operation was substantially higher because of the additional driving associated with guiding hunters and may also involve picking up hunters in town. Providing guiding services requires additional labor and includes a cost for the operator to become licensed as an outfitter and guide. This is a requirement in Wyoming if the hunting enterprise used lands not owned by the operator, including public lands, or if guides are hired by the operator.

The budget for Example 2 is shown in Table 2. In this example the breakeven charge is $24.81 per hunter day. Comparing the break-even charge with the estimated fee of $36.32 per day (Table 1) suggests that this type of operation is also profitable.

Example 3 describes an agricultural operation that provides 14,400 acres for deer and antelope hunting. The hunting enterprise operates for 28 days with thirty-five customers hunting an average of four days per hunter or 140 hunter days. With the inclusion of lodging and meals, Example 3 is the most capital and labor intensive operation considered in the analysis. Costs of the recreation enterprise increase substantially because of the increase in labor inputs, investment in cabins, and food expenses. One hundred percent of the fixed costs of the cabins were allocated to the recreation operation because most operators indicated that these units were used only for the hunting enterprise. Vehicle requirements were similar to Example 2.

The budget for Example 3 is shown in Table 2. When allocating 15% of the fixed vehicle costs to the enterprise, the break-even charge is $77.90 per hunter day. In comparing the break-even charges with the estimated fee of $111.93, it appears this option is also profitable.

Discussion and Conclusions

Additional income was the primary reason cited by operators for beginning a recreation enterprise. While ranch recreation has the potential to earn a profit, realizing that potential depends on each operator's situation. Each operator must evaluate his particular situation and consider any subjective factors, such as dealing with the public, when assessing the potential of a ranch recreation enterprise. When landowners recognize and are able to realize a profitable situation through hunting and other recreation activities on their land, wildlife habitat will be viewed as an asset and not a liability.

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Exotic Big Game: A Controversial Resource

Stephen Demarais, David A. Osborn, and James J. Jackley

Establishment of exotic big game in the United States has become a topic of great controversy due to possible dietary competition and disease interactions with native wildlife and domestic livestock. The potential for greater financial returns from exotic big game production than from traditional livestock ranching stimulates the introduction of exotics in spite of these dangers. To insure success, managers should consider all biological and economic aspects of exotic big game before venturing into this industry.

Exotic big game refers to all non-native hoofed mammals which have game status in at least part of their current U.S. distribution. Managed appropriately, exotic big game can improve the economic stability of ranching and increase the diversity of game species available to hunters. If not responsibly managed, exotics may inadvertently become unwanted, even harmful inhabitants of our rangelands.

Problems can occur when stocking exotic big game with incomplete knowledge of the biology of the species, its habitat requirements, disease relationships, or its impact on native biota (Ables 1977). Additional research on the ecological implications of free-ranging exotics is needed to establish proper management guidelines for these species.

Pros and Cons

The positive aspects of exotic big game are summarized in five general categories: (1) year-round income to the landowner, (2) increased opportunities for hunters, (3) preservation of endangered species, (4) filling of open niches, and (5) aesthetic value.

Incorporation of exotic big game hunting and/or exotic venison production into a ranching enterprise can generate year-round income. Many states allow exotic big game to be harvested at the landowner's discretion. The

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Fig. 1. *Exotic species depleted in their native lands, such as this blackbuck antelope, can be raised in the United States for eventual repopulation.*

harvest of animals can be scheduled according to optimal growth and development, economic factors, and market demand. Exotic vension production can be a lucrative form of agriculture (von Kerckerinck 1987).

Introductions of aoudad sheep, Persian ibex, and Siberian ibex in New Mexico are examples where introduced big game have increased hunting opportunities for the public (Upham 1980). The islands of Hawaii have no native deer; however, axis deer and black-tailed deer were introduced on Hawaii in 1868 and 1961, respectively (Tomich 1969). Thirty-eight thousand hunters received permits to hunt axis deer in Hawaii during the 1988 season, and more than 50 percent of the hunters were successful (T. Kaiakapu, pers. comm.).

