

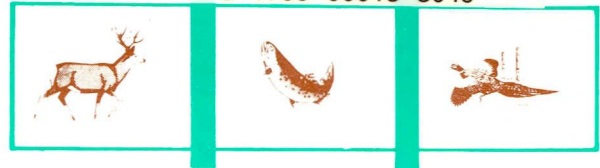
Outdoor Facts

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Wildlife Information Leaflet

Number 114

BOTTLE-RAISING WILD RUMINANTS IN CAPTIVITY¹

Wild ungulates are frequently bottle-raised to enhance survival of "orphaned" neonates and/or to provide tractable animals for exhibit or research. Good animal husbandry techniques, an appropriate diet, and patience and caring are essential for properly bottle-raising wild neonates. The success of any protocol for bottle-raising wild ungulates should be evaluated on its ability to humanely bring healthy neonates to weaning at growth rates approximating those of their dam-raised counterparts.

Here, we describe procedures developed at the Colorado Division of Wildlife's Foothills Wildlife Research Facility to successfully bottle-raise neonatal elk (*Cervus elaphus nelsoni*), bighorn sheep (*Ovis canadensis canadensis*), pronghorn antelope (*Antilocapra americana*) (Wild et al. 1991), and mule deer (*Odocoileus hemionus*). Included are recommendations on diet and feeding protocols as well as medical management for captive neonatal ungulates.

FEEDING AND HUSBANDRY

Diet

A variety of protocols for bottle-raising wild ungulates have been reported. These differ primarily in composition and volume of milk formulas fed. The most widely recommended diets consist predominantly of homogenized cow's or goat's milk, and are strictly limited in volume fed (Buckland et al. 1975, Schwartz et al. 1976, Hobbs and Baker 1979, Neil et al. 1979, Brinkley 1987). In our experience, such protocols commonly lead to malnutrition, manifested in gastrointestinal disturbances (e.g., diarrhea) and/or suboptimal growth rates in wild neonates. Other protocols have used diets mixed to simulate dam's milk and volumes fed have been determined using mathematical formulas (Robbins et al. 1981, Parker and Wong 1987, Carl and Robbins 1988). Although neonates raised using the

latter protocols grow at natural rates, the procedures for mixing and calculating volumes to be fed can prove burdensome.

Growth rates approaching those observed in dam-raised neonates have also been achieved in white-tailed deer fawns (*O. virginianus*) (Silver 1961, Pekins and Mautz 1985), elk calves, bighorn lambs, and pronghorn fawns (Wild et al. 1991) by feeding undiluted evaporated milk. We have raised over 40 wild neonates using this protocol and have incurred no mortalities associated with gastrointestinal disturbance or diet.

We recommend feeding neonatal ungulates >2 days old unrestricted quantities of undiluted evaporated milk² at each feeding. Neonates fed *ad libitum* evaporated milk will regulate their own intake and will not overeat. Data in Table 1 offer general guidelines for expected milk consumption and animal weight.

Neonates should have access to alfalfa hay, concentrated feed (such as Calf Manna®), a mineralized salt block, fresh water, and if possible, fresh native vegetation at all times. In addition, neonates commonly ingest soil, and should have access to soil that is not grossly contaminated with fecal material.

Schedule

Initially, neonates should be fed 5 times daily (every 4 hours between 0600 and 2200). Once individuals accept the bottle, milk consumption usually increases rapidly. Soon thereafter, most neonates start refusing 1 feeding each day. When individuals skip a meal daily for about 3 consecutive days and eat well otherwise, reduce frequency to 4 feedings per day spaced at about 5-hour intervals. Using this

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²Bottle-raised neonates should receive *ad libitum* first milking bovine colostrum for 24-48 hours after birth.

Table 1. Consumption of undiluted evaporated milk and weight ranges of bottle-raised pronghorn, bighorn, elk, and mule deer.

Species	Age (wk)	Total daily milk intake (ml ^a)	Weight (kg ^b)
Pronghorn	1	220-420	3.2-5.3
	4	400-800	5.2-8.2
	8	650-1240	8.0-14.5
	12	740-1170 ^c	11.8-22.3
Bighorn sheep	1	460-580	5.0
	4	840-1030	9.0-10.0
	8	780-950	13.0-14.5
	12	1190-1410 ^c	17.5-21.0
Elk	1	500-2380	19.5-23.0
	4	1990-3490	25.5-37.0
	8	2660-4540	41.0-57.5
	12	480-3060	56.0-74.5
Mule deer	1	600	nd ^d
	4	890-1100	nd
	8	900-1250	nd
	12	430-580	nd

^a28 ml = 1 ounce.

