

MOOSE HUSBANDRY AT THE COLUMBUS ZOO: THE NUTRITION ASPECT

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ABSTRACT: The Columbus Zoo in Columbus Ohio, USA is the most southern facility to exhibit moose (*Alces alces*). This paper is a review of our management practices through the years. A total of 10 orphaned calves have since been received. Four survived past age one with 2 breeding and producing twin calves. Nutrition is a major concern with moose in captive environments. The use of pelleted moose rations along with the supplementation of browse is discussed. Browse is utilized as a daily dietary component during the spring, summer, and fall seasons. Fresh frozen leaves are a new component of our browse program during the winter. In addition, a brief description of the exhibit outlines the features included for accommodating moose in Ohio.

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There was an interest among staff members in exhibiting moose at the Columbus Zoo (hereafter referred to simply as "the zoo"). Not many institutions have moose and none in our region of the country, the nearest institution in the United States being Minnesota Zoo in Apple Valley, Minnesota. The zoo had never exhibited moose before. In 1986, research began into what housing needs, dietary requirements, and husbandry practices would need to be met. Adding moose to the animal collection would expand the North American perspective of the zoo.

Business and organizations like to contribute funds to the zoo; donations provide a way of demonstrating interest in the community. The Moose Lodge organization through their various chapters was willing to provide the funding to construct the exhibit. Knowing the funds would be available for the housing, the question remained; could we raise moose in the central region of Ohio?

An initial concern was weather. Columbus is located on the 40° of latitude.

In the summer months, temperatures can reach or exceed 32°C (90°F) for 15 days consecutively. During the winter there may be 3-day-periods of subzero temperatures. Precipitation averages 97 cm (38 in) for the year, primarily during the spring and summer months. Snowfall measures 71 cm (28 in) between November and April. Fall is the driest season. Temperature extremes have reached -30° C (-22°F) and 41°C (106°F) (personal communication B. Gelber, WCMH-TV, Columbus, Ohio).

The First Moose at the Zoo

The opportunity to acquire a moose (*Alces alces americanus*) from the Toronto Zoo (Ontario, Canada) developed. This gave us the chance to understand moose husbandry directly. They had a 4-month-old wild orphan whose mother died from impact with a vehicle. In October 1987, he arrived at the Columbus Zoo. Upon arrival, the diet for this calf consisted of aspen cubes with grated carrot, chopped lettuce, half of an apple, and a banana offered 2 times per day. Along with these

food items free choice alfalfa hay was provided. Browse of poplar, willow, and apple was offered daily or as available. We continued this protocol for a while until atypical stools developed. After communication with C. Schwartz (Alaska Department of Fish and Game), the decision was made to discontinue the alfalfa hay, as this could be a contributing factor in the fecal quality. A later study indicated hay as a causal agent for diarrhea in moose (Shochat et al. 1997).

The pelleted moose ration we started with was a variation of the Minnesota Zoo (Apple Valley, Minnesota) diet that was based on the Kenai Moose Research Center (Kenai, Alaska) diet formula. An area grain mill in Ohio worked with us to manufacture the diet. After reviewing the Minnesota diet, a change in the type of aspen used was made. Unfortunately, we are unable to locate the original composition of our diet to verify the change, due to the company being sold during the early 1990s.

The initial housing was an off-exhibit pen not designed for moose. This was only a temporary measure until we confirmed a permanent exhibit would be built. After

completion of the moose exhibit in spring 1990, time came for transfer to the new area. Unwilling to be lured into a horse trailer for the move, our moose had to be anesthetized. Three months after the relocation he died. The necropsy results concluded a bacterial (*Clostridium chauvoei*) infection was the cause of death in relation to the injection site of the anesthesia.

Alaskan Moose Calves

After the death of the Canadian moose, other moose needed to be obtained. Knowing the orphan situation for moose (*Alces alces gigas*) from previous communication with the Moose Research Center staff this was the chosen route. Six calves were obtained from different sources between 1989 and 1991 (Table 1). When the permit process was finalized and flight arrangement set, the first Alaskan moose calf arrived in June 1989. The first 2 calves were not a success story. One died within 2 weeks of bacterial meningitis and septicemia. The other died at 4 months of age. For this calf, we are unable to locate the record for the exact feeding regimen. The medical records indicate several days of

Table 1. Fate of moose reared at the Columbus Zoo between October 1987 and March 2001.

