

# The Nutritional, Ecological, and Ethical Arguments Against Baiting and Feeding White-Tailed Deer

ROBERT D. BROWN,<sup>1</sup> Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station TX 77843-2258 USA  
SUSAN M. COOPER, Texas A&M University, Texas Agricultural Experiment Station, Uvalde, TX 78801-6205 USA

## Abstract

The use of food plots, supplemental feeding, and baiting has been a common and legal practice in Texas for many years. There is now controversy as to whether Texas Parks and Wildlife Department should include this extra nutrition as part of their carrying capacity estimates used to determine harvest permits for private landowners. Managers should remember that nutrition is only one component of carrying capacity, which includes water, shelter, and space as well. Extensive data exists about the potential negative impact of feeding on deer. Studies in Texas (Murden and Risenhoover 1993) have shown that fed deer (*Odocoileus virginianus*) can degrade rangeland by overconsuming high-quality plants and underconsuming low-quality plants. Güterrez (1999) did not find that effect when South Texas deer were offered winter food plots. Donier et al. (1997) found in Minnesota that winter supplementation increased browse pressure within 900 m of feeders. Other reports (Williamson 2000) show increased browse pressure within a 1-mile radius of feeders, perhaps due to concentration of deer. Cooper et al. (2002) found 50% kernel home range sizes of fed deer were half that of unfed deer and that browse pressure near the feeder was 7 times that of unfed deer. Supplemental feeding has been suspected of contributing to the spread of tuberculosis in deer, chronic wasting disease in elk (*Cervus canadensis*) and deer, and brucellosis in elk and bison (Bison bison; Williamson 2000). Crowding due to supplemental feeding led to fighting and injuries in Michigan deer (Ozoga 1972). Feeding has actually led to starvation in deer due to increases in population when feeding was initiated (McCullough 1977, Schmitz 1990). Supplemental feed is consumed by nontarget species, possibly leading them to pass disease and to attract predators. Cooper and Ginnett (2000) found decreased survivorship of simulated turkey nests within 400 m of deer feeders in Texas. In 1998 we found illegal levels of aflatoxin in 40% of 100 randomly purchased bags of "deer corn" in Texas (N. Wilkins Texas Cooperative Extension, USA unpublished data). The ecological significance of deer feeding and baiting is only part of the issue. Feeding leads to ethical questions as well. Feeding is part of the domestication process, along with fencing, breeding, and health programs that, due to their expense, may lead to the desire for private ownership of wildlife. Baiting, likewise, adds to the advantages of the hunter over the hunted and may decrease hunter satisfaction and increase concerns of the antihunters and the nonhunting public (Ortega y Gasset 1995). Deer managers and agency personnel should review the data presented here and incorporate it into their decision making when considering feeding or baiting of deer. (WILDLIFE SOCIETY BULLETIN 34(2):519-524; 2006)

## Key words

baiting, deer, hunting, *Odocoileus* spp., supplemental feeding

The Hill Country of Texas, USA, a few miles west of San Antonio, is arguably the epicenter of the multimillion dollar hunting industry in Texas. Kerrville, in Kerr County, provides hunters with everything from lodging to taxidermy services. In the Kerrville Wal-Mart, the sporting-goods section brims with camouflage clothing, game calls, and ammunition. This past fall, Wal-Mart customers could also purchase a "Feeder Repeater" (Moultrie Feeders, The Woodlands, Texas). This \$4.95 (US) battery-operated device fits in the palm of your hand, and when activated, it sounds like an automatic deer feeder. The advertising on the package states, "We make the call, you make the shot," and "gives you the extra spin when you need it." It even refers to a Wildlife Society Bulletin article (Henke 1997) by stating, "A recent study from Texas (Henke) demonstrated that with little training deer would arrive at a timed feeder when it goes off."

This is a fine example, or perhaps a terrible example, of what hunting has become. From laser range finders to doe urine lures to cloning of white-tailed deer (*Odocoileus virginianus*), the hunting "industry" has surpassed any concept of rational wildlife population or habitat management, much less the concept of fair chase. Supplemental feeding and baiting of deer have become part of this matrix of tools used to "produce" a "quality" or "trophy" animal for commercial gain. The question yet to be answered

about supplemental feeding of white-tailed deer is "Do they need it?"