^b1 kg = 2.2 lb.

^c*Ad libitum* feedings continued for a total of 16-20 weeks for training purposes.

^dBody weight of mule deer fawns not determined.

approach, total daily milk consumption will not change appreciably when feeding frequency is reduced. The same criteria can be used to reduce to 3, then 2 feedings per day. By about 10 weeks of age, neonates need to be fed only once per day. Weaning procedures are discussed below.

Equipment and Procedures

Neonates of small ruminant species (pronghorn and deer) can be fed using 8-ounce baby bottles. Nipple openings should be enlarged slightly with the heated tip of a straightened paper clip to ensure proper milk flow. Soft lamb nipples are used on larger capacity (500-2000 ml) plastic bottles for larger ruminant species (e.g., bighorn lambs and elk calves). Calibrated bottles are ideal for easy measurement of milk intake. Milk should be warmed to about body temperature in a hot water bath before feeding. Bottles and nipples should be rinsed with warm water after each feeding, and washed with soap and thoroughly rinsed weekly. Total intake volume should be recorded for each feeding and summed daily.

Starting a young neonate nursing from a bottle can be challenging. Species, age, and individual's condition and temperament all contribute to accep-

tance of the feeder and bottle. In general, time to acceptance increases with age, and animals >2 weeks old can be very reluctant to feed from a bottle. Neonates purposefully separated from the dam for bottle-raising should be taken at 24-48 hours of age. At this age neonates have received adequate colostrum from the dam, and will quickly accept the bottle and imprint on humans. We recommend involving only 1 or 2 feeders per individual neonate, particularly until they fully accept bottle feeding. Familiarity with individual feeders appears to minimize stress on neonates and maximize milk intake (Fig. 1).

We have used 2 different methods successfully for initiating bottle nursing in healthy neonates. One approach encourages the neonate to eat while restrained, the other relies on the neonate initiating feeding. Regardless of method used, patience and tenderness are essential. Using the restraint method, the neonate is held, cornered, or approached when in hiding posture and the nipple is placed in its mouth. Sucking can be stimulated by moving the nipple back and forth, or twirling it slightly to achieve proper positioning. In addition, the jaws or cheeks can be squeezed gently to stimulate sucking and swallowing. Only a small amount of milk (<5 ml), if any, should be squeezed into the mouth. Stimulating defecation by wiping the perineal area (around the anus and vulva) with a warm, damp paper towel or sponge often initiates nursing as well.

The second technique relies on neonates actively seeking out the nipple without being restrained. In this case, a feeder imitates behavior of the dam to encourage nursing. The animal can be approached slowly, or enticed to approach the feeder by vocalizations from crouched or kneeling position. Gently stimulating defecation often calms the neonate, and initiates nursing attempts. Neonates will often begin sucking on the feeder's hair or face first, then the nipple can be substituted.

Using either method, if a feeding attempt fails and the animal is in good health, we usually refrain from another attempt for about 4 hours. Feeders must be flexible, innovative, and responsive to neonates' needs. Intractable neonates may require feeders to try different techniques, offer different nipple styles, and occasionally alter their approach based on health concerns.

If a neonate has not begun to nurse within about 2-4 days, or is in poor health, special care may be necessary and animal health must be monitored closely. If health begins to deteriorate or the neonate begins to weaken, offering electrolyte solution

(see below) in the bottle and/or a bowl is beneficial. We use force-feeding only as a last resort. Each feeding session should still be started with attempts to bottle nurse. Failing acceptance of the bottle, a short segment of rubber tubing can be attached to a dose syringe and milk (or electrolyte solution) slowly dripped into the corner of the mouth. Swallowing can be induced by gently stroking the throat in a downward motion. Extreme care must be taken to avoid aspiration of milk into the lungs because this can lead to pneumonia. Neonates of small species should receive about 300 ml per day, larger species about 1000 ml per day via force feeding. Neonatal ruminants should not be fed milk via orogastric tube; however, electrolyte solution can be administered in this way if required.

