	473.6	592	740	888
3000	300	480	600	750	900
3040	304	486.4	608	760	912
3080	308	492.8	616	770	924
3120	312	499.2	624	780	936
3160	316	505.6	632	790	948
3200	320	512	640	800	960
3240	324	518.4	648	810	972
3280	328	524.8	656	820	984
3320	332	531.2	664	830	996
3360	336	537.6	672	840	1008
3400	340	544	680	850	1020
3440	344	550.4	688	860	1032
3480	348	556.8	696	870	1044
3520	352	563.2	704	880	1056
3560	356	569.6	712	890	1068
3600	360	576	720	900	1080
3640	364	582.4	728	910	1092
3680	368	588.8	736	920	1104
3720	372	595.2	744	930	1116
3760	376	601.6	752	940	1128
3800	380	608	760	950	1140

Daily Feeding Quantities Based on a Percentage of Red Panda Body Weight

Body Weight	Daily Feeding Quantities (mL) Based on % of Body Weight				
(grams)	10% of body wt.	16% of body wt.	20% of body wt.	25% of body wt.	30% of body wt.
3840	384	614.4	768	960	1152
3880	388	620.8	776	970	1164
3920	392	627.2	784	980	1176
3960	396	633.6	792	990	1188
4000	400	640	800	1000	1200
4040	404	646.4	808	1010	1212
4080	408	652.8	816	1020	1224
4120	412	659.2	824	1030	1236
4160	416	665.6	832	1040	1248
4200	420	672	840	1050	1260
4240	424	678.4	848	1060	1272
4280	428	684.8	856	1070	1284
4320	432	691.2	864	1080	1296
4360	436	697.6	872	1090	1308
4400	440	704	880	1100	1320
4440	444	710.4	888	1110	1332
4480	448	716.8	896	1120	1344
4520	452	723.2	904	1130	1356
4560	456	729.6	912	1140	1368
4600	460	736	920	1150	1380
4640	464	742.4	928	1160	1392
4680	468	748.8	936	1170	1404
4720	472	755.2	944	1180	1416
4760	476	761.6	952	1190	1428
4800	480	768	960	1200	1440
4840	484	774.4	968	1210	1452
4880	488	780.8	976	1220	1464
4920	492	787.2	984	1230	1476
4960	496	793.6	992	1240	1488
5000	500	800	1000	1250	1500