

**ETHOLOGY, SOCIAL ORGANIZATION, AND HABITAT USE OF THE
AFRICAN UNGULATE, KOBUS LECHE**

THESIS

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By

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ABSTRACT

The specialized areas of habitat in which red lechwe, *Kobus leche leche*, are found in Africa are quite different than those found on Texas ranches. Environmental, social, and biological determinants mitigate the lechwes habitat preferences for a variety of behaviors. Red lechwe utilize a single habitat in which to graze, rest, mate, and socialize in Africa, rather than clustered territories in which to carry out specialized behaviors. Differences in the social organization, physiology, habitat preference, and behavior of these exotics were found compared to those for populations in Africa. The ecological differences in a managed territory consisting of supplemental feed, compared to those areas of Africa in which red lechwe populations are found, give rise to the evaluation of habitat preference for exotics on Texas ranches in relation to their ethology.

INTRODUCTION

South Africa has 17 national parks covering over three million hectares of land, as well as hundreds of smaller provincial or private conservation areas (Ellis 1994). From 1933, this program of reserving wilderness areas as "national parks" was promoted internationally by the London Convention for the Protection of Flora and Fauna, which set the guidelines for creation of wildlife sanctuaries outside the political control of the colonial regimes as the key to international conservation policy (Steinhart 1994). With colonialism, Africans faced restrictions from an outside authority that denied them the right to use resources as they saw fit (Hackel 1999). It is a truism to say that all of this land was originally taken, with a greater or lesser degree of coercion, from the ancestors of black South Africans (Ellis 1994). Rural Africans have been forced to maneuver within the often narrow confines of their social and economic environment (Hackel 1999). The priorities they set and the economic choices they are forced to make often lead to actions that are not compatible with wildlife conservation (Hackel 1999).

Conservationists came to realize that local people, who commonly are hostile to wildlife conservation, had to be won over as supporters of their efforts (Hackel 1999). This is certainly true in Africa, where rural inhabitants often view wildlife conservation as misguided because it puts the needs of wildlife above those of people (Hackel 1999).

Although this response is primarily a reaction to people's present day economic needs, it also has strong roots in the colonial legacy that alienated rural Africans from conservation efforts (Hackel 1999). In the early period, a very narrow band of society's leading sportsmen, armed with the very latest high-powered rifles, set out to bag as many specimens of as many species as they could (Steinhart 1989).

These holiday hunters were not in themselves a major source of danger to the wildlife, still less to African hunting (Steinhart 1989). But they contributed to the ideological foundations of the hunting dilemma: their very eminence and wealth, their social standing and class backgrounds supported the belief that proper hunting was the sport of gentlemen who obeyed a civilized and human set of rules for the game (Steinhart 1989). These rules included the exclusive use of firearms and a disdain for the use of weapons and techniques, which were considered unsporting (Steinhart 1989). As even this brief description of the opposing values of African and white hunting makes evident, a collision course between the two seems to have been inevitable (Steinhart 1989). As these hunters became gamekeepers and a new ethos of game preservation emerged, the African hunters who continued to hunt for food and profit now found themselves transformed into poachers, the bane of the game preservationists and the licensed hunters alike (Steinhart 1989)

Over the past two decades, Africa has faced numerous problems, including political instability, economic stagnation, and rapid population growth (Hackel 1999). Collectively, the problems add up to what has been characterized as a profound economic and environmental crisis (Hackel 1999). The dilemma is that even the most enlightened

programs, if wildlife is to be a priority, must reduce people's land-use options forever because large areas of natural habitat must be preserved (Hackel 1999).

The transnational nature of environmental problems has highlighted the need for cooperation between nation-states (Duffy 1997). In southern Africa the field of wildlife conservation has already witnessed a growth in multinational conservation schemes (Duffy 1997). Wildlife constitutes an important natural resource in southern Africa and its use can provide revenue, meat, hides, and other products, as well as the basis for a lucrative tourism industry (Duffy 1997). But intensive use raises the question of how to conserve this resource (Duffy 1997). Some argue in favor of environmental policies, which are guided by principles of optimum natural resource use; others see human beings as an integral part of any ecosystem and favor community-based conservation or environmental regulation by the state (Duffy 1997). These differing approaches have shaped concepts of what constitutes good conservation practice (Duffy 1997).