## Nutritional Issues

### Nutritional Requirements of Deer

Quite likely no wildlife species has been studied as much as white-tailed deer, and yet we still know very little about the nutritional requirements of this species because deer are wild animals and expensive to study. Field studies, including bite counts and fecal analyses, can determine the deer's food habits, but it takes a large number of hand-reared, tame animals kept in pens, or even crates, to determine nutritional requirements. General requirements of deer have been determined for water, protein, energy, and some minerals, but scant information is available on requirements for vitamins, trace minerals, and even some macrominerals. Most of the requirement information is based on studies of only a few animals and then generally only on fawns or nonpregnant does. Rarely is information available for nutritional requirements adjusted for the environment or for the physiological state of the animal. For instance, it is unknown how protein or energy needs are impacted by cold northern winters or hot southern summers. We have little information to adjust requirements of pregnant does at different stages of gestation or lactating does, growing fawns, or rutting bucks.

The general nutritional requirements of white-tailed deer can

<sup>1</sup> E-mail: rdbrown@tamu.edu

easily be summarized. Their crude protein (CP) requirement is about 13–20% for weaned fawns (Ullrey et al. 1967) but only 4% for maintenance and 10% for growth in adult bucks (Asleson et al. 1996). Pregnancy has little impact on protein requirements, as the average fawn contains only 525 grams of protein at birth, which was produced over a 6-month period (Robbins and Moen 1975). Velvet deer antlers are about 80% protein (Ullrey 1983), but again, the total amount of protein in antlers is small and added over several months. Lactation leads to the highest protein requirements of any physiological condition, as deer milk averages 8.2% protein or 36.4% on a dry matter basis, nearly double that of cow milk (Ofstedal 1981). The protein requirements of does at various stages of lactation are not known.

As ruminants, deer need fiber, but fiber is never in short supply in a browsing animals' diet. Dietary fiber, along with digestible soluble carbohydrates, supply most of the deer's energy. Ullrey et al. (1970) estimated the maintenance digestible energy (DE) requirement of a 54-kg doe to be 13,360 kJ/day. Standing, eating, locomotion, pregnancy, growth, and lactation all increase energy requirements. It is assumed that these easily double daily energy requirements, on average. Deer need substantially more energy to maintain their body temperature in cold weather, and they may need more energy to pant to lose heat during hot weather. But again, little is known about how much more energy is needed at different ambient temperatures.

The needs of deer for calcium (Ca) and phosphorus (P) have been studied fairly extensively but with varying results. The total mineral content of a deer's body is only about 5%, and hardened antlers, on average, are about 22% Ca and 11% P (Robbins 1993). Numerous researchers have calculated Ca and P requirements for antler growth, but estimates vary widely from 0.09–0.64% Ca and 0.14–0.56% P (French et al. 1956, McEwen et al. 1957, Ullrey et al. 1983, Jacobson 1984). Most recently, Grasman and Hellgren (1993) found that P requirements of deer varied seasonally, as one might expect. The seasonal estimate varied from 0.12–0.16%.

Hellgren and Pitts (1997) also estimated the sodium requirements of white-tails, and copper is beneficial in rations for farmed red deer (*Cervus elaphus*; Sugar et al. 1991). Nothing else is known about minerals and deer, yet rarely has a specific mineral deficiency been found in deer. Likewise, vitamin deficiencies are rare in deer. As ruminants, deer are assumed not to need B vitamins or vitamins C or K. Vitamin A deficiencies have been found (Youatt et al. 1976), and white muscle disease, caused by either a vitamin E deficiency or a selenium deficiency, has been found in northern white-tails (Forbes 1961). Selenium deficiency has also been found in both white-tailed deer (McDowell et al. 1995) and in black-tailed deer (*O. hemionus columbianus*; Flueck 1994). Blood concentrations of vitamin D, the vitamin that helps with mineral metabolism, are known to vary seasonally (Van der Eems et al. 1988), but it is not known what the requirements might be.

### **Malnutrition Versus Undernutrition**

Cowan and Clark (1981) opined that starvation is the only deficiency disease of free-ranging deer, and, with the exception of hunting harvest and accidental injuries, the most common cause of death of deer. Specific nutritional deficiencies or malnutrition in deer are rare, and there seems to be no nutrient, which, when

given in large amounts, will cause the deer to grow spectacular antlers. Deer have evolved to browse on varied diets and to survive feed shortages. Mule deer (*O. hemionus*) in captivity have been known to survive from 10–64 days with no feed at all and to fully recuperate when refed (deCalestra et al. 1975). Male deer reallocate minerals from their skeleton during antler growth, and these minerals are replaced from the diet after the antlers are shed (Cowen et al. 1969). Deer may even be able to increase the absorption of certain nutrients during times of need (Stephenson and Brown 1984). Deer can survive a 15–20% loss of body weight in the winter (Hershberger and Cushwa 1984) and may reduce their feed intake in winter even if feed is available (Wheaton and Brown 1983). Deer in northern states have starved to death during the winter. Efforts at supplementing them have often failed because their rumen microflora were too depleted to digest feed when it was finally offered (Ullrey et al. 1970). Meyer et al. (1984) found that in southern Texas, energy intake among deer was most limited during the hot, dry summers, and energy was more nutritionally limiting than was protein.

