CASE STUDY: SEASONAL DIETS FOR BROWN BEARS (*URSUS ARCTOS*) AT BROOKFIELD ZOO—SUCCESSFUL IMPLEMENTATION LED TO REDUCED WEIGHT AND IMPROVED BEHAVIOR

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Abstract

From 1995 – 2008 the brown bears (*Ursus arctos*) at Brookfield Zoo were fed a standard diet consisting of carnivore meat products, fish (seasonally), dog food, apples, carrots, lettuce, bread, and a small assortment of fruit as treats. The diet increased or decreased in amount based on the bears' motivation for food (i.e., by season), but the diet composition was rarely changed to reflect what the bears would seasonally find in the wild. Under new direction, it was determined that the obese bears needed to lose a significant amount of weight and a seasonal-like diet should be implemented. Additional variation in diet items, high levels of greens and produce during the spring months, and increased meat items in the fall months were some of the changes applied to the bears' diet. Working with the keepers to provide exact amounts of dietary enrichment items and items that can be easily scattered around the exhibit increased the bears' activity levels, reduced stereotypic behaviors, and by the second summer resulted in the lowest weights ever recorded for the adult males.

Introduction

The brown bear's (*Ursus arctos*) natural diet is very diverse; a true omnivore with a diet that includes carrion, forbs, grasses, berries, insects, and fish. Several studies investigated the diet of brown bears in different regions using fecal content analysis yet all have stated that it is difficult to approximate amounts and importance of diet items based on this method.[1,3,7] Changes in weather/temperature, availability of prey items, and natural variation in availability force bears to adapt to what items are available. Several studies have found that after emerging from the den in the spring, many bears gorge themselves on ungulate calves (moose, caribou) which are an easy prey species.[1,7] Grasses, forbs, insects, and fruits are a consistent part of the diet throughout the spring and summer.[1-4,7,8] Near the end of summer, when bears reach their hyperphagic stage, berries become a major diet item; the availability of most berries is high during this time and is a flush dietary item while prey items are not as available.

There are few guidelines within the Association of Zoos and Aquariums institutions for how to manage brown bear diets and weight. Variation in climates where brown bears are held leads to different managerial approaches based on whether the bears enter an inactive state. Seasonal diets are used in some institutions, but not in others.

Diet Changes

In late 2007, it was directed that the bears needed to lose a significant amount of weight and should be put on a more seasonally appropriate diet. The previous diet for the bears never changed with regard to composition (Table 1) but only by amounts as dictated by the bears'

appetites. By waiting for the bears to change their intake, there was no approach of anticipating their needs and making the changes beforehand and managing the bears' weight. The bears did have some seasonally appropriate weight gain and loss, but from 1999 – 2004 the weights increased overall until they hit a maximum of 560 kg in the winter of 2004 – 2005. Additionally, during this time period there were increased cases of keepers reporting stereotypic behavior by both animals and increasingly aggressive interactions.

The first step was establishing what "seasonal" entailed. In general, it was agreed that greens (different varieties of lettuce) were going to make up the majority of the diet as a means to maintain physical satiety of these animals who do not expend as many calories as a wild animal. This approach was especially relevant the first year of implementation, since the goal was to get the bears to lose weight when they naturally want to gain weight to replace what was lost during hibernation. The increase in meat products was delayed until early summer and peaked in mid-late summer (Table 2). In the autumn wild bears focus on what is available, this is usually a harvest of berries. Again, due to the goal of reducing weight, produce (fruit + vegetables) was not significantly increased, but its percent contribution to the diet was raised slightly. The new diet regime was started in May 2008; Table 3 represents one example of the new diet. Besides trying to decrease caloric intake during the most active time of year, there were significant cultural issues with the keeper staff that needed to be addressed through the diet adjustments in 2008. This led to an initial increase in aggressive behavior between the bears (and increase in keeper logging of the behavior). During this time period, the bears consumed all food that was offered, which was a greater volume of food with fewer calories than previously offered; this resulted in significant weight loss during the summer of 2008 (Figure 1).