Early zoological expeditions recorded that habitat fragmentation and wide spatial variation of animal densities and diversities were distinctive features of African ecosystems (McNaughton 1986). Modern scientific studies of African savanna-grassland mammals began in the 1950s, long after the distributions and densities of the major game animals had been affected by growing human populations, colonial land and hunting policies, and virulent exotic diseases that affected the animals both directly and indirectly (McNaughton 1986). The mammalian fauna has been increasingly isolated and fragmented within game reserves of varying size, habitat diversity, and animal species diversity; the ability to sustain it in the absence of active management is increasingly questioned (McNaughton 1986).

In response to this need for conservation of wildlife native to Africa, specifically game animals, DD Ranch in Rosanky, Texas has sought to answer the questions raised by conservationists in Africa. Specifically, will populations of exotic ungulates, native to Africa, be sustainable in a managed habitat with ecological conditions similar to those of their native lands. The red lechwe, *Kobus leche lech*, a popular game animal in Africa, deemed low on the list for conservation, has become a test case for international conservation. This species has demonstrated a success in sustaining a reproductive herd and adaptations to an alternate habitat. For conservation purposes, it is sufficient to know what habitats are being used; for theoretical purposes it is interesting to know why habitats are being used in a particular way (Williamson 1994).

Observations and time budget recordings of habitat use by red lechwe were performed during February through December 2002 on DD Ranch in Rosanky, Texas. Data from previous observations of the species were incorporated into this research to expand on the findings. There have been few behavioral observations of this African ungulate on Texas ranches in forest or dense brush habitat. The native habitat of red lechwe is typically open grassland and water rich environments because of their physiology; however, they have been found to enter and use forest habitat on DD Ranch. Habitat preference for the red lechwe may change in relation to their predation response.

Hunting of this species on DD Ranch is limited to culling for specific management goals. Only three adult males were present during my study. One adult male ostracized from the herd and was removed. The management goal for red lechwe on the ranch is a stabilized herd. However, the red lechwe on the ranch share territorial leks and habitat with other species, both exotics and Texas natives, which are tagged and hunted

These interspecific interactions and disturbances by hunters may underlie the social organization of the herds, as well as determine their habitat use.

The goals of this study were three fold: to determine habitat preferences based on behavior, evaluate predator response by red lechwe in Texas compared to Africa, and to identify social organization of the red lechwe herd. Comparisons of habitat preferences, social organization, and behavior of red lechwe in Africa were based on previous research. Observations and calculations of behavioral time budgets and habitat use of the red lechwe in Texas formed the basis for comparison.

Populations of red lechwe in southern Africa are normally distributed in floodplains, these African antelopes have been displaced due to heavy poaching by commercial meat hunters (East 1998). The estimated population of red lechwe (71,380) occurs in Botswana on the Okavango Delta and the Linyanti-Chobe River (East 1998). The Red lechwe is the most abundant large mammal on the Kafue flats. Here, the red lechwe is restricted to the margins between swamps and floodplains on the flat, silted-up river basins of the Central African plateau (East 1998). The preferred habitat includes areas along unstable margins between swamps and shallow floodplains (Kingdon 1997). In these floodplains and waterlogged areas, they are totally dependent on water to drink and vegetation for food and shelter (Kingdon 1997). They have been characterized as slow and clumsy on hard ground. Red lechwe are tied to swampy floodplains by their physiology and their soft hooves (Kingdon 1997). The distribution of the red lechwe and herd size and structure vary greatly. Herd sizes range from a single individual to compact herds of thousands in the Kafue flats (Sheppe and Osborne 1971). At the present time, the

red lechwe is deemed lower risk for conservation dependency (East 1998). However, this status could change as social and environmental situations in Africa fluctuate

Captive populations of the red lechwe include 42 in European Zoos and an additional non-zoo population in the United States, including 500 held on Texas ranches (East 1998).

Climate and environment play a large role in the migratory habits of ungulates. The stimulus for migration is based on available food resources and suitable habitat associated with daily routines. Biological activity is dominated by the marked rainy season, which begins in late October or early November and continues until March or April (Sheppe and Osborne 1971). Red lechwe tend to stay closer to water than any of the other antelopes. It is the only species that enters into water to feed (Sheppe and Osborne 1971). In spite of this, the red lechwe is not dependent on water, and in captivity it does well in wooded enclosures with no open water (Sheppe and Osborne 1971). The seasonal movements of the red lechwe are highly variable from year to year. They seek good grazing and avoid mud, flood, and human disturbance (Sheppe and Osborne 1971). Red lechwe avoid dense brush in Africa.

