RAISING MOOSE CALVES IN ONTARIO[1]

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Abstract: Moose (Alces alces) calves were raised in captivity in Ontario to study the association between ticks and moose. Calves were obtained from the following sources: 14 had been orphaned or abandoned; 29 were removed from cows when approximately 1-14 days of age; and 5 were collected at 6-8 weeks of age. Two of 3 calves were successfully raised in 1980, 4 of 27 in 1981, and all of 18 in 1982. Techniques used are described.

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Moose calves were reared for study of the association between winter ticks (Dermacentor albipictus) and moose. Techniques have been reported for raising other ungulates such as white-tailed deer (Odocoileus virginianus), caribou (Rangifer tarandus), red deer (Cervus elaphus), pronghorns (Antilocarpa americana), and wapiti (Cervus elaphus) (Trainer 1962, Jones 1966, Youngson 1970, Schwartz et al. 1976, Hobbs and Baker 1979). A thorough study of mother-infant relations in moose (Stringham 1974) and recent description of techniques used to raise moose in Alaska (Regelin et al. 1982) are valuable additions to the limited, readily available literature on moose.

[1]Ministry of Natural Resources, Wildlife Research Section Contribution No. 83-09.

High early mortality of moose calves in the present study during 1981 produced a resolve to describe techniques used so that others might benefit from our experiences. Description of techniques for raising moose was encouraged further when all calves handled in 1982 were raised successfully. Interpretations of the usefulness of various techniques are in part subjective since sample sizes are small and causes of good or poor health cannot always be identified or ranked as to their relative importance.

METHODS

Capture

Fourteen orphaned or abandoned calves were collected by field staff of the Ministry of Natural Resources and in most cases transported by truck to our rearing facilities at the Wildlife Research Station (WRS), Algonquin Provincial Park, Ontario (45°33', 78°35').

Twenty-nine remaining neonatal calves were captured on islands within Algonquin Park in 1981 and 1982. Islands were searched by a line of 3-8 people spaced just within eyesight of one another. Searchers were coordinated through use of portable 2-way radios. Two Norwegian elk hounds assisted in searches during 1981. Cows were immobilized with xylazine hydrochloride[2] if calves could not be captured otherwise. Calves were transported to rearing facilities at the WRS via motor boat and truck or flown from the bush in De

[2]Rompun, Cutter Laboratories Inc., Mississauga, Ontario L4W 2A1.

Havilland Turbo Beaver or single engine Otter aircraft and then transported by truck. Calves were held on the floor or lap during air transport and either hand held or confined to ventilated plywood carrying boxes (120 x 55 x 60 cm) for road transport.

Five 6- to 8-week-old calves were captured in 1981 to replace the unexpected neonatal mortalities. A Hughes 300 helicopter[3] was used to locate cows and calves feeding on aquatic plants. A calf was separated from the cow and a rope placed around its neck. The passenger left the helicopter and swam to shore with the calf. Calves were immobilized with xylazine hydrochloride and moved to WRS by helicopter.

Holding Facilities

The 1980 and 1981 neonatal calves were initially bedded in plywood stalls (244 x 61 cm) within a large garage. One or 2 calves were placed in each stall with twins being kept together. A forced-air furnace maintained the temperature at a minimum of 10°C.

Outdoor pens were enclosed with 2.5m high page wire fencing overlaid with snow fencing. Six pens were 29.6 x 16.5 m and a 7th pen was 29.6 x 35 m. The front gates were 2.1 x 1.5 m and were constructed of double layers of pine (2.5 x 15 cm). A plywood shed (2.9 x 2.9 x 2.7 m) was built in each pen. The areas between the side walls and low pitched sloped roof of each shed were left open to provide good ventilation. No heat was provided. Prepared feed was available in rubber pails (0.4 m diameter, 26.5 l capacity) within covered self-feeders.

[3]Hughes Helicopters Inc., Culder City, California 90230.