Defecation and urination should be stimulated at every feeding for about the first month. This activity is important in order to establish bonding with the feeder, avoid constipation and allow for frequent evaluation of fecal consistency. Overstimulation, as evidenced by straining without defecation, should be avoided.

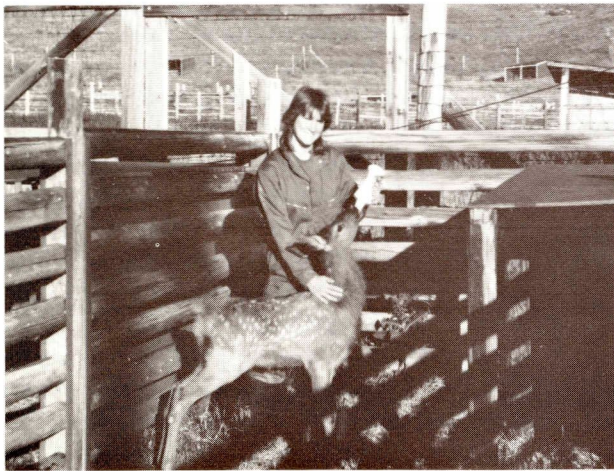


Fig. 1. Author bottle-feeding 4-week-old elk calf. (Photo by M. W. Miller)

Weaning

Bottle-raised animals occasionally wean themselves voluntarily, but forced-weaning is usually required. Individual response, as well as intended use of the animal, may influence weaning procedures. In some cases, milk is used as a reward in training programs and may be continued for months beyond regular weaning dates. In most cases, however, prompt weaning is desirable. Neonates often begin decreasing milk and increasing dry feed intake by 8 wks of age; however, some animals fed *ad*

libitum evaporated milk will continuously increase milk intake if allowed. Milk intake should be limited at 6-8 weeks of age to begin a gradual weaning process. Initially, milk intake should only be stabilized and daily consumption not allowed to increase over volumes observed during the final week of free choice feeding. When the neonate has adjusted to limited feeding, volume offered can be further restricted. Weaning should be completed by about 3 to 3.5 months of age. Forced-weaning is often traumatic for young ungulates as evidenced by pacing, vocalization, and slight weight loss. Generous amounts of dry feeds and fresh water should be available to weaned neonates.

Housing

Outside stalls or small pens with shelters and clean soil floors that are isolated from domestic animals are ideal for housing wild neonatal ungulates. Access to warmth from a heat lamp should be available during cool or damp weather. Initially, neonates should be housed individually. Neonates ≥ 2 weeks of age that are well-accustomed to bottle-nursing and the feeder can be grouped with others of the same species for part or all of the day as long as all in the group appear healthy.

HEALTH CARE AND MONITORING

Evaluation

Proper diet, good sanitation and husbandry practices, and keen observational skills of feeders are essential components for rearing healthy neonates. Treatment of minor health problems can usually be performed by feeders under veterinary supervision, but unresponsive or more severe conditions should be examined promptly by a veterinarian.

Overall health of neonates can be assessed using simple techniques. Health assessments should be performed upon receipt of new animals and at frequent intervals on all neonates in order to appreciate normal conditions and to recognize early signs of problems. The skin, eyes, nose, mouth, ears, umbilicus, and limbs should be inspected for signs of trauma or disease. In newborn (<24 hours old) ungulates, the umbilicus may still be moist and should be dipped in tincture of iodine; a veterinarian should be consulted if the umbilicus does not dry within 24 hours, or if pus or urine are noticed coming from it. Attitude can be assessed based on overall appearance, activity level, posture, and appetite. Hydration status is assessed by pinching up a fold of

skin over the shoulders, then watching its return to normal position; in dehydrated individuals, the skin loses elasticity and the fold returns to normal more slowly than in well hydrated animals. Characteristics of feces (consistency, appearance, odor) should be noted at each feeding. We also recommend measuring body weights on bottle-raised neonates at least weekly; this is an excellent method for monitoring condition and overall health. Rectal body temperature is normally about 100.5-103°F and can indicate illness if outside this range. Body temperature should be taken during the morning or evening when the animal is at rest; excitation and hot weather can elevate the temperature quickly.