Thus, white-tailed deer are quite adaptable to nutritional stress. Specific nutrient deficiencies are rare, but overall undernutrition is not. It appears that the deer's bodily needs take precedence over antler production. Rather than diverting minerals from the body to the antlers, bucks on inadequate diets produce poor antlers. Poor antler size was correlated with poor range conditions as early as 1951 (Severinghaus et al. 1951). Pinned deer on adequate diets in Texas (Harmel 1979) and in Michigan (Ozoga and Verme 1982) had better antler growth than those on poor diets. Cowan and Long (undated), Ozoga and Verme (1982), and Jacobson and Griffin (1982) found that deer on restricted diets shed their antlers earlier than did deer on adequate diets. In general deer, even fawns, if nutritionally stressed, will catch up with their better-fed neighbors once adequate feed is offered (Long et al. 1959). The results depend on the length of the nutritional stress and the condition of the deer when the stress began.

If deer numbers are kept below carrying capacity, however, the deer generally can survive and even thrive despite seasonal restrictions in diet quality and quantity. Supplemental feed may help more deer survive or help surviving deer do better during periods of severe winter weather or drought, when nutritional conditions are poor. There is no evidence, however, that feeding deer beyond what is required will produce a larger animal or larger antlers. Once nutritional needs are met, genetics determines body and antler size (Demarias 1998). It should be noted that the dangers of supplemental feeding are numerous, even if it is being used to supplement an inadequate diet or to get the deer herd through a nutritionally stressful period.

## **Ecological Issues**

### **Supplemental Feeding Can Harm the Habitat**

Deer habitat consists of food, water, shelter, and space. Thus, food plots and supplemental feeding only alter "nutritional carrying capacity" not "total or real carrying capacity." Supplemental feeding can greatly increase deer population densities, if there is adequate water. But the amount of space and cover remain the same, thus, the space and cover per deer decreases. One of the arguments used by those in support of supplemental feeding is

that it not only enhances the nutrition and, thus, the health and physiology of the deer (not necessarily true), but also that it could take pressure off of the natural vegetation by decreasing grazing and browsing (Taylor 1996). Presumably, this could lead to a greater biomass of vegetation, more diversity of plants and, thus, a better range or forest vegetative condition. Unfortunately, there is little data to support this, and substantial data to refute it.

### Texas Studies

**Sonora study.**—In 1990 our department set up a series of studies with deer and goats (*Capra hircus*) at the Sonora, Texas, USA, Experiment Station (Murden 1993, Murden and Risenhoover 1993, 1996, Murden and Taylor 1999). Deer were provided pelleted supplements, or not, and placed in 0.4-ha enclosures so that their foraging behavior could be observed. The researchers predicted supplemented deer would become more selective in their foraging, rather than less selective, since their immediate nutritional needs had been met by the supplement. That is exactly what they found. Although the total number of plant species consumed was not different, whether the deer were supplemented or not, the deer's movement rates or foraging times increased, and the deer sought out and ate the less common, more nutritious plants at a higher rate than when not supplemented. Between consumption of pellets and foraging, their overall diet improved, which is what is wanted from supplementing. Thus, the supplement allowed the deer more time to select the plants that were higher in protein and energy than did the deer that were not supplemented.

Murden and Risenhoover concluded that supplementing deer could cause the animals to stay in an area where forage resources were depleted, whereas they would normally disperse to seek better forage. Supplementation may, thus, lead to overutilization of high-quality plants and underutilization of low-quality plants, which, if continued over time, would lead to simplification of the vegetative community, loss of palatable plant species, and degradation of the range.

**Kingsville study.**—Gutierrez (1999) at Texas A&M University, Kingsville, USA, attempted to take Murden and Risenhoover's penned deer study to the field. He harvested deer, which did or did not have access to winter wheat food plots in southern Texas. Like Murden and Risenhoover's tame deer consuming food pellets, the wild deer, which were grazing food plots, continued to browse and graze on native vegetation, but the deer that had consumed the wheat in the food plots did not increase their selectivity of native plants.

The author cautioned, however, that in Murden and Risenhoover's studies, the pellet fed was higher in quality (16% CP and 16 kJ/gr DE) than most of the surrounding native plants, whereas in his study, the winter wheat was of similar quality (16% CP; 14.65 kJ/gr DE) to the excellent condition of the surrounding native range plants. This could have impacted the selectivity of the deer. He also reasoned that his deer may have become more selective at the plant parts scale, which was not measured.