The 7 pens were connected along the back by a chute 1 m wide and 2.5 m high. Doors into the chute allowed for transfer of moose between pens and access to an enclosed weigh scale.

The outdoor pens had approximately 50% canopy cover consisting of white pine (Pinus strobus), white birch (Betula papyrifera), trembling aspen (Populus tremuloides) and largetooth aspen (Populus grandidentata). The well drained forest floor of the pens had an abundance of raspberries (Rubus sp.), grasses, wild sarsaparilla (Aralia nudicaulis), bracken fern (Pteris aquilira) and red-berried elder (Sambucus pubens) at the outset of the experiments. All but the red-berried elder rapidly disappeared from browsing, grazing, and trampling.

Crushed stone (5 cm diameter) was added to the perimeter of the pens, the feeding area, and the entrance to the sheds to increase hoof wear.

Rearing Techniques

Upon arrival at the WRS, moose calves were weighed, given vitamin E-selenium[4] or [5] IM at prescribed dosages, had their umbilicus disinfected, and were offered their first feeding. In 1980 and 1981, preventative doses of chloramphenicol[6] were given IM twice daily for

[4]Bo-Se, Chromalloy Pharmaceutical Inc., Oakland, California 94621.

[5]Dystosel, Rogar/STB, Mississauga, Ontario L4V 1L5.

[6]Zoomycetin 500, P.V.U. Inc., Cambridge, Ontario N1T 1A3.

the first 4-5 days. In 1982, antibiotics were only given therapeutically.

Calves were kept in the garage at night in 1980 and 1981 and were taken to the outdoor pens or walked in the woods during the day. They were moved to the outdoor pens permanently after 2-4 weeks in captivity. In 1982 all calves were placed directly in the outdoor pens upon arrival at the WRS but were confined to the sheds at night and during rainstorms for the first month. Straw was changed regularly in both the garage and outdoor sheds and faeces were removed daily.

Four staff shared in rearing 3 calves in 1980 and 8 staff shared in both the capture and care of all calves in 1981. No more than 14 calves were held at one time in 1981. In 1982, 10 people were responsible for capturing 18 calves and 10 people were responsible for raising them.

In 1980 and 1982, bonding was encouraged by staff spending time walking and playing with their calves, hand feeding browse, grooming them with hands and brushes, sponging faces to remove milk, wetting them down on hot days, or laying with them. Staff often slept with calves during the first 1-2 nights in captivity. Calves were greeted upon entry to the pens by reciprocating calf-like vocalizing and participating in naso-nasal testing (see Geist 1963). In 1981, the time for these activities was restricted because of staff shortage.

Records for each calf included types and quantities of feed, description of faeces, medications, weights, rectal temperatures, respiratory rates, heart rates, and general behaviour and comments.

These records were used at daily meetings to decide on changes in diet and medication.

Calves were weighed irregularly in 1980 and 1981 but weighed upon arrival and daily through to September in 1982.

Calves were haltered after less than 30 days in captivity in 1980 but haltering was not repeated sufficiently to habituate the calves. In 1982, most calves were first haltered at 24-40 days and all calves were haltered daily for much of July and all August. Calf halter ropes were 1.2 cm in diameter with a lead of 3 m.

Different milk formulas were used in each year of the study. In 1980, a human baby formula[7] was used. It was mixed with water as prescribed and supplemented with corn oil and casein or soya bean meal. After 5-7 weeks, a commercial livestock milk replacer[8] was gradually substituted in place of the baby formula.

At the start of 1981, evaporated milk, a pig milk substitute[9] and water were used in a 5:2:3 ratio. The water was later replaced by whole milk. Corn syrup (10-15 ml/feeding) was added to the formula at each feeding for 1 week. Colostrum (266-1686 ml) from Holstein cows was given to 9 of the younger calves during the first 2 days of feedings.