The climate of the Kafue flats has not been recorded directly, yet the area surrounding these plains have significant data (Sheppe and Osborne 1971). Average monthly temperatures in Namwala range from 15.3°C in July to 25.2°C in October (Sheppe and Osborne 1971). The minimum recorded temperature is -1°C and frosts are rare. The maximum recorded temperature is 39°C, but the humidity is low during the hot months and the nights are much cooler (Sheppe and Osborne 1971).

The red lechwe is primarily a grazer. Most feeding occurs for a few hours before dawn and after dusk (Kingdon 1997). During the high flood season, the diet of red lechwe usually consists of wet grasses found along the edge of permanent water (Sheppe & Osborne 1971). In the dry season, they do not feed in permanent water bodies because of limited vegetation (Sheppe and Osborne 1971). The favored grasses are *Echinochloa*, *Panicum*, *Brachiaria*, *Paspalum*, *Acroceras* and *Oryza*; also the fresh roots of trampled reeds, *Phragmites*, are eaten.

STUDY AREA

Observations and time budget recordings of red lechwe habitat use and behavior were performed during spring and fall, 2002, on DD Ranch in Rosanky, Texas. DD Ranch, located in Bastrop County, Texas, has a comparable climate to areas of North Africa, creating a hospitable environment for red lechwe. The ranch covers 1,420 ha of roaming space for ungulates to roam, of which about 3 km² were used by red lechwe during observation periods

The total number of red lechwe in the study area was 21 with a mean herd size of nine. One male lechwe was removed from the property near the end of the study. The herd included three adult males, one juvenile male, one juvenile female born that year, and 18 adult females. The male red lechwe on the ranch are documented as some of the largest in the world with horn size greater than the average 70cm for the species. Recognition of the territorial male and adult bachelor males was based on both size and location of males. All of these males all engaged in rutting, mating, and social behavior throughout the course of observations.

The study area had three distinctive habitats; forest/dense brush, open grassland, and water. Resources were plentiful, as supplemental feed was provided in most open grassland fields.

METHODS

Observations of the red lechwe were performed between 1400h and 1730h in varying intervals. I had a total of 16 observation periods with a mean time of 3 hours per observation period. Observations occurred in four pastures. Four permanent deer blind structures are located in the center of each field. I observed red lechwe from these blinds and a mobile blind with minimal disturbance to the animals. In several instances, the proximity of the red lechwe made observations from foot or truck more realistic, because they were out of range of the blinds. I used the same vehicle and personally conducted all observations to cause the least disruption to the normal behavior of the ungulates. The red lechwe became accustomed to the vehicle on the second visit, as they no longer became alert.

Observations were made ocularly with the aid of 7X35 mm binoculars. I documented behavior with a 30 meter distance camera. Recordings of the temperature, overall weather condition, and noticeable habitat changes were noted in addition to the behavior, location, and gender of the red lechwe. Time budgets consisted of five to 15 minute sequences over several hours. I collected data on location and duration of behavior.

In most instances, behaviors occurred in states long enough to record duration. I used focal animal sampling as the primary method of observation. All occurrences of specified behavior were recorded during the sample periods of the focal animal. I recorded the length of the sample period, and the duration of behavior. Behaviors observed include mating, grazing, social interaction, aggression, and standing/lying idle.

RESULTS

Spring observations

The Red lechwe were observed in open grassland, forest and at the edge of dense brush openings during spring. At no time were they observed in bodies of water. Red lechwe spent 56% of the time in forest or forest edge habitat near dense brush. This habitat was used more than any of the other habitats (Fig 1). The herd used open grassland fields 44% of the time. Mating, feeding, and resting behaviors were observed in all habitats frequented by red lechwe. The forest habitat included the dense brush barrier at the edge of the open grassland where the herd displayed everyday activities. (Fig 2).

Fall observations

In seven observation periods during September through December, I measured habitat use and behavioral organization of the herd. During these seven observations the herd was split into two groups 63% of the time and united 37% of the time. Both groups spent 9% of the time in the water (catfish pond), 47% in the open grassland, and 44% in the dense brush/forest habitat (Fig 3).