**Uvalde studies.**—This tendency for feeders or food plots to reduce the dispersal of deer and concentrate them in an area is a major concern. Vanderhoof and Jacobson (1990), studying free-ranging deer in Mississippi forests, found that deer did not change their home ranges due to the presence of food plots. They did find, however, that the deer tended to stay in the area of their

home range nearest the food plot. Cooper et al (2002), studying deer behavior at the Texas Agricultural Experiment Station, Uvalde, USA, found that does with no feeder in their home range had 95% kernel home range estimates of 756 ha, which was not statistically different from a home range size of 776 ha for does with a feeder. But, using the 50% kernel estimate as an indicator of core area use, does with feeders had a core area of only half the size (54 ha) of those with no feeder (100 ha).

They also put out seedlings in plots around feeders and at control sites. The deer browsed 7 times more heavily near the feeders than at control sites. These results are similar to those of Doenier et al. (1997) who found in Minnesota that winter supplementation of deer increased browse pressure within 900 m of feeders. Cooper et al. (2002), concluded that supplemented deer still browse, use portions of their home range more intensively, and could cause habitat deterioration near the feeders. In addition, Cooper and Ginnett (2000) found increased predation in artificial turkey nests within 400 m of deer feeders. Keith McCaffery (Wisconsin Department of Natural Resources, Madison, USA, personal communication) perhaps said it best, "One does not protect a garden from deer by placing a large feed pile in the center of it."

### Feeding Increases the Deer Population

There is abundant scientific literature addressing the effects of increasing deer populations on their condition, habitat, and predator populations. Numerous studies have shown that supplemental feeding of deer contributed to overpopulation; consequences include decline in their condition, as well as reduced quality of the area's vegetation. Remember that deer can twin, and fawns can breed. When diet quality and quantity increase, reproduction and survival are enhanced, leading to overpopulation, which again leads to overbrowsing of the native vegetation. Mule deer and elk (*Cervus elaphus*) in the west (McCullough 1997) and white-tailed deer in the east (Schmitz 1990) stripped habitats of all available food when populations exploded due to supplemental feeding. Thus, ultimately, supplemental feeding lead to starvation. Pekins and Tarr (1997) observed that supplemental feeding does not prevent malnourishment; it usually just increases the population size at which malnourishment occurs.

Finally, remember that the feed or bait being provided may not be nutritious at all and may be consumed by animals other than deer. Nontarget species are often monogastric animals and may be more susceptible to nutritional diseases than deer (Davis 1996). We found that 40% of a sampling of 100 bags of deer corn sold in Texas 2 years ago had levels of aflatoxin that were illegal, and 20% had levels that would be toxic to birds and other nontarget species, as well as deer, if consumed over a long period of time (N. Wilkins, Texas Cooperative Extension, USA, unpublished data). The possibility of disease transfer between animals also is increased when numerous animals feed from a common feed source (Quist et al. 1997). Supplemental feeding has been suspected of contributing to the spread of tuberculosis in deer, chronic wasting disease in elk and deer, and brucellosis in elk and bison (*Bison bison*; Williamson 2000). Also, crowding due to supplemental feeding led to fighting and injuries in Michigan deer (Ozoga 1972).

Although supplementation may improve the nutritional condition of deer that are in a poor habitat, supplementing deer is

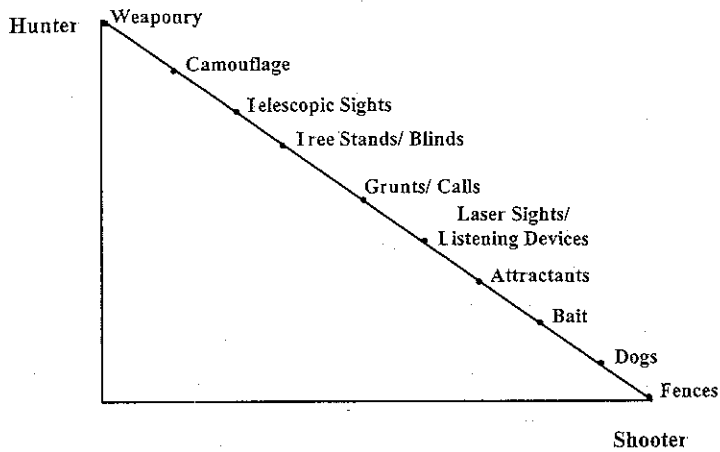


Figure 1. The continuum from hunter to shooter

potentially ecologically dangerous—for the deer, for the range or forest, and for the rest of the animals and birds that use that habitat. To paraphrase the Scottish scientist, J. B. S. Haldane, “Ecological systems are not only more complex than we think, they are more complex than we can think.” (Singh 2005)