The preservation of endangered species often can be accomplished more easily in the United States than in developing countries. Through the efforts of the African Fund for Endangered Wildlife and Game Conservation International, the American Association of Zoological Parks and Aquariums, and ranchers in the United States, a Species Survival Plan has been established to enrich the genetics of captive endangered species (Winckler 1985).

Niche refers to a species' specialized requirements, which include food, cover, and space. A niche can be considered "open" if all the necessary requirements for a species are present but not being used. The ring-necked pheasant, introduced in the United States from Asia, successfully filled a niche which opened as the native prairies were converted to cereal grains and other domestic grasses (Robinson and Bolen 1989).

Another positive aspect of exotic big game is their aesthetic value. Each year approximately 10,000 paying tourists visit the Y.O. Ranch, a commercial wildlife enterprise specializing in exotic and native big game in Kerr County, Texas to view and photograph these animals (L. Schreiner, pers. comm.).

Negative aspects of exotic big game can be summarized into the following four general categories: (1) competition for niches, (2) uncontrolled spread, (3) disease complications, and (4) interbreeding with native wildlife.

Theoretically, only one species can occupy a niche. If two species share the same niche one or both species will

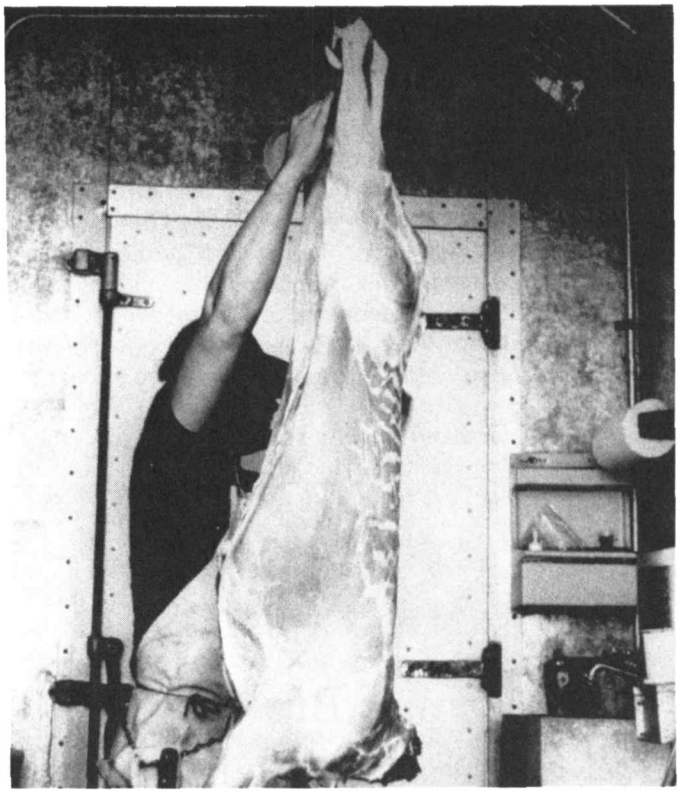

Fig. 2. *The expanding venison market provides a commercial use of exotic game presently occupying rangelands in Texas.*

suffer. For example, the decline of white-tailed deer on Assateague Island, Maryland, is attributed to sika deer (Keiper 1985).

The effects of unregulated competition between native white-tailed deer and two species of exotic deer within 96-acre deer-proofed enclosures were studied in Texas. Equal numbers of axis deer and white-tailed deer and sika deer and white-tailed deer were placed in two separate enclosures for nine years without human interference. After nine years, the axis/white-tailed deer enclosure contained 15 axis deer and only three white-tailed deer and the sika/white-tailed deer enclosures contained 62 sika deer and no white-tailed deer. With no human intervention to regulate density and minimize competition, and limited resources within the 96-acre enclosures, axis deer and sika deer outcompeted native white-tailed deer (Baccus et al. 1985).