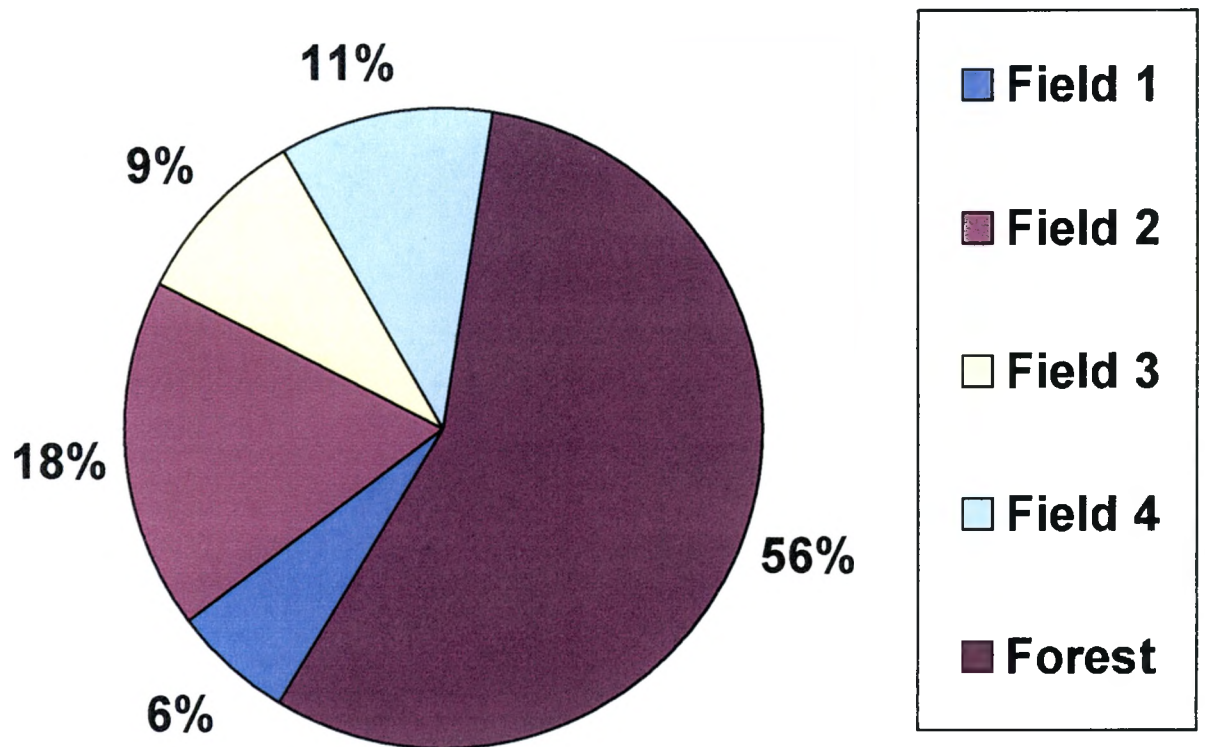


Figure 1. Percent habitat use by red lechwe during spring observations at the DD Ranch in Bastrop County near Rosanky, Texas in 2002.



Figure 2. Landscape photograph showing red lechwe use of forest edge and dense brush during spring observations at the DD Ranch in Bastrop County near Rosanky, Texas in 2002.

Behavior

Mating behavior was observed concurrently with grazing and feeding behavior. Mating pairs were observed in close proximity to the rest of the group within 10m of the nearest group member.

Behavior of the group consisted of grazing and rutting between two of the smaller males at the beginning of February. On 22 February, one male was observed alone in Field 2. The segregation of this male continued throughout the fall. The rutting behavior between males was not observed within close proximity to the rest of the herd after 22 February in spring. In fall, male rutting and chasing behaviors were observed only once. The behavior lasted over 50 minutes with violent rutting and chasing through the grassland into the catfish pond and through the adjacent field. This was carried out while a female lechwe, in a group of six, grazed at the edge of the pond and in the open grassland where the chasing occurred.