Diarrhea

Fortunately, many gastrointestinal disturbances associated with dilute milk formulas can be avoided using the diet recommended here. However, diarrhea still occurs occasionally in debilitated animals or with inadequate sanitation. Normal neonatal stools range from soft, yogurt consistency to formed pellets. Stools are usually gold colored when animals are on a strictly milk diet but are darker green as vegetation intake increases. Normal stools are not particularly foul-smelling. Diarrhea is characterized by fluid stools, often having a foul odor and/or abnormal color, sometimes with presence of blood, excessive mucus and/or gas bubbles. Neonates with diarrhea are often depressed and have lower milk intakes.

Animals with diarrhea should be isolated and caretakers should follow good sanitation procedures (e.g., wearing protective clothing, disinfecting hands and shoe soles after contact, using a separate bottle and nipple). Neonates and their bedding must be kept as clean as possible. Fly repellent, such as Cutter KRS®, can be used on the animal as needed. As an initial treatment, discontinue milk and substitute an electrolyte solution on the same feeding schedule for 24-48 hours. Revive® and Biolyte® are the most efficacious electrolyte products for domestic calves (Fettman et al. 1986). If these cannot be obtained, a homemade solution can be mixed (Lewis and Phillips 1979; Table 2). We have used these commercial and homemade formulations successfully in treating wild neonates. Products containing table sugar, or sucrose, should never be administered. A bowl of electrolyte solution can also be made available in addition to water for free choice consumption. In our experience, most neonates respond with firmer stools in 24-48 hours. At that time, return to feeding undiluted milk; do not mix

Table 2. Recipe for a homemade electrolyte solution (Lewis and Phillips 1979).

Combine:	1 package (1.75 ounce) fruit pectin
	2 teaspoons lite salt
	10.5-ounce can beef consommé
	Warm water to make 2 quarts
	2 teaspoons baking soda

Refrigerate until use.

Discard unused portion after 2 days.

milk with electrolyte solution or water, as this can prolong diarrhea (Fettman et al. 1986).

If diarrhea persists beyond this 24-48 hour period a veterinarian should be consulted. A fecal sample should be collected and submitted to a diagnostic laboratory for bacterial culture and antibiotic sensitivity, and screening for viruses and parasites.³ Regular feedings with electrolyte solution should be continued and about 20-50 ml bismuth subsalicylate (e.g., Pepto-bismol®) administered orally 2-4 times per day. Antibiotics can be prescribed by a veterinarian, but should be reserved for treating confirmed bacterial infections or systemically ill neonates. Oral administration of some antibiotics, such as chloramphenicol, neomycin, ampicillin, and tetracycline, can induce diarrhea in healthy domestic calves (Rollin et al. 1986) and should be avoided in wild neonates with diarrhea. Oral or injectable trimethoprim-sulfa is the drug of choice for susceptible bacterial infections. It is safe and efficacious at recommended dosages of 33 mg/kg of drug combination orally, or 1 ml of injectable 24% suspension per 10 kg subcutaneously, given twice a day.

Drugs that alter gut motility, particularly those that decrease it (parasympatholytic agents such as atropine and scopolamine), can exacerbate diarrhea and should be avoided. If gut microflora have been altered or eliminated by prolonged diarrhea or antibiotic therapy, plain yogurt (with active cultures) can be added to evaporated milk, or commercial products such as Probios® used in an attempt to reestablish normal flora. As an alternative, we have occasionally fed a few normal fecal pellets from a healthy, unaffected neonate of the same species to a sick individual to promote reestablishment of normal flora in the gut.

³If laboratory work is not possible, a screening test using litmus paper to check fecal pH may be useful. Normally, fecal pH is neutral (pH 6-7); an acidic pH indicates a possible viral infection, while an alkaline pH is more indicative of a bacterial infection.

Other Conditions

"Overeating disease" (enterotoxemia) and other clostridial infections occur occasionally in bottle-raised ungulates, but these problems are readily prevented by proper vaccination. We recommend vaccinating all neonates with multivalent *Clostridium* spp. toxoid (e.g., 7-way clostridium vaccine) upon arrival, 3 weeks later and again at weaning. Use recommended domestic lamb dosages for deer, bighorn, and pronghorn neonates and domestic calf dosages for elk calves.

Internal and external parasites occur frequently in wild neonates. To prevent illness in neonates or spread of parasites to other animals, an anthelmintic such as ivermectin can be administered at cattle dosages to control most common parasites.