Uncontrolled spread of exotics can be a problem. Some landowners do not want to include them in their management plan. Approximately 45 percent of the exotic big game in Texas are not behind game-proof fencing (Traweek 1989). Population control is difficult without adequate fencing (Harmel and Litton 1981).

Disease complications can result from the interactions of native game, exotic game, and domestic livestock. The tropical bont tick native to Africa is the most notorious biological vector of heartwater disease and three were recovered from recently released black rhinos in Texas despite quarantine efforts (Winckler 1985). Heartwater has not been reported in the United States; but if it is introduced, this disease could result in high mortality of cattle, sheep, goats, and deer (Mebus and Logan 1988).

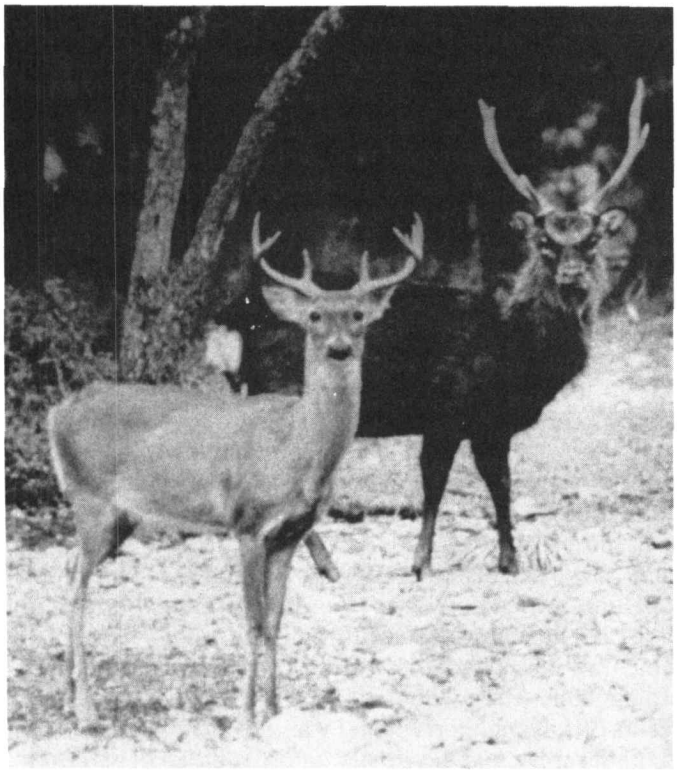

Fig. 3. *Exotic and native game on common rangelands are controversial due to possible dietary and disease interactions.*

Interbreeding among similar species degrades the integrity of both populations. Hybridization of red deer and North American elk is so common among farmed deer in New Zealand that a deer bloodtyping service has been developed to ensure a breeding stock of pure animals (Brown 1988). Inter-breeding between sika deer and red deer has been documented in Czechoslovakia, Great Britain, Ireland, and New Zealand (Ratcliff 1987).

Current Status

Texas heads the list of states inhabited by exotic big game, both in total numbers and species. A survey conducted in 1988 estimated the population of exotics in the state in excess of 164,000 animals (Traweek 1989). Sixty-seven species were represented. Axis deer, native to India, Sri Lanka, and Nepal, is the most common exotic species in the state with 39,000 animals. Nilgai antelope, also from India, ranks second with over 36,700 and blackbuck antelope, almost extinct on the plains of India and Pakistan, ranks as the third most common exotic with over 21,200 animals. These three species along with aoudad sheep (from North Africa), fallow deer (originating in the Mediterranean area), and sika deer (from southeast Asia) constitute 87 percent of the total number of exotics in Texas.