## Ethical Issues

### Do Real Hunters Use Bait?

Although we have presented the scientific reasons for not supplementing or baiting deer, there is a need to look at the influence of intensive management on the future of hunting. Texas A&M has been involved in an effort to address this very issue in our state (Brown et al. 2003). Adams and Causey (2000) reported Adams’ earlier studies that showed why Texans hunt—mostly for meat, for being with friends and family, and for being with nature. In fact, less than 7% of hunters nationwide are “trophy hunters,” but about 19% in Texas hunt trophies. They also reported what the Texas general public thinks of hunting. Fortunately, they generally approve of it, except hunting for trophies and hunting for profit. But the question of intensive management and with it supplemental feeding and baiting requires that we remind ourselves of why we hunt at all.

In 1942 the Portuguese philosopher, Jose Ortega y Gasset published his book, *Meditations on Hunting* (translated by H. B. Wescott and republished in 1995). It is a wonderful read and right on the mark because his many philosophical thoughts have been substantiated with surveys of hunters and the nonhunting public. Ortega y Gasset (1995) is probably best remembered for his statement in the book, “One does not hunt to kill; one kills to have been hunting.” According to Ortega y Gasset, we continue to hunt, although it is no longer necessary to hunt, to reassure us of who we are. The essence of hunting is to pit our senses, abilities, knowledge, and experience against that of a wild animal. As he put it, “Hunting is a contest or confrontation between two sets of instincts” (Ortega y Gasset 1995). But look what we are doing in Texas and elsewhere. We are on a continuum from being the “Hunter” to what we call the “Shooter.” We are using Gilbert’s (2000) nomenclature in which he defined the “Shooter” as the “Meat Harvester,” “Slob Hunter,” “Poacher,” and “Hunting Jock.” These individuals shoot deer but do not necessarily hunt them. The shooters have little or no knowledge of deer biology or

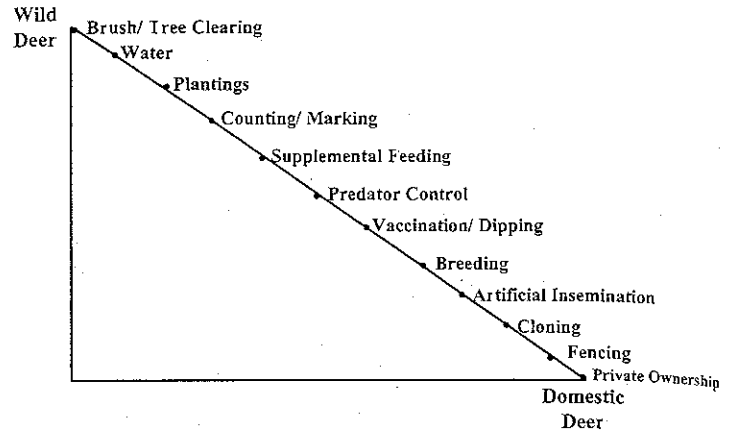


Figure 2. The continuum from wild to domesticated deer

behavior, have few hunting skills, and participate for the kill not the hunt. Along a continuous evolution, we give the hunter advantages over his prey: first the weaponry, then camouflage, telescopic sights, tree stands and blinds, grunts and calls, laser sights and listening devices, doe urine and other attractants, corn and “deer suckers” as bait, containment with fences, and finally, but at least not in Texas, the use of dogs (Fig. 1). At what point do we have so much advantage over the deer that we are no longer really hunting, but only shooting, since the deer really has no chance to use its natural instincts to avoid the hunter?

### Are Fed Deer Wild Deer?

On the other side of it, we have an evolving continuum from wild deer to domesticated animals. In the domestication process, we first clear the brush and trees to clear pastures, then we provide waterers or tanks, we count and mark our animals (or take photos or videos of our deer), we erect fences to contain them, we control predators so we will be the only consumers, then we start a herd health program such as dipping or vaccination, then comes supplemental feeding, we buy and import breeding bucks, maybe we even try artificial insemination, and finally, as has now been done at Texas A&M University, we clone deer (Fig 2; Miller 2005). If these are superior deer, what are they superior to? What abilities have they developed to survive in the wild? They may be larger, but they are not superior.