Pneumonia occurs occasionally in neonates, and is usually caused by aspirating milk or other feed into the lungs. Bighorn lambs also appear particularly susceptible to pneumonia unrelated to milk aspiration; theirs are often bacterial infections caused by *Pasteurella* spp. Clinical signs of pneumonia can include depression, loss of appetite, nasal discharge, coughing, and elevated body temperature. If pneumonia is suspected, a veterinarian should be consulted. Procaine penicillin G administered subcutaneously at 22,000 U/kg daily is an appropriate treatment for aspiration pneumonia. Pasteurellosis in bighorn lambs may require more intensive therapy (Wild and Miller 1991).

Minor trauma, such as abrasions, can usually be treated by washing with an antiseptic solution or soap and water, then kept clean until a scab forms. Antibiotics are usually not required unless signs of infection are present. If flies are abundant, Cutter KRS® (or a comparable product) can be applied directly to the wound to prevent or treat fly strike (myiasis). Severe lacerations or fractures should be examined by a veterinarian and the most practical and humane action taken. Euthanasia is an option that should be considered and exercised in cases of severe trauma (or illness), especially in recalcitrant individuals.

Thorough examination of wild ungulates, especially when injured, may require chemical immobilization by a veterinarian. Xylazine HCl, alone or in combination with ketamine HCl, is a useful sedative when administered intramuscularly (IM) or intravenously (IV). Sedative dosages vary based on individual and degree of excitation, but in general can be administered at the following dosages to young wild ruminants: about 0.2-0.3 mg/kg xylazine with or without 1 mg/kg ketamine IV or 0.5-0.8 mg/kg

xylazine with or without 2-3 mg/kg ketamine IM. Yohimbine HCl can be used to reverse the effects of xylazine at a dosage of 0.125 mg/kg.

Castration

Bottle-raised males intended for use in research, and sometimes display, are often castrated to reduce aggression and possibility of injury to handlers or other animals. The procedure should be performed by a veterinarian with the animal under anesthesia. Castration can be performed as soon as the testicles descend into the scrotum (usually by about 2 months of age) using a closed technique like that used in male llamas or stallions.

TRANSPORTATION

Care must be exercised in transporting neonates to avoid injury or overheating. Clean dog kennels are satisfactory for young or small neonates. Larger boxes with adequate ventilation or partially enclosed horse trailers can also be used for larger individuals. Sedation can be used for fractious individuals. Unanesthetized neonates should not be hobbled or hog-tied during transport.

PLACEMENT

We discourage private citizens from picking-up "abandoned" neonates; in Colorado, it is illegal for private individuals to possess wild animals without proper permits from the Division of Wildlife. Neonatal deer, elk, moose, and pronghorn are frequently left alone by the dam and display hiding behavior until about 2 weeks of age (Fig. 2). This is normal defensive behavior and these animals are not in danger if left undisturbed. However, if healthy, legitimately orphaned, or injured neonates are found, a representative from the Colorado Division of Wildlife should be notified immediately.



Fig. 2. Wild elk calf in hiding posture.

The ultimate disposition of a neonate may influence some aspects of its husbandry. If animals are to be used for display or research, imprinting and habituation to humans is desirable. One exception to this may be imprinting intact males; they often become aggressive toward humans after reaching sexual maturity, particularly during the rut. If orphans are raised for release at weaning (i.e., "rehabilitated"), human contact should be minimized to preclude habituation. Once they accept the bottle, individuals destined for release should be approached only for feedings. Group housing should also be employed to encourage intraspecific socialization. However, because it is difficult to ensure that bottle-raised neonates are not habituated to humans, we do not recommend their release back to the wild.

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APPENDIX

Manufacturer information for products listed. Similar products by other manufacturers are available.

- Calf Manna® -- Pro-Manna, Denver, CO 80216
- Probios® -- Pioneer Hi-Bred International, Inc., West Des Moines, IA 50131
- KRS® -- Cutter Animal Health, Mobay Corp., Shawnee, KS 66201
- Revive® -- TechAmerica, Fermenta Animal Health Co., Kansas City, MO 64190
- Biolyte® -- Upjohn Co., Kalamazoo, MI 49001
- Pepto-Bismol® -- Procter and Gamble, Cincinnati, OH 45202

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