All calves were raised on a 2:1 mixture of homogenized pasteurized whole cow's milk and evaporated milk in 1982. Unsuccessful attempts

[7]Enfalac, Mead-Johnston Ltd., Belleville, Ontario K8N 1E2.

[8]Purlac, United Cooperatives of Ontario, Mississauga, Ontario L5A 3A4.

[9]SPF-lac, Borden Inc., Norfolk, Virginia 23501.

to encourage 2 calves to regularly consume evaporated goat's milk were terminated after 9 days by providing the whole milk and evaporated milk formula.

Formula was offered in 1980 and 1981 in beer bottles (341 ml) or white plastic bottles (550 ml) equipped with flexible black lambs' nipples, 6.5 cm long and having a base diameter of 2.6 cm tapering to 1.4 cm. Formula was also offered in calf-feeding bottles (2.22 l capacity) with a calf nipple 7.5 cm long and 2.5 cm in diameter once calves had been on formula for 25-56 days. In 1982, formula was offered in large-mouthed plastic bottles (920 ml) capped with firm lambs' nipples 9.0 cm long and having a base diameter of 2.3 cm tapering to 1.3 cm. Holes in the nipples were enlarged to increase milk flow. Formula was heated until lukewarm before being presented to calves.

Bottles, nipples and all formula mixing equipment were rinsed following each feeding, washed in soap and warm water, rinsed again and sterilized.

Calves were fed 6 times daily (at 4-hour intervals) upon arrival at the WRS in 1980 and 1981. In 1982, calves were fed 5 times daily at 0630, 1030, 1430, 1830, 2230 hrs. Feedings were reduced gradually through to weaning (Table 1).

Volume of formula varied according to the product used, and the health of the moose. Much more formula was given during the early stages in 1982 than in 1980 and 1981 (Table 2) Volume of formula was slowly reduced through to weaning (Table 2). Liquid multiple

vitamins[10] (1 ml) were added daily to the milk of each calf.

Browse was available to calves from their first day of captivity and was replaced when wilted. Species most frequently offered were trembling aspen and willow (Salix sp.) but white birch, yellow birch (Betula alleghaniensis), striped maple (Acer pensylvanicum), hard maple (Acer saccharum), red maple (Acer rubrum), beaked hazel (Corylus cornuta), large tooth aspen, pin cherry (Prunus pensylvanica), and dogwood (Cornus sp.) were also provided.

Fresh water was available at all times except for limited periods when first encouraging calves to take formula. Dirt and trace mineralized salt were available at all times.

No specific feeding techniques were required when calves readily accepted formula from a bottle. However, some calves resisted having the nipple in the mouth or refused to suckle once the nipple was in the mouth. The bottle was offered to these calves as described by Schwartz et al. (1976) and Jones (1966). Sucking action was sometimes induced by gentle rhythmic pulling and pushing of the nipple while holding the mouth firmly shut. Using the nipple to exert light pressure down onto the tongue also stimulated sucking on occasion. Placing the nipple into the side of the mouth initiated chewing on the nipple which encouraged sucking when the nipple was slipped quickly back to the front of the mouth. Placing the nipple in the front of the mouth and stimulating tongue movement with a finger from the side of the mouth was helpful at times. Squirting milk into the mouth was

[10]Pardec, Parke Davis Canada Inc., Scarborough, Ontario M1L 2N3

used with extreme caution since bloating sometimes followed. None of these techniques predictably induced a sucking action. The specific nipple used when a reluctant calf first fed vigorously from a bottle was used for subsequent feedings. Formula was offered in a dish when calves could not be encouraged to feed from a bottle. Calves still refusing to feed were given glucose IV.