You can see that at some point, we stop being hunters, and the deer stop being wildlife. We ask you, where are we now and where are we going with all of this? How far can we go and retain our self-respect and our honor as hunters? Thus far, we have avoided any quotes from Aldo Leopold on this subject, but the following is appropriate here: “The recreational value of a game animal is inverse to the artificiality of its origin and the intensiveness of the management system that produced it. A proper game policy is a happy medium between the intensity of management necessary to maintain a supply of game animals and that which would deteriorate its quality or recreational value” (Leopold 1931). Or, as David Langford, former Executive Director of the Texas Wildlife Association (San Antonio, USA) has stated, “Once animals are dependant on their de facto owners for their nourishment, the principles of wildlife management have been

replaced by those of animal husbandry" and, finally, "The more like animal husbandry that wildlife management becomes, the less defensible hunting becomes" (personal communication)

## Management Implications

A properly managed deer herd does not need supplementation, and a deer hunter does not need bait. We risk damage to the

habitat and to deer and other wildlife populations with supplemental feeding. Supplemented deer may be larger in body and antler size, and they may still be skittish, but they are not superior animals, worthy of the hunt. We also argue that if we continue in our current direction, we will not have the choice of how we hunt deer or possibly even whether we hunt deer. The nonhunting public will make those decisions for us.