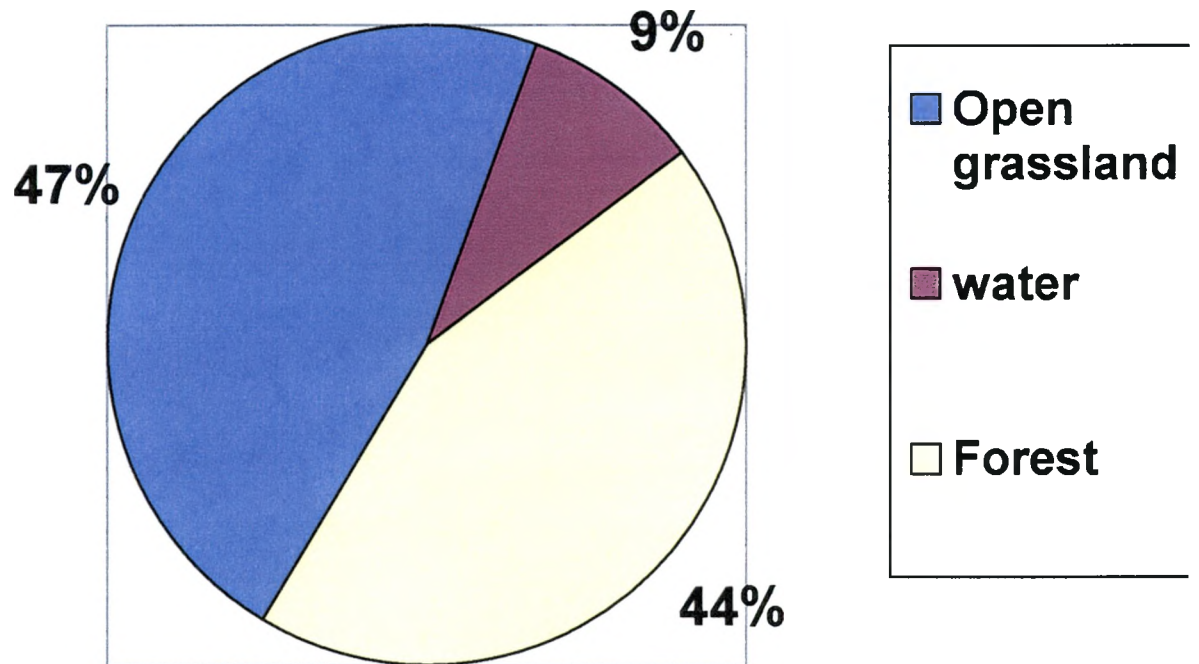


Figure 3. Percent of habitat type use by red lechwe during fall observations at the DD Ranch in Bastrop County near Rosanky, Texas in 2002.

Mating behaviors were recorded during each observation period. These behaviors would last from 15 minutes of male rutting behavior to over one hour of mating attempts. Male to male mounting attempts were noted on three occasions in the spring. Males would quickly dismount, and no thrusting behavior was observed. The mounting attempts were observed to continue for a duration of up to 10 minutes (Fig. 4). Rutting behavior, chases, or nudging preceded mounting behavior. The attempts ended each time with the mounted male turning his head sharply while nudging the mounting male with his horns (Fig. 5). The fighting and intimidation displays observed by males often resulted in violent rutting and stronghold techniques. This behavior was observed twice in ousted males in Field 2 far away from the group.

Disturbances to the normal behavior of red lechwe occurred on five separate occasions. When people approached their habitat, they ran for protection. During the first three instances, the entire group, led by females, ran into dense brush and forest areas. One instance, when a go-cart startled them, the entire group ran into the forest area rather than the catfish pond. The body of water was substantially closer to the group, yet they all ran around the water and into the forest area for protection. This occurred again in fall, when disturbed by trucks. The herd ran into the dense brush at the first sight of people.



Figure 4. Two males separated from the red lechwe herd engaged in male-male mounting behavior at the DD Ranch in Bastrop County near Rosanky, Texas in 2002.



Figure 5. Male-male mounting behavior showing the mounted male turning to gauge the mounting male at DD Ranch in Bastrop County near Rosanky, Texas in 2002.