In 1980, calves were weaned onto a commercial ruminant ration[11] containing 16% crude protein, 2.5% crude fat, and 16% crude fibre. The ration was available to calves within 1-2 weeks of capture. In 1981, Master Feeds Calf Starter-Grower[12] (18% crude protein, 8.5% crude fibre) was offered first and beet pulp pellets (crude protein 9%, crude fate 0.3%, crude fibre 20%) were gradually mixed in with the starter-grower until the ratio was 2 parts starter-grower to 1 part beet pulp. In 1982, a pelleted weaning product[13] (25% crude protein, 3% crude fat, 6% crude fibre) was offered first and was gradually replaced with ruminant ration[11]. The ruminant ration was first added as 20% of total prepared food after 40-53 days in captivity. The ruminant ration was increased in 10% proportions every 5-7 days.

Early interest in pelleted ration was encouraged by pouring some pellets into the calf's mouth and holding it shut. A more effective technique was to feed a calf many striped maple leaves including some

[11]United Cooperative of Ontario, Mississauga, Ontario L5A 3A4.

[12]Maple Leaf Mills Ltd., Toronto, Ontario M4P 2X5.

[13]Calf Manna, Carnation Co., Milling Division, Los Angeles, California 90036.

with a few pellets rolled inside. Calves seldom spat out the disguised pellets when the food was placed at the back of the mouth. Less browse was offered during this period but fresh leaves were mixed with solid ration in the feeder. To avoid abrupt changes in diet, initial consumption of pellets was limited to 30 gm daily.

Bloat was treated successfully with 5-15 ml of aluminum hydroxide and magnesium hydroxide[14] administered 3-6 times daily or a bismuth subsalicylate suspension[15] given in 5-10 ml dosages at 45-minute intervals. The abdomen of animals with bloat sometimes was massaged.

Constipation was treated effectively by persistent, firm, rhythmic patting of the back posterior to the pelvis until faeces were voided. Calves stood still for this treatment. Regular wiping of flank and anal areas to induce defecation (Youngson 1970, Buckland et al. 1975, Schwartz et al. 1976) was seldom successful. Enemas of soapy water were used occasionally. Mineral oil[16] given in cases of suspected constipation was frequently followed by diarrhea which might otherwise have been avoided.

Diarrhea was a frequent and difficult problem. Preventive treatment for 3 calves in 1980 included 0.4 g of VanSup[17] (containing neomycin, streptomycin, tetracycline hydrochloride) given twice daily for 50 days after arrival at the WRS. Therapeutic treatment during 1980 and 1981 started with partial or complete substitution of milk

[14]Diovol, F. W. Horner Ltd., Montreal, Quebec H3C 2W6.

[15]Pepto-Bismol, Norwich-Eaton, Paris, Ontario N3L 3G6.

[16]Pharmo Mineral Oil, Pharmo Products, Markham, Ontario L3R 2R7.

[17]VanSup, Rogar/STB Inc., Mississauga, Ontario L4V 1L5.

with electrolytes and glucose[18] until calves showed signs of improvement. Pepto-Bismol (5-10 ml orally/day), kaolin and pectin[19] (90 ml orally/day), a mixture of neomycin, sulfathoiazole, and sulfamethazine[20] (60 ml orally/day), chloramphemicol (2500 mg IM/day), and tylosine[21] (0.5-1.0 ml IM/day) were also used. Treatments usually consisted of one drug but occasionally two from the above list. Diarrhea was treated differently in 1982. Milk was removed or reduced in the diet and replaced with electrolytes and glucose at first signs of loosening faeces. After no more than 2 feedings, milk was reintroduced as 15-30% of the formula and was gradually increased to 100% within a few days. Pepto-Bismol was given orally (8.7 $\pm$ 4.56, 1-10 ml/dose) in a series of doses (μ = 5.2) usually spaced 45 minutes apart. Pepto-Bismol treatments were started as soon as loosening faeces were recognized. If diarrhea was not eliminated within 2 days, Kaopectate was given orally (29.2 $\pm$ 12.4, 10-45 ml) in doses 1-4 hrs apart. If diarrhea persisted, 2 suspensions were used together. A mixture[22] of chlorhexidine hydrochloride, dihydrostreptomycin sulphamethazine, salts, and kaolin was administered orally (20 ml/dose), 1-4 times daily at 5- to 12-hr intervals. The other, a

[18]Electrolytes, Austin Laboratories (Canada) Ltd., Guelph, Ontario N1H 6L8

[19]Kaopectate, Upjohn Company of Canada, Don Mills, Ontario M3B 1Y6.