## Literature Cited

- Adams, C. E., and L. A. Causey. 2000. The future of hunting in Texas. Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, USA.
- Asleson, M. A., E. C. Hellgren, and L. W. Varner. 1996. Nitrogen requirements for antler growth and maintenance in white-tailed deer. *Journal of Wildlife Management* 60:744-752.
- Brown, R. D., K. L. Brown, D. K. Langford, G. L. Graham, and M. E. Berger. 2003. Preserving Texas' hunting heritage: a strategic plan for ensuring the future of hunting in Texas. Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, USA.
- Cooper, S. M., R. M. Cooper, M. K. Owens, and T. F. Ginnett. 2002. Effect of supplemental feeding on use of space and browse utilization by white-tailed deer. Page 31 in D. Forbes and G. Piccini, editors. Land use for water and wildlife. Texas Agricultural Research and Extension Center, UREC-02-031, Uvalde, USA.
- Cooper, S. M., and T. F. Ginnett. 2000. Potential effects of supplemental feeding of deer on nest predation. *Wildlife Society Bulletin* 28:660-666.
- Cowan, R. L., and A. C. Clark. 1981. Nutritional requirements. Pages 72-86 in W. A. Davidson, editor. Diseases and parasites of white-tailed deer. Southeastern Cooperative Wildlife Disease Study, University of Georgia, Athens, USA.
- Cowan, R. L., E. W. Hartsook, and J. B. Whelan. 1969. Deer antler growth—ideal test for study of bone metabolism. *Science in Agriculture* 17:1.
- Cowan, R. L., and T. A. Long. Undated. Studies on antler growth and nutrition of white-tailed deer. Pennsylvania Cooperative Wildlife Research Unit, Pennsylvania State University, University Park, USA, 107:1-8.
- Davis, D. S. 1996. Aflatoxins and disease concerns. Pages 143-145 in C. W. Ramsey, editor. Supplemental feeding for deer: beyond dogma. Texas A&M University, College Station, USA.
- deCalestra, D. S., J. G. Nagy, and S. A. Bailey. 1975. Starving and refeeding mule deer. *Journal of Wildlife Management* 39:633-639.
- Demarais, S. 1998. Managing for antler production: understanding the age-nutrition-genetic interaction. Pages 33-39 in C. E. Cearley and D. Rollins, editors. The role of genetics in white-tailed deer management. Texas A&M University, College Station, USA.
- Doenier, P. N., G. D. DelGuidice, and M. R. Riggs. 1997. Effects of winter supplemental feeding on browse consumption by white-tailed deer. *Wildlife Society Bulletin* 25:235-243.
- Flueck, W. T. 1994. Effect of trace elements on population dynamics: selenium deficiency in free-ranging black-tailed deer. *Ecology* 74:807-812.
- Forbes, S. E. 1961. Diseases and parasites of the Pennsylvania white-tailed deer. *Pennsylvania Game News* 32(12):42-46.
- French, C. E., L. C. McEwen, N. D. Magruder, R. H. Ingram, and R. H. Smith. 1956. Nutrient requirements for growth and antler development in the white-tailed deer. *Journal of Wildlife Management* 20:221-232.
- Gilbert, F. F. 2000. Considerations in managing wildlife populations for sport. *Wildlife Society Bulletin* 2:457-463.
- Grasman, B. T., and E. C. Hellgren. 1993. Phosphorus nutrition in white-tailed deer: nutrient balance, physiological responses, and antler growth. *Ecology* 74:2279-2296.
- Gutierrez, M. A. 1999. Effects of cool-season food plots on white-tailed deer diet selectivity in south Texas. Thesis, Texas A&M University, Kingsville, USA.
- Harmel, D. E. 1979. Antler formation in white-tailed deer. Job Performance Report, Texas Parks and Wildlife Department, Federal Aid Project No. W-109-R-2, Austin, USA.
- Hellgren, E. C., and W. J. Pitts. 1997. Sodium economy in white-tailed deer (*Odocoileus virginianus*). *Physiological Zoology* 70:547-555.
- Henke, S. E. 1997. Do white-tailed deer react to the dinner bell? An experiment in classical conditioning. *Wildlife Society Bulletin* 25:291-295.
- Hershberger, T. V., and C. T. Cushwa. 1984. The effects of fasting and refeeding white-tailed does. The Pennsylvania State University Agricultural Experiment Station, Bulletin 846, University Park, USA.
- Jacobson, H. A. 1984. Investigations of phosphorus in the nutritional ecology of white-tailed deer. Progress Report for Federal Aid in Wildlife Research Project W-48-31, Study XXLL, Mississippi State University, Mississippi State, USA.
- Jacobson, H. A.; and R. N. Griffin. 1982. Antler cycles of white-tailed deer in Mississippi. Pages 15-22 in R. D. Brown, editor. Antler development in cervidae. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA.
- Leopold, A. 1931. Game methods: the American way. Page 231 in C. Meine and R. L. Knight, editors. The essential Aldo Leopold: quotations and commentaries. The University of Wisconsin, Madison, USA.
- Long, T. A., R. L. Cowan, C. W. Wolfe, T. Radar, and R. W. Swift. 1959. Effect of seasonal feed restriction on antler development in white-tailed deer. The Pennsylvania State University Agricultural Experiment Station, Progress Report 209, University Park, USA.
- McCullough, D. R. 1997. Irruptive behavior in ungulates. Pages 69-98 in W. J. McShea, H. B. Underwood, and J. H. Rappole, editors. The science of overabundance: deer ecology and population management. Smithsonian Institution, Washington, D.C., USA.
- McDowell, L. R., D. J. Forrester, S. B. Linda, S. D. Wright, and N. S. Wilkinson. 1995. Selenium status of white-tailed deer in southern Florida. *Journal of Wildlife Diseases* 32(2):205-211.
- McEwen, L. C., C. E. French, N. D. Magruder, R. W. Swift, and R. H. Ingram. 1957. Nutrient requirements of white-tailed deer. Transactions of the North American Wildlife and Natural Resources Conference 22:119-132.
- Meyer, M. W., R. D. Brown, and M. W. Graham. 1984. Protein and energy content of white-tailed deer diets in the Texas Coastal Bend. *Journal of Wildlife Management* 48:527-534.
- Miller, M. L. 2005. Rack of the clone. *Bugle* 22(7):60-64.
- Murden, S. B. 1993. Assessing competitive interactions among white-tailed deer and angora goats. Thesis, Texas A&M University, College Station, USA.
- Murden, S. B., and K. L. Risenhoover. 1993. Effects of habitat enrichment on patterns of diet selection. *Ecological Applications* 3:497-505.
- Murden, S. B., and K. L. Risenhoover. 1996. Forage use by white-tailed deer: influence of supplemental feeding. Pages 131-141 in C. W. Ramsey, editor. Supplemental feeding for deer: beyond dogma. Proceedings of a Symposium in Kerrville, Texas Agricultural Extension Service, 8-10 October 1996, College Station, USA.
- Murden, S. B., and C. A. Taylor. 1999. Ecological impacts of supplementing free-ranging white-tailed deer. CD-ROM. G. M. Dryden, editor. Nutritional ecology of herbivores: feeding and management of cervids in the twenty-first century. Fifth International Symposium on the Nutrition of Herbivores, Texas A&M University, 11-16 April 1999, College Station, USA.
- Oftedal, O. T. 1981. Milk protein and energy intakes of suckling mammalian young: a comparative study. Dissertation, Cornell University, Ithaca, New York, USA.
- Ortega y Gasset, J. 1995. Meditations on hunting. Translated from the 1942 original by H. B. Wescott. Wilderness Adventures, Bozeman, Montana, USA.
- Ozoga, J. J. 1972. Aggressive behavior of white-tailed deer at winter cuttings. *Journal of Wildlife Management* 36:861-868.
- Ozoga, J. J., and L. J. Verme. 1982. Physical and reproductive characteristics of a supplementally fed white-tailed deer herd. *Journal of Wildlife Management* 46:281-301.
- Pekins, P. J., and M. D. Tarr. 1997. The impact of winter feeding on the population dynamics of white-tailed deer in northern New Hampshire. Federal Aid in Wildlife Restoration Study W-12-R, Proj. 3, Job 2, New Hampshire Fish and Game Department, Concord, USA.
- Quist, C. F., E. W. Howerth, J. J. Fisher, R. D. Wyatt, D. M. Miller, and V. F.