The second step was establishing an appropriate weight range for these bears. After consulting with several institutions, a goal range of 363 kg ± 36 kg was established for Axhi and 400 kg ± 40 kg for Jim. The weight gain in the winter months of 2008 – 2009, although still reaching weights of 450 kg, was achieved in half the time; by anticipating lower appetites the bears started losing weight in December 2008 compared to February of the previous winter. Due to the improved weight loss over the winter months, the diets for 2009 contained even fewer calories than the diets in 2008 and as a result the bears reached their lowest weight in 8 years, looked much healthier, and were more active. Using varied small food items, stereotypic and aggressive behavior were reduced from the previous years. A comparison of the calories of the diet over the 12 month period is presented in Table 4; the calories are expressed as gross energy of the diet items.

The differences in the nutrient composition for several time periods over 2008 – 2009 are summarized in Table 5. Dog and primate recommendations were used for a comparison since there are no formal requirements for ursine species and dogs and primates are the most similar species with established recommendations[5,6]. From May – November, all of the nutrients measured in the bear diet met at least one of the known requirements of dogs or primates. Several nutrients (Ca, P, Cu, Fe) were lower than both recommendations in January; considering that the animals naturally do not eat during this period, there is little concern for deficiency of these nutrients.

Logistically, the implementation of the diet change was challenging. The number of food items offered doubled, and did not follow a set schedule as before (Table 3). Previously, the treat items (peanuts, blueberries, grapes, and raisins) were sent in bulk, but only offered once a week. There was no oversight by the Zoo Nutrition department for how much was actually being fed out. A new system of controlling the treats with full management by the Zoo Nutrition staff was put into action. A random arrangement of the different fruit, vegetables, cereals, prey, and meat products meant the animals received a completely different set of food items day-to-day that repeated on a weekly basis. Another husbandry change occurred for the winter: instead of using the previous practice of waking the animals up daily for feeding and wellness checks, the animals were allowed to dictate whether they were fed. If they woke up, they were fed; if they didn't wake up, they weren't fed. This was a major shift in previous husbandry protocols which woke the bears up daily for feeding which encouraged the bears to eat during a time when their bodies are not motivated for eating. As a result, the bears started losing weight earlier in the winter of 2009 and came out of "hibernation" approximately 20 -30 kg less than 2008.

Behaviorally, according to the observations of several keepers that care for the bears, the bears are presenting with fewer days or reduced duration of stereotypic behaviors and aggressive bouts in 2009. There was an increase in aggressive and stereotypic behavior when the diet change started, since the animals were offered few calories during a time when they are trying to replace lost winter weight. As a result, more items that could be thrown or hidden during the day (Mazuri Omnivore Chow (Mazuri, St Louis, MO), cereals, waxworms) and introduced two knuckle bones twice weekly. The knuckle bones provided a diet item that could keep the animals occupied for a long period (scooping the marrow out) without significantly impacting the caloric content of the diet. Live fish and fishcicles were offered on alternate weeks to provide different enrichment during the summer months. In 2009, all anecdotal reports of negative behavior have decreased significantly.

Overall, the diet change has been a success: the bears have lost weight and are more active with less aggression and stereotypic behaviors. There has been an increase in foraging behaviors and they are more visible for the guests of the zoo. The most important aspect is that the animals are now on a more natural weight cycle that better reflects how they would respond to diet challenges in the wild. The variety of diet items also provides ample stimulation and a well-balanced diet. As this diet change continues, more data will be collected to follow the trends of weight and behavior.

LITERATURE CITED

1. Elgmork, K. and J. Kaawa. 1992. Food habits and foraging of the Brown Bear *Ursus arctos* in central south Norway. Ecography 15(1): 101-10.
2. Felicetti, L.A., C.T. Robbins, and L.A. Shipley. 2003. Dietary protein content alters energy expenditure and composition of the mass gain in Grizzly Bears (*Ursus arctos horribilis)*. Physiol. Biochem. Zool. 76: 256-61.
3. Gao, R.J., R. Case, D.F. Penner, and P.D. McLoughlin. 2002. Feeding patterns of barren-ground grizzly bears in central Canadian Arctic. Arctic 55(4): 339-44.
4. Mowat, G. and D.C. Heard. 2006. Major components of grizzly bear diet across North America. Can. J. Zool. 84: 473-89.

5. National Research Council. 2006. Nutrient Requirements of Dogs and Cats. National Academy Press. Washington, DC.
6. National Research Council. 2003. Nutrient Requirements of Non-human Primates 2nd rev. ed.. National Academy Press. Washington, DC.
7. Persson, I-L., S. Wikan, J.E. Swenson, and I. Mysterud. 2001. The diet of the brown bear *Ursus arctos* in the Pasvik Valley, northeastern Norway. Wildl. Biol. 7(1): 27-37.
8. Servheen, C. 1983. Grizzly bear food habits, movements, and habitat selection in the Mission Mountains, Montana. J. Wildl. Manag. 47(4): 1026-35.