Source	Date of Arrival	Sex	Age	Fate	Age	Cause
Toronto Zoo	October-87	male	5 months	Died	3 years	Bacterial infection
Alaska Fish & Game	June-89	male	26 days	Died	35 days	Bacterial meningitis & septicemia
Alaska Fish & Game	June-89	female	27 days	Died	4 months	Diarrhea & weight loss
Alaska Zoo	August-89	male	3.5 months	died	8 years	Colic
Alaska Zoo	July-90	male	~2 months	died	2 years	Encephalitis
Alaska Zoo	July-90	female	~2 months	surviving	10.5 years	
Alaska Zoo	October-91	female	~4 months	surviving	9.5 years	
Columbus Zoo	June-94	male	birth	died	5 days	Salmonella
Columbus Zoo	June-94	female	birth	stillborn		Stillborn
Alaska Zoo	August-98	male	~3 months	surviving	2.5 years	

diarrhea and observations of consuming moose ration and browse. Lankester et al. (1993) reported similar atypical fecal quality in hand-reared calves. This calf showed visual signs of weight loss.

The third moose calf arrived 2 months later in 1989. This bull calf (Juneau) grew to adulthood and survived to 8 years of age. The necropsy report indicated colic as the cause of death. The following year, 1990, a bull and cow calf arrived. The bull died 2 years later of encephalitis and the cow (Riva) is currently residing in our moose exhibit. Opinion was that the exhibit could accommodate another cow, arrangements were made and this calf arrived in 1991. She too is residing in our moose exhibit.

After a few years, we felt comfortable with our moose program and wanted to try breeding moose. In 1993, the older cow, Riva was chosen to breed with 5-year-old Juneau. The results of the pairing resulted in twin calves born outside in a torrential downpour. The female calf was still-born. The male calf survived for 5 days succumbing to a *Salmonella* sp. infection. This pairing has been the only breeding allowed to date. In need of a replacement bull, the Alaska Department of Fish and Game was contacted and arrangements were once again made for receiving a bull calf. This calf arrived in 1998 bringing our present collection to 3 moose.

Of the 8 orphan calves received at the zoo, including the Canadian moose, the mortality rate was 25% before 1 year of age. The ages at arrival ranged from less than 1 month to approximately 5 months. If the twin calves born at the zoo are included, the mortality rate increases to 40%. The mortality rate of captive calves has been reported to approach 70% (Schwartz 1992).

Nutritional Components for Calves

The moose calves that we received over the years arrived on various dietary

formulas. No changes were made to their formulas after arrival. We maintained them on their same formula or one of similar ingredients. The calves were provided with a pre-measured ad libitum pelleted moose ration. In addition, fresh cut browse was provided free choice, twice daily. Towards fall, we decreased the browse to once a day. Change in seasons made this change necessary. During winter months, browse twigs would be provided 1 - 2 times a week for the moose calves. Spring allowed us to offer daily browse again.

We continued with our original moose ration until May 1991. At this time the Mazuri Moose Maintenance diet (Purina Mills, Brentwood, Missouri) was tried. The 2 types of diet were combined starting with a 50 : 50 mix. The moose accepted the change in diet quite readily. The change to 100% Mazuri Moose Maintenance diet occurred on 17 September 1991, offered ad libitum. Each morning the remaining ration was measured and recorded. Any time the entire ration was consumed, the amount offered increased by an additional 1.9 liters (2 quarts). Decreases in the amount offered occurred when there was 5.5 - 7.6 liters (6 - 8 quarts) left for 5 - 6 days. We increased to allow for ad libitum feeding, but decreased to avoid wastage. We used bananas and carrots as treat items.

Fecal quality was monitored on a daily basis. The method utilized was similar to that of the Minnesota Zoo, where they used a grading scale of 1 to 6. We chose a 1 to 5 system. A normal pelleted stool was graded as a 1. Grade 2 stools were a clump or ball of pellets. A stool recorded as a grade 3 was a "cow patty", while a grade 4 was a loose cow patty. Grade 5 stools were diarrhea. Anytime a grade 5 stool was found, willow (*Salix* sp.) browse was provided and the veterinary staff were notified. Even as 3 or 4 type stools were discovered, willow was provided. This was a precau-

tionary step. Usually after the browse had been offered, the diarrhea subsided within a day. On occasion, diarrhea has lasted 4 to 5 days before improvement.