Texans have seen exotics that were first introduced in the 1930's for aesthetic reasons evolve into commercial game animals and meat producers. Few other states offer fee hunting of exotic big game. Several states recognize the potential of the venison industry and have exotic deer farms or anticipate them in the near future. The North American Deer Farmers Association has members in 22 states (J. von Kerckerinck, pers. comm.).

The legal status of exotic big game is receiving attention in some state legislatures. In Arizona, recent legislation removed axis deer, fallow deer, sika deer, and blackbuck antelope from a list of species which require permits for ownership (R. Engle-Wilson, pers. comm.). The propagation of exotic ungulates will soon be legal in Vermont, but a confinement law will be stringently enforced (B. Day, pers. comm.). Farmers in Maine will be allowed to sell exotic venison effective January 1, 1990 (J. Powell, Pers. comm.). The Texas Legislature passed a law in 1987 that qualified landowners for an agricultural tax exemption when exotic big game is raised for meat production (Salmon et al. 1989).

An amendment to the Agricultural Marketing Act of 1946 effective February 13, 1989, added water buffalo and all members of the deer and antelope families to a list of species eligible for USDA certification. Either federal or state meat inspectors may perform the ante-mortem and post-mortem inspections required for certification. This USDA approval enables venison to be sold interstate and exported (Federal Register 1989).

Research Progress

Dietary Overlap

The areas most needing research have been identified as the dietary overlap and the disease complications associated with exotic introductions (Demarais and Osborn 1988). An understanding of the forage needs and the competitive relationships among ungulate species is needed for proper management.

Food habits of aoudad (barbary) sheep, blackbuck antelope, axis deer, fallow deer, and sika deer were studied in the Edwards Plateau Region of Texas. The study suggested that all five exotics have the ability to compete directly for forage with the white-tailed deer (Butts et al. 1982).

Browse comprised about one-half of the aoudad's diet and forb use varied with seasonal availability, in studies conducted in New Mexico and Texas (Simpson et al.

1978, Simpson et al. 1980). Diet overlap and potential competition between aoudad and both native mule deer and desert bighorn sheep has been described.

Blackbuck antelope compete with white-tailed deer for browse and forbs on the Edwards Plateau (Butts et al. 1982). However, dietary overlap with cattle on grasses may be more severe.

Dietary overlap studies have shown conflicting results among exotic deer species and white-tailed deer (Demarais and Osborn 1988). Axis and fallow deer diets vary from primarily grasses (Smith 1977, Elliott and Barrett 1985) to primarily browse (Butts et al. 1982). Grasses were highly preferred and intensively grazed by fallow deer in Germany (von M. Petrak 1987).

Springtime diets of axis, fallow, sika, and white-tailed deer were differentiated by forage class (i.e., grass, forb, browse) on the Edwards Plateau of Texas (Henke et al. 1988). Axis and fallow deer consumed >93 percent grass, white-tailed deer consumed >90 percent forbs and some browse, and sika deer consumed a variety of all three forage classes during May-July.

Dietary overlap and potential competition exist between sika deer and white-tailed deer in Texas (Butts et al. 1982) and Maryland (Keiper 1985). Sika deer appear very adaptable to new areas and will utilize many different plant species (Obrtel et al. 1985).

The ability of sika and fallow deer to use a grass diet gives these species a competitive advantage over white-tailed deer where quantities of forbs and browse are limited. Forage competition between white-tailed deer and axis and fallow deer may not be significant when forbs and browse are present in adequate amounts, because the forage classes consumed by these species can be quite different (Henke et al. 1988).

Disease Complications

There is a potential for disease complications among mixed populations of native and exotic big game and domestic livestock. A preliminary disease survey conducted by the Southeastern Cooperative Wildlife Disease Study, the U.S. Department of Agriculture, the Zoological Society of San Diego, and Texas Tech University showed evidence of exposure (i.e., antibody titres) to four diseases or disease groups within one or more of the species surveyed (Heuschele et al. 1988). The results indicated possible exposure to malignant catarrhal fever and bluetongue/epizootic hemorrhagic disease. Either disease, if established, could result in mortality of domestic livestock and big game.