[20]Shur Gain Scour Treat, Canada Packers Inc., Mississauga, Ontario L4W 2S5

[21]Tylan, Canada Packers Inc., Mississauga, Ontario L4W 2S5.

[22]Polyansyn, Ayerst Laboratories, Don Mills, Ontario M3B 1S3.

suspension[23] containing diphemanil methylsulfate, procaine penecillin-G, dihydrostreptomycin, chlorpheniramine and procaine hydrochloride was given IM (0.8 ml/dose) twice daily. These treatments were continued until diarrhea disappeared. Yogurt, Lactobacillus capsules, and faeces of healthy moose were all mixed with formula at times to reestablish gut flora following treatment with antibiotics.

Results and Discussion

Two of 3 calves were successfully reared to yearling age in 1980, 4 of 27 in 1981, and all of 18 in 1982. Dodds (1959) reported rearing 3 of 5 calves to yearlings and Regelin et al. (1982) raised 6 of 8 calves.

Conditions which differed between the unsuccessful year of 1981 and the highly successful year of 1982 in the present study and which are thought to be important include: condition of orphaned or abandoned calves when received, suspected age at capture, stress of capture, number of calves kept in one building, warmth provided calves, number of people to which any single calf was exposed during the first month in captivity, closeness and amount of contact between handlers and calves, number of feedings/day, extent of milk reductions when treating diarrhea, and the amount of milk or milk substitute provided.

[23]Diathal, Schering Canada Ltd., Pointe Claire, Quebec H9R 1B4.

The 7 orphaned or abandoned calves received in 1981 were transported 612-2217 (μ = 1165) km to the WRS and the only orphan which lived had the shortest trip. In 1982, 5 orphans transported 322-787 (μ = 600) km all lived. The stress of transit should not be discounted. However, the length of time that calves have been orphaned or abandoned, the stress of capture, and the treatment of calves before delivery are likely more important.

Age at capture likely influences the ease with which moose calves adapt to captivity. In 1981, many calves were collected when perhaps only 1-4 days old but other calves were left with the cow until about 2 weeks of age. In 1982, all calves were captured as young as possible. Most smaller, less coordinated, hence perhaps younger calves adapted to bottle feeding and people more readily than other calves. Moose calves captured at 1-2 days of age in Alaska adapted to bottle feeding after 1 feeding (Regelin et al. 1982) and other newborn wild ruminants have adapted more quickly than older individuals to bottle feeding (Neil et al. 1979).

All 5 calves captured at 6-8 weeks of age rejected milk entirely and did not eat browse or aquatic plants for 3-5 days. One calf died after 6 days in captivity. The remaining 4 calves were emaciated by the time that they started eating prepared ration, 19-23 days after capture. These calves could not be approached and handled when recently captured. Regular treatments for disease were impractical and stressful since these calves were difficult to approach. Close bonding was not realized, although these older calves did become more tolerant of people over time. Capturing 6- to 8-week-old calves for experimental studies dependent on direct contact between researcher

and moose is not recommended.

Size at capture was thought to be important to calf survival since larger calves could afford to lose more weight than smaller calves during the stressful first few days in captivity. Wapiti calves have a better chance of survival in captivity if they have a large rather than small birth weight (Thorne et al. 1976). This led Hobbs and Baker (1979) to suggest that leaving young wapiti with the dam longer would increase survival once they were in captivity. In 1981, of the present study, some moose calves were left with the cows until about 2 weeks of age so that they would be larger. However, birth weight and size at capture must be distinguished from one another. In the present study, malnutrition leading to death might have been reduced had a few of the older calves been captured earlier and perhaps, therefore, taken less than 3-5 days to accept bottle feeding.