Adult Moose Nutrition

The only change between calves and adults is the amount of browse. Treat items are continued, as noted with calf nutrition. Mushrooms were tried as another treat, but only the older cow liked them. Browse is offered once a day as trees begin to bud in the spring. As fall approaches and the leaves begin to fall, the quantity of browse

is decreased in preparation for winter. During the winter months, browse offerings occur only once or twice a week. Browse varieties (Table 2) vary depending on the season.

Due to the boundaries of the exhibit, the moose cannot directly choose which type of browse to feed on. We have noticed however, certain choices they make during various seasons. Ash (*Fraxinus* spp.) is consumed more in the spring, especially by the current bull. Cottonwood (*Populus deltoides*) is not always consumed immediately unless the upper sections of the tree

Table 2. Browse species offered to adult moose reared at the Columbus Zoo.

Browse listing	
Hedge maple - <i>Acer campestre</i>	River willow - <i>Salix purpurea</i>
Hackberry - <i>Celtis occidentalis</i>	Rose of Sharon – <i>Hibiscus rosa sinensis</i> ¹
Grapevine - <i>Vitis</i> spp. ²	Serviceberry – <i>Amelanchier</i> spp. ¹
Forsythia - <i>Forsythia</i> spp. ³	Silver maple - <i>Acer saccharinum</i>
Flowering dogwood - <i>Cornus florida</i>	Slippery elm - <i>Ulmus rubra</i>
Crimson King maple - <i>Acer platanoides</i>	Sugar maple - <i>Acer saccharum</i>
Crabapple - <i>Malus</i> spp. ²	Sweetgum - <i>Liquidambar styraciflua</i>
Cottonwood – <i>Populus deltoides</i>	Sycamore - <i>Platanus occidentalis</i>
Cornelian cherry dogwood – <i>Cornus mas</i>	Basswood - <i>Tilia americana</i>
Corkscrew willow – <i>Salix matsudana</i>	Tuliptree - <i>Liriodendron tulipifera</i>
Red chokeberry – <i>Aronia arbutifolia</i>	Nannyberry Viburnum – <i>Viburnum lentago</i> ¹
Bradford pear - <i>Pyrus calleryana</i>	Water hyacinths - <i>Eichhornia crassipes</i>
Boxelder - <i>Acer negundo</i>	Weeping willow - <i>Salix alba</i> ‘Tristis’
River birch - <i>Betula nigra</i>	Witch hazel - <i>Hamamelis</i> spp.
Green ash - <i>Fraxinus pennsylvanica</i> ⁴	Yellowtwig dogwood – <i>Cornus sericea</i> , <i>Flaviramea</i> ¹
White ash - <i>Fraxinus americana</i> ⁴	Redtwig dogwood - <i>Cornus sericea</i> ¹
Aristocrat pear - <i>Pyrus calleryana</i>	Quince - <i>Chaenomeles</i> spp. ¹
Apple – <i>Malus</i> spp. ²	Quaking aspen - <i>Populus tremuloides</i>
Alder - <i>Alnus glutinosa</i>	Pussy willow - <i>Salix dicolor</i>
Mulberry - <i>Morus</i> spp. ²	Norway maple - <i>Acer platanoides</i>
Linden - <i>Tilia cordata</i>	Honey locust - <i>Gleditsia triacanthos</i> variety <i>inermis</i>
Kousa dogwood – <i>Cornus kousa</i>	

¹ Offered in limited quantities due to availability.

² Fruit removed or limited quantity.

³ Blooms only are consumed.

⁴ Bull consumes year-round; cows consume only in winter.

are provided. We have noticed during the winter, most of the bark will get stripped off the cottonwood branches.

A recent addition for winter browse is fresh frozen leaves, which may or may not be on small branches. Leaves collected from various tree species are flattened and frozen until wanted. The moose eat the leaves after thawing. They have readily accepted this type of browse. A listing of the frozen plant materials is provided in Table 3. We also “force” browse in the winter, which provides fresh browse on occasion. We do this by cutting the branches, bringing them inside, and then placing them in a container of water. When the leaves are at least half emerged the browse is fed out.

We are able to offer such a variety of plant material because central Ohio is situated within the temperate deciduous forest

region with a forest type of American beech (*Fagus grandifolia*) – maple (*Acer* spp.). Around the zoo, American beech and sugar maple (*Acer saccharum*) forest fragments are common. This canopy exists along with cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and maple on wet river flood plains. There is influence of white oak (*Quercus alba*) and black oak (*Quercus velutina*). Red maple (*Acer rubrum*) along with green ash (*Fraxinus pennsylvanica*) and oak, influences some areas.