Table 1. Average percentages of major food items offered to the brown bears at Brookfield Zoo from 1995 – 2008.

	April	June	August	October	December	February
Meat products[1]	53%	48%	51%	51%	54%	55%
Dry dog food[2]	6%	7%	7%	7%	6%	7%
Fruit	10%	14%	13%	13%	12%	12%
Vegetable	9%	12%	11%	11%	10%	10%
Greens	14%	15%	13%	13%	12%	12%
Bread	8%	4%	3%	3%	6%	4%

[1]Meat products include products like Milliken Meats, Dallas Crown Carnivore, and Natural Balance Zoo Carnivore.
[2]Dry dog food was Nutrena River Run (now Loyall brand, Cargill, Inc)

Table 2. Average percentages of major food items offered to the brown bears at Brookfield Zoo in 2008 – 2009.

	April	June	August	October	December	February
Meat products	2%	14%	15%	13%	8%	0%
Dry dog food	1%	2%	2%	2%	2%	0%
Fruit	10%	12%	14%	14%	17%	17%
Vegetable	9%	8%	9%	11%	13%	15%
Greens	78%	64%	60%	59%	60%	68%

Table 3. Example of current diet items and amounts (g) for one of the brown bears at Brookfield Zoo in 2009.

Diet Item	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Omnivore meatloaf[1]	227	227	227	227	227	227	227
NBZC[2]			908	454			908
Sportmix[3]			165		165		165
Herring		454		908			454
Capelin		908			908		
Lettuce	5000	4000	4000	4000	4000	5000	4000
Fruit rotation		715	1210		990		715
Veggie rotation	990			990			1100
Peanuts		110		110			
Strawberries	275				440		
Blueberries			625				625
Grapes		550		550		550	
Hard boiled eggs			310				310
Raisins		220			330		
Mixed greens	1500	1500	1500	1500	1500	1500	1500
Mixed berries		330				550	
Whole adult rat (250 g ea)				250			
Small rabbit (227 g ea)		227			227		
Shank bone (~1400g meat)	1400					1400	
Knuckle bone	2 bones					2 bones	
Waxworms (62 g/tub)			62			62	
Cereal			100		200		

[1]Omnivore meatloaf is an in-house mixture of 30% Natural Balance Zoo Carnivore, 35% Ground Sportmix dog food, 30% frozen mixed vegetables, 5% water.
[2]NBZC = Natural Balance Zoo Carnivore
[3]Sportmix is a dry dog food (adult maintenance bite size: 21% protein, 8% fat) produced by Midwestern Pet Foods.