Stress of capture likely has an adverse effect on moose calves. Heart rates of newborn calves at capture frequently exceeded 200 beats/min and occasionally remained at that level for more than an hour. Techniques for capturing calves in Algonquin Park were altered in 1982 to reduce as many potential stressors as possible. Calves were exposed to less noise by ferrying them in quieter De Havilland Turbo Beaver rather than Otter aircraft. Fewer calves ran swiftly or swam during capture in 1982 (5 of 13) than in 1981 (8 of 15). The more controlled captures of 1982 were due in part to the collection of less mobile calves and to using a larger, more experienced staff to localize the cow and calves.

Dogs assisted in locating calves in 1981. Calves returned to the WRS in the same canoe, boat, plane or truck within olfactory and

visual contact of the dogs. Young calves were observed subsequently to be agitated by moving objects below their own level of sight. They occasionally lashed out with their forelegs at handlers crouched in front of them or at children holding feed bottles. Calves raised by Markgren (1966), although familiar with dogs, displayed "head-low threats" (see Geist 1963) at approaching dogs and were similarly aggressive towards small children. Dogs were not used during capture of calves in 1982 and dogs and children were not allowed in the pen area for the first month that calves were in captivity.

Use of a number of outdoor sheds in 1982, instead of one garage, as in 1981, likely reduced stress because of noise from the forced air furnace or from other calves. It also provided a cooler environment. Franzmann (personal communication) suggested that heat should not be provided because warm surroundings may depress appetite and vigour. In contrast, the use of heat lamps and nursery pens to minimize chills and drafts are 2 factors considered important for successful rearing of white-tailed deer fawns (Buckland et al. 1975).

Eight staff shared all of the driving for orphans, locating and capturing calves and the early care of calves in 1981. Since calves were fed 6 times daily, feedings were alternated amongst staff and a calf might be fed by 6 different handlers daily. This system did not allow for bonding or uninterrupted assessment of the calves. Dudzinski (personal communication) later recommended that one or no more than 2 people should feed a young calf. Trindle et al. (1978) indicated that "multiple feeders or surrogate mothers" were stressful to young mule deer (Odocoileus hemionus) fawns and others raising moose have restricted the number of people to which their calves were

exposed (Regelin et al. 1982; Samuel and Pybus, personal communication). However, 4 people shared in the feeding of 2 calves in Sweden (Markgren 1966) and in feeding 3 calves in 1980 in the present study. The "committee" approach to feeding may have been successful in these 2 cases because of the high staff-to-moose ratio.

Close contact with calves and use of what Reichert (1972) calls "tender loving care" has been considered important in raising other wild ruminants (Buckland et al. 1976, Schwartz et al. 1976) and was used in the successful rearing of moose calves in Alaska (Regelin et al. 1982) and in the present study. The quality of care in the present study was comparable in the unsuccessful and successful years. The major difference between the years was in the amount of "tender loving care". An abundance of close contact and limitation on the number of people associated with each calf are considered 2 important techniques which led to successful rearing of calves in 1980 and 1982 in contrast with 1981. In 1981 there were too many calves for the amount of time which could be given to "tender loving care".

Use of 6, rather than 5, initial feedings/day in 1981 appeared to provide more care but alternatively may have disrupted an extended nightly rest period, possibly important to young calves. The extra feeding may also have reduced the appetite of calves normally reluctant to feed. In addition, it definitely reduced the amount of rest available to staff. As many as 12 initial daily feedings have been used successfully for raising moose (Markgren 1966) and 7 for caribou (Jones 1966). Moose have been successfully raised on 6 initial feedings (Denniston 1956, present study 1980) but 5 initial feedings/day are sufficient (Regelin et al. 1982, present study

1982).