Bull Moose

The bull and cows roam the exhibit together until the first sign that velvet on the bull’s antlers is starting to shed. At this time, the bull is transferred into the barn area. He stays in this area until the antlers drop. The reasoning for this is two-fold, control of breeding and the perimeter fencing of the exhibit (see exhibit design section). We do not want to breed all species at the zoo.

While the bull is off the main exhibit, he has access to the barn and holding yard. Here we can maintain a rutting bull without direct contact. Also, if the decision is made to breed, this area could be used. Unconsumed browse is left to accumulate as a brush pile to assist in removing velvet. There is capability of hanging browse and larger branches for stimulus.

Studies have shown that bull moose reduce food intake during the winter months (Schwartz et al. 1984, 1988; Miquelle 1990). Each year this has been seen with all of our bulls starting with their first winter. When this occurs, extra browse twigs are provided or we may offer some of the forced or frozen plant material.

Exhibit Design

The moose area includes the main exhibit, barn, and holding yard all intercon-

Table 3. Frozen plant material offered to moose reared at the Columbus Zoo.

Species ¹
Quaking aspen - <i>Populus tremuloides</i>
Silver maple - <i>Acer saccharinum</i>
Linden - <i>Tilia americana</i>
Sweetgum - <i>Liquidambar styraciflua</i>
Sugar maple - <i>Acer saccharum</i>
Tuliptree - <i>Liriodendron tulipifera</i>
Weeping willow - <i>Salix bablonica</i>
Honey locust - <i>Gleditsia</i> spp.
Witch hazel - <i>Hamamelis</i> spp.
Grapevine - <i>Vitis</i> spp.
Mulberry - <i>Morus</i> spp.
Rose of Sharon - <i>Hibiscus rosa-sinensis</i> - with flowers
Banana leaves - <i>Musa</i> spp.
Chinese dogwood - <i>Cornus kousa</i>

¹ Amounts provided depend on availability of supply. All have been consumed at various times.

nected. This encompasses approximately 0.4 ha (1 acre). The barn measures 5.5 x 32 x 4 m (18 ft x 80 ft x 13 ft) that includes 4 stalls and a storage room. The perimeter of the exhibit is controlled by a 1.8 meter (6 ft) electric fence. Posts measure 15.2 cm by 4.5 m (6 in by 15 ft) spaced about 5.5 m (18 ft) apart with 21 strands of 4 mm (1/8 in) stainless steel aircraft cable attached on the interior side. Only 4 of the strands are charged with the 6,500-voltage charger. The arrangement of these strands relate to a moose between the ankle and head regions.

The door system in the barn provides varying ways of transfer and allowances for stall size. Side doors allow for the formation of 1 - 4 stalls. Each stall has a door for access into the holding yard. A short aisle-way allows for ease of transfer between the main exhibit and holding yard.

The bull mainly utilizes the holding yard. The main exhibit cannot withstand a rutting bull challenging the electric fence daily (Schwartz 1992). Any time the exhibit is being serviced for such things as cleaning, mowing, or maintenance work, the moose are confined to the barn.

Two additions to the barn provide ways of keeping moose cooled down. A waterline that runs across the top and at every 3 m (10 ft) has an extension reaching approximately 0.5 m (2 ft). Attached to each end is a mister head allowing for water to spray down onto the moose. The other addition is a ceiling fan within each stall. These provide good air circulation within the barn.

The exhibit has 3 types of habitat encompassed into one area. During construction, a treed area was left to allow the moose a shaded area. Other trees remain outside the exhibit and create additional shade. Grass covers the main exhibit. The grass is maintained at a low height to discourage moose consumption (Shochat 1997). Water features are provided in the

way of 2 ponds of differing depths. The larger is 3 m (10 ft) in depth and the other is approximately 1 m (3 ft). Both ponds are utilized during the summer months. The moose can usually be found soaking in the larger pond.

CONCLUSION

The Columbus Zoo is the most southern facility to exhibit moose. Three factors aid in the quality of our moose program. These are the daily monitoring of moose ration consumption, evaluation of fecal quality, and supplementation with browse. Doing all these daily provide us with the information needed to adjust any food item directly. In addition, the daily recording of consumption and fecal quality provides a historical record. Several institutions have had individuals develop wasting disease; to date we have not seen this. Supplementation with browse is regarded as part of the daily husbandry for moose. In talking with other institutions regarding moose, unless there is a large amount of acreage available for free-range browsing, browse is not provided to the extent we provide.

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