- Nettles 1997. Evaluation of low-level aflatoxin in the diet of white-tailed deer. *Journal of Wildlife Diseases* 33:112-121
- Robbins, C. T. 1993. *Wildlife feeding and nutrition*. Academic, San Diego, California, USA
- Robbins, C. T., and A. W. Moen. 1975. Milk consumption and weight gain of white-tailed deer. *Journal of Wildlife Management* 39:355-360
- Schmitz, O. J. 1990. Management implications of foraging theory: evaluating deer supplemental feeding. *Journal of Wildlife Management* 54:522-532
- Severinghaus, C. W., H. F. McGuire, R. A. Cookingham, and J. E. Tanck. 1951. Variations by age class in the antler beam diameters of white-tailed deer related to range conditions. *Transactions of the North American Wildlife and Natural Resources Conference* 15:551-570.
- Singh, S. 2005. What a long strange trip it would be. *Los Angeles Times* 15 February 2005; Book Reviews Part R:7.
- Stephenson, D. C., and R. D. Brown. 1984. Calcium kinetics in male white-tailed deer. *Journal of Nutrition* 114:1014-024
- Sugar, L., Z. Lassu-Merenyi, and J. Kelemen. 1991. Importance of copper supplementation in farmed red deer. Pages 453-455 in R. D. Brown, editor. *The biology of deer*. Springer-Verlag, New York, New York, USA.
- Taylor, C. A. 1996. The range supplement interaction. Pages 7-16 in C. W. Ramsey, editor. *Supplemental feeding of deer: beyond dogma*. Texas A&M University, College Station, USA.
- Ullrey, D. E. 1983. Nutrition and antler development in white-tailed deer. Pages 49-60 in R. D. Brown, editor. *Antler development in cervidae*. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, USA
- Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay, and B. L. Bradley. 1967. Protein requirements of white-tailed deer fawns. *Journal of Wildlife Management* 31:679-685
- Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay, B. L. Schoepke, and W. T. Magee. 1970. Digestible and metabolizable energy requirements for winter maintenance of Michigan white-tailed does. *Journal of Wildlife Management* 34:863-869
- Van der Eems, K. L., R. D. Brown, and C. M. Gundberg. 1988. Circulating levels of 1,25 dihydroxyvitamin D, alkaline phosphatase, hydroxyproline and osteocalcin associated with antler growth in white-tailed deer. *Acta Endocrinology* 118:407-414
- Vanderhoof, R. E., and H. A. Jacobson. 1990. Production and use of agricultural food planting by deer on Marion County Wildlife Management Area, Mississippi. Completion Report: 1984-1989. Mississippi Department of Wildlife, Fisheries and Parks, Jackson, USA
- Wheaton, C., and R. D. Brown. 1983. Feed intake and digestive efficiency of white-tailed deer. *Journal of Wildlife Management* 47:442-450.
- Williamson, S. J. 2000. Feeding wildlife—just say no! *Wildlife Management Institute*, Washington, D.C., USA
- Youatt, W. G., D. E. Ullrey, and W. T. Magee. 1976. Vitamin A concentrations in the livers of white-tailed deer. *Journal of Wildlife Management* 40:172-173



**Susan Cooper** (left) is an assistant professor of wildlife sciences at the Texas Agricultural Experiment Station in Uvalde, Texas. She obtained her B.S. in zoology at the University of Newcastle upon Tyne, United Kingdom; her M.S. in ecology at the University of Aberdeen, United Kingdom; and her Ph.D. in ecology at the University of Witwatersrand in South Africa. Prior to coming to Uvalde as a research associate in 1993, she had research experience in South Africa, Botswana, Alaska, Kenya, the United Kingdom, and at Michigan State University. Susan's area of interest is the nutritional ecology of ungulates. **Bob Brown** (right) is professor and head of the Department of Wildlife and Fisheries Sciences and Director of the Institute for Renewable Natural Resources at Texas A&M University. He received a B.S. from Colorado State University and a Ph.D. from the Pennsylvania State University, both in animal nutrition. He was a faculty member at Texas A&M University and a research scientist at the Caesar Kleberg Wildlife Research Institute in Kingsville from 1975-1987 and head of the Wildlife and Fisheries Department at Mississippi State University from 1987-1993 before coming to Texas A&M. Bob is the President of The Wildlife Society.