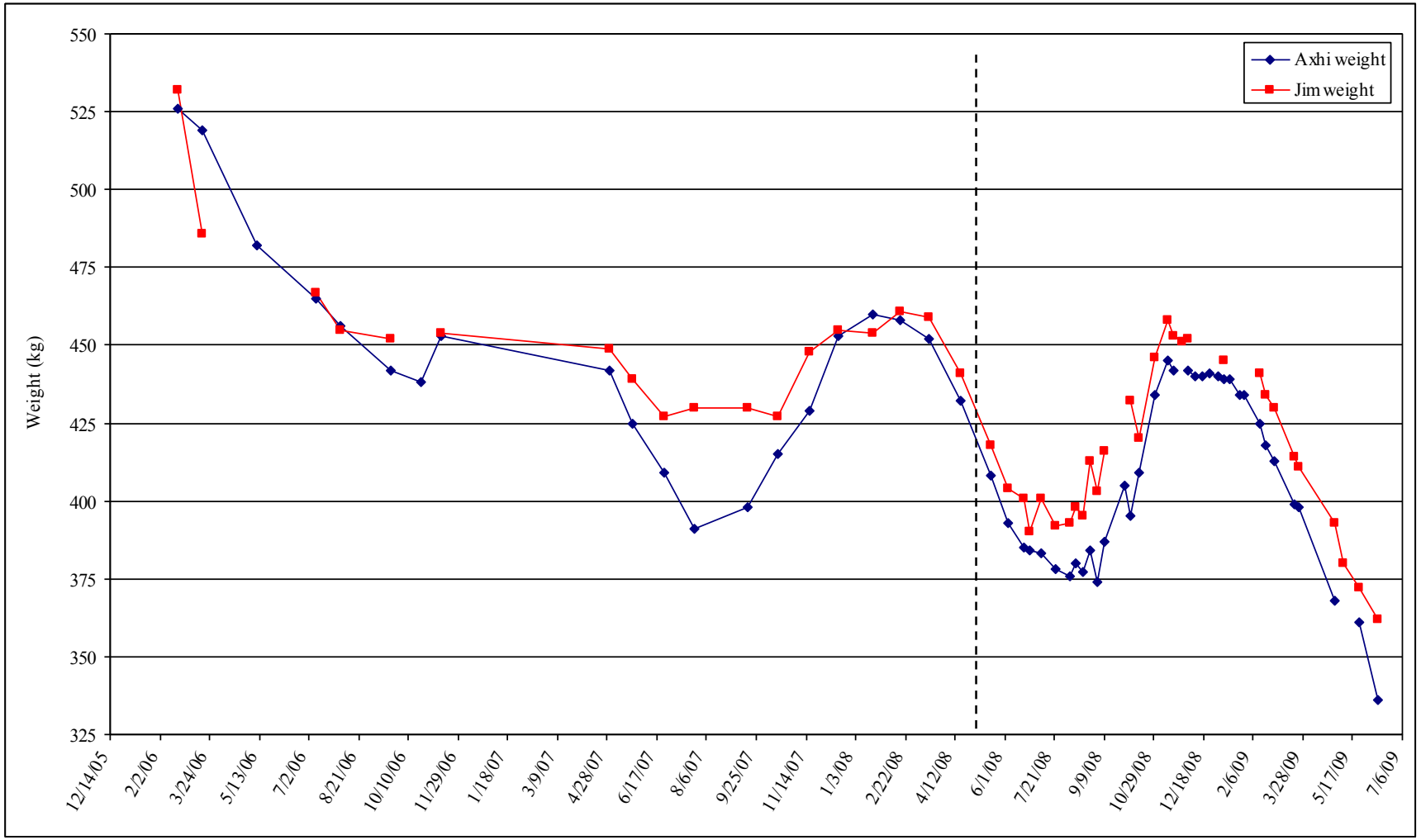

Figure 1. Weights for the two brown bears at Brookfield Zoo from 2005 – 2009. The new diet was implemented in May 2008.

Table 4. Average daily calorie intake of a brown bear at Brookfield Zoo on the new diet regimen 2008 – 2009.

	Calories
May 2008	7128
Early June 2008	7488
Late June 2008	7887
Late July 2008	8894
August 2008	16120
Early Sept. 2008	17633
Late Sept. 2008	15815
October 2008	9174
November 2008	5716
December 2008	3590
Late January 2009	1622
April 2009	2580
May 2009	4603
Early June 2009	5133
Late June 2009	6132

Table 5. Zootrition analyses of seasonal diets offered to the bears in 2008 – 2009 and requirements for dogs and primates.

Nutrient	**Dog Reqts**[1]	**Primate Reqts**[2]	**July 2008**	**Sept. 2008**	**Nov. 2008**	**Jan. 2009**	**May 2009**
Crude Protein (%)	18	16.7	32.8	44.5	35.9	18.9	32.5
Crude Fat (%)	5		16.3	21.2	18.6	11.6	16.3
Ash (%)			6.5	6.4	5.06	6.3	6.2
Ca (%)	0.6	0.56	0.98	1.38	1.29	0.24	0.97
P (%)	0.5	0.44	0.84	1.09	1.02	0.34	0.82
Mg (%)	0.04	0.17	0.13	0.14	0.13	0.14	0.13
Cu (mg/kg)	7.3		8.71	8.87	11.9	5.72	9.53
Fe (mg/kg)	80	200	118.9	125.6	161.6	65.2	117.7
Zn (mg/kg)	120	11.1	71.2	80.8	116.5	32.6	77.4
Vitamin A (IU/g)	5	13.9	67.2	50.4	26.5	63.5	68.9
VitaminE (mg/kg)	50	55.6	80.6	92.9	111.5	50.4	92.2

[1]From National Research Council. 2006. Nutrient Requirements of Dogs and Cats. National Academy Press. Washington, DC.

[2]From National Research Council. 2003. Nutrient Requirements of Non-human Primates 2nd rev. ed.. National Academy Press. Washington, DC.