Malignant catarrhal fever (MCF) is an infectious viral disease that has been documented throughout the world. In Africa, the disease is closely associated with the wildebeest and in the eastern part of this country accounts for as much as 7 percent mortality in domestic cattle herds (Heuschele 1985). In countries outside of Africa, a sheep-associated virus is more common. Outbreaks of the wildebeest strain are usually linked to zoological collections (Odend'Hal 1983). In New Zealand, sheep-associated MCF has become a serious disease in farmed deer, killing 20-50 percent of infected herds (McAllum 1980).

Evidence suggests that MCF could be a problem in domestic livestock, native herbivores, and exotic big game in North America (Heuschele 1985). The reported hosts for MCF are numerous, including many species which are popular on big game ranches. The first naturally occurring outbreak of MCF in North America was reported in a herd of axis deer and one white-tailed deer on a Texas ranch (Clark et al. 1970). Sanford and Little (1977) documented two separate incidents of sika deer mortality in Canada due to MCF. In one of these cases, a sika deer having successfully passed a period of quarantine succumbed to MCF within 24 hours ot its release to the Metro Toronto Zoo.

The range of bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV) includes many countries the world-wide (Hoff and Trainer 1981). The northeastern United States, Canada, and New Zealand are currently free of BTV (Odend'Hal 1983). Two varieties of EHDV are believed to exist in North America and four of the 20 identified varieties of BTV occur in the United States (Thomas 1981). The viruses are very similar and are collectively referred to as hemorrhagic disease. In the wild, infected animals may be attracted to water and lose both appetite and fear of man (Trainer 1964).

Cattle and goats are susceptible to BTV yet rarely show clinical signs of disease. They are considered to be important long-term reservoirs of the virus. Areas experiencing high deer mortality as a result of hemorrhagic disease are typically those where the population has surpassed carrying capacity (Prestwood et al. 1974).

Die-offs associated with BTV and EHDV have occurred in other native and exotic big game. Rieman et al. (1979) analyzed serum from axis deer and fallow deer, finding 60 percent and 33 percent, respectively, testing positive for BTV antibodies. The higher prevalence exhibited in axis deer was attributed to their close proximity to cattle.

Conclusion

Exotics have been present in localized areas for many years. Little has been done to answer biological questions vital to successful management. We should strive to capitalize on the positive qualities of exotic big game while minimizing their negative effects. This task can only be achieved by increasing the knowledge available to rangeland resource managers.

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Frasier's Philosophy

One of the greatest obstacles to the advancement of new or different ideas is the inability for effective communication. Recently, I was in a meeting with two well-respected scientists. We were attempting to write a scientific article for publication in a refereed journal. The discussion became very heated in defining and describing what constitutes a scientific study. One person was trained in the biological sciences and the other in an engineering field. It was a major surprise to realize that both of these people were arguing the same point, even to the point of using the same words. The problem was that the words used were being assigned different conceptual meanings, depending upon the individual's discipline. Once it was realized that there were no basic differences, the work rapidly progressed to a satisfactory conclusion.

This type of conflict can occur when a group of people agree upon the meaning of a term. If others, outside the group, do not accept this definition, there will always be disagreement and misunderstanding. This is some of the basis for the misinterpretations and misconceptions that some people have of the Society for Range Management. We have definitions and meanings of words and phrases that are not perceived in the same light by others outside the Society. I use as an example the word "range." We use it to mean a type of "land resource." To many people it is a type of "land use" primarily use by domestic animals. As long as this difference in word meaning exists, there will always be misunderstanding. There are two choices: (1) convince others of our meaning or (2) use another word with a universally accepted meaning. Let us hope that we have the wisdom to make the right choice.

Consider how hard it is to change yourself and you'll understand what little chance you have of trying to change others.

Jacob M. Braude