Low amounts of milk given calves when healthy in 1981 is considered a factor leading to malnutrition and death within the first 2 weeks calves were in captivity. However, 11 of 16 malnourished calves which died in 1981 had as much or more milk/day in the first week (μ = 436ml, 324-562) than 3 of 3 calves raised successfully through the early stages in captivity in 1980 (μ = 404ml, 313-450). The remaining 5 malnourished calves in 1981 consumed less than 300 ml of milk/day and 4 of the 5 suffered from diarrhea.

Diarrhea was not a serious problem for calves during the first week in captivity in 1980 or 1982. However, 8 of 16 calves which died of malnutrition in 1981 had diarrhea in the first week of captivity and the diarrhea was not managed effectively. Recommendations to replace milk with electrolytes and glucose until diarrhea disappeared were inappropriate since calves may have been underfed before treatment. In 1982, diarrhea in calves was successfully arrested when treatment included removal of milk from the formula for as little as 1 feeding. Had this technique been used in 1981, some calves which died of malnutrition may have survived.

There has been great variation between studies in the amount of milk provided calves during their first week in captivity. During the first week in captivity calves in an Alberta study consumed a daily average of 2646 ml of a formula identical to that offered calves during 1982 of the present study (Pybus and Samuel, personal communication). A formula used in Alaska was a milk substitute with higher crude fat and crude protein values than the 1982 formula in the present study (Regelin et al. 1982). However, during the first week in captivity the Alaskan

calves consumed an average daily volume of 3030 ml of formula (Regelin et al. 1982). In marked contrast, calves in 1982 of the present study consumed an average of 1640 (900-2600) mls of formula/day and 2 calves raised raised to yearlings in 1980-81 received only 313-448 ml of milk/day during the first week in captivity.

The milk offered to surviving calves in 1980 and 1981 may have been near the minimum required for survival. Providing moose calves such little nutrient is not recommended.

The volumes and type of milk provided Algonquin calves in 1982, while much less than in previous studies (Regelin et al. 1982, Dodds 1959, Markgren 1966, Pybus and Samuel, personal communication), is highly recommended. All calves survived with a minimum of diarrhea. Algonquin calves had only 58% of the milk volume provided to Alaskan calves during the first 3 weeks in captivity. However, Algonquin and Alaskan calves were similar in weight at capture (μ = 16.6 and 14.9 kg respectively) and at 30 days of age (28 and 25 kg respectively) (see Regelin et al. 1982). Algonquin calves may have exhibited comparable growth on reduced milk since most calves willingly ate prepared solid ration after 2-3 weeks in captivity.

The Calf Manna used in 1982 was a better weaning product than those used in 1980 and 1981. Some calves had to be restricted in their consumption of Calf Manna pellets from the first day the pellets were presented. Other calves required and received a lot of determined coaxing by use of hand feeding. Sixteen of 18 calves started enthusiastically eating Calf Manna pellets 9-27 (μ = 18) days after arriving at the WRS and all 18 calves were weaned 64-78 days after capture. The Calf Manna contained some dried milk, thus making

the earlier weaning a more gradual transition from milk products to grains.

The amount of diarrhea in the Algonquin moose in 1982 was apparently influenced by the volume of milk consumed. Nine cases of diarrhea appeared in 183 days (1 case/20.3 days) during which calves were fed 2000-2499 ml of formula daily. Twenty-two cases of diarrhea occurred in 172 days (1 case/7.8 days) during which feeding was 2.5 l or more daily. Nine of the latter 22 cases (41%) of diarrhea appeared within 24 hr of formula volume having reached or exceeded 2.5 l/day. Once these trends were recognized, all calves were held to 2.5 l or less formula/day. Other factors thought to result in diarrhea were increases in formula exceeding 10-15% within 24 hrs and the initial conversion from fluid milk to Calf Manna.

Twenty-nine of 42 (69%) diarrhea cases were remedied with reduction or elimination of milk for 1-2 feedings and treatment with Pepto-Bismol. Twenty-seven of the 29 cases lasted 2 days or less. The remaining 2 cases lasted 3 and 7 days. Initial treatment of diarrhea as being of digestive rather than infectious origin could have been dangerous. However, avoiding antibiotics had the advantage of reduced potential disruption of gut flora and perhaps more rapid return to optimal gut balance and renewed growth.

Calves in the present study were first observed to eat dirt 1-6 days after capture. Markgren (1966) reports moose calves eating dirt from the first day for approximately 2 weeks after capture.

Twenty-three calves were first reported browsing 1-9 (μ = 6) days after capture and jaw action suggestive of rumination was first

reported on the second day in captivity. Play was usually observed within 3-10 days after capture and included running about by themselves and attempts at butting other calves. Most calves followed their handlers around within 1-5 days of capture.

Respiration rates in calves 1-4 days in captivity varied from 18 to 132 exhalations/min and were influenced by prior activity. Heart rates of calves during the same period varied from 60 to 144 beats/min, far below the 200+ beats/min often recorded during capture of calves.

Eighty-four percent of 228 rectal temperatures recorded for young calves 2-3 months of age were 38.0-38.9^{o}C. Temperatures exceeded 39.2^{o}C on 2 occasions (39.6^{o}C and 40.6^{o}C) and were lower than 37.0^{o}C once (36.8^{o}C).

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Table 1. Feeding schedules for raising moose calves in Algonquin Provincial Park, Ontario.

Number of feedings	1980	1981	1982
6	1*	1	
5	9	5	1
4	29	6	40
3	104	60	56
2	117		63
1	139		
0	160	120	69-78

*Days in captivity.

Table 2. Weekly milk consumption by moose calves raised in Algonquin Provincial Park, Ontario.

Weeks	1980 n = 2	1981 n = 2	1982 n = 18
1	2.2-3.1[a]	2.8-6.8	11.5(6.3-18.2)2.85[b]
2	3.6-4.0	7.2-10.5	14.6(8.6-19.6)3.41
3	6.2-6.6	8.7-16.3	15.0(9.0-20.8)3.19
4	6.6-7.3	9.3-17.1	13.3(7.1-20.1)3.59
5	8.3-8.5	8.2-13.3	13.9(10.0-19.7)2.57
6	9.2-9.8	12.5-14.3	14.4(8.4-18.2)2.45
7	9.3-10.3	14.9-18.0	13.0(9.5-15.4)1.62
8	10.1-10.6	16.0-20.9	10.8(6.1-13.2)2.15
9	10.3-11.2	13.5-21.3	7.3(3.3-9.5)1.91
10	8.9-10.4	15.1-23.9	4.3(0.7-6.1)1.65[d]
11	6.6-10.4	19.2-24.1	1.8(0.2-3.3)1.25[e]
12	6.6-10.2	19.2	0.9(0.2-0.7)0.25
13	6.6-10.7	15.0-20.0	
14	6.6-10.2	5.8-25.4[c]	
15	6.4-12.4	21.2	
16	5.3-12.4	16.1	
17	4.1-10.4	8.7	
18	4.1-8.3		
19	3.0-8.3		
20	2.1-7.1		
21	2.1-4.0		
22	2.1-3.6		
23	1.5-3.1		
Total	136-189	173-292	120(99-139)13.2

[a] Litres of milk or milk substitutes within formula.
[b] Mean (range) standard deviation.
[c] 1 calf weaned.
[d] 2 calves weaned.
[e] 6 calves weaned.

Table 3. Known or suspected causes of death of moose calves raised in Algonquin Provincial Park, Ontario.

Cause of death	Number of calves	Days from capture to death
Terminal *E. coli* septicemia	2	53, 79
Actinomycosis	1	93
Early handling and transportation of orphans	2	0.5, 0.3
Blindness	1	9
Direct stress of capture	1	6
Vaginal infection	1	4
Malnutrition	16	8.9 ± 3.28(3-12)*

*Mean ± S.D. (range)