Fear of predation was primarily spurred by hunting, as on one occasion, hunters were located in the deer blind above the open grassland where red lechwe were grazing. As guns were fired, the red lechwe quickly dashed into the dense brush for safety. Meanwhile, the hunters walked down to the kill in the middle of the field. The moment that the last of the hunters drove away in their trucks, the first female wandered out from the dense brush, looked around and made her way straight to the kill site. The rest of the herd eventually followed her to the very spot, vocalizing, smelling, looking, and nudging one another. They gathered around this spot for 20 minutes in a large herd.

Neutral behavior toward other animal species on the ranch was noted on several occasions. The red lechwe were observed grazing within 1.5m of axis deer (*Axis axis*) on two occasions. Bison (*Bison bison*) frequently shared the same area with red lechwe with no aggressive displays. The most frequently observed animal in close proximity to red lechwe was eland (*Taurotragus oryx*). Eland were observed sharing the habitat of Field 2 with red lechwe engaged in normal behavior. I did not observe the red lechwe acting aggressively toward any other animals on the ranch.

The social organization was based on female interactions with one another. With only two juveniles in the herd about one year old, there were no out-groups of juvenile interaction. One solitary on one occasion interacted with females. Adult male interactions consisted of both rutting and socializing. Adult females were never alone and congregated together in one large herd. On three occasions the adult females split, yet remained in groups of at least three individuals during all observations.

BEHAVIOR	Female	Male
Feed	55	53
Walk/run	14	10
Same sex social interaction	100	9
Stand/lie idle	31	37
Mating behavior	16	16
Aggression	0	12

Table 1. Diurnal time budget for male and female red lechwe based on the percent time spent in each behavior at the DD Ranch in Bastrop County near Rosanky, Texas in 2002.

DISCUSSION

Observations of the behavior of the red lechwe in the forest habitat and open grassland consisted of agonistic behavior. The term agonistic behavior denotes all behavior shown in situations of conflict between two or more individuals. This includes all forms of aggression, threat and intimidation but also nonaggressive responses to them, viz, defense, appeasement, and submission (Kingdon 1997). The most prevalent five types of agonistic behavior included predation response, social organization, group leadership, mating, and interactions with other species. Since social competition is generally related to reproductive success smaller herds of antelope may be expected to display more aggression as competition becomes greater (Leuthold 1977).

Predation response

One of the most important environmental factors shaping ungulate behavior in the course of evolution is undoubtedly predation (Leuthold 1977). The constant risk of being caught and eaten affects more facets of ungulate life, including escape mechanisms, activity patterns, group size and formation, and mother-young relations. (Leuthold 1977). When ungulates first perceive the presence of a predator or any other suspect object they usually interrupt ongoing activities and adopt postures facilitating the perception of further clues on the whereabouts and behavior of this predator (Leuthold 1977). Red lechwe characteristically enter water to escape from predators (Sheppe and Osborne 1971). Predator response is an effect of group size, whether to defend territory or flee depends on the group size (Sheppe and Osborne 1971).

Hunters are the main predator of the red lechwe on DD Ranch. During my study, no coyote (*Canis latrans*) predation on red lechwe occurred. As the risk of predation from wild animals decreases for red lechwe, their preferred habitat may change. The observation periods were during the hottest times of the day, suggesting the lechwe may seek the forest habitat as protection from heat. Observations of mating, resting, and feeding behavior in the dense brush and forest area suggest that red lechwe may have developed a preference for the forest habitat for everyday activities. Red lechwe spend substantial amounts of time, a duration of up to two hours at a time, in the forest habitat. This habitat gives the greatest protection from humans, since red lechwe did not perform daily functions in the dense brush. Humans may be seen everyday in the open grassland, so the best protection from hunting is in the forest area.

Social organization

In the field, three classes of animal could be easily and consistently recognized: adult females (i.e. greater than 1 year old), one territorial male adult, and juveniles (Williamson 1990). Agonistic behavior included visual and vocal signals and interactions ranging from ritualized dominance encounters with no physical contact to all-out fights with repeated and heavy engagement. Dominance encounters were usually initiated by a dominant male making a direct approach (Williamson 1990). Group size ranged from three to 21, and only a subordinate male was found in a herd comprised of a single individual. Groups were undynamic. Individual red lechwe remained in the same group for hours, often during the entire observation period.

Within these groups, four types of social behaviors were recognized. I did not observe adult female to adult female hostility, territoriality, or dominance behavior. Adult female to adult female interaction was the most common behavior observed. Adult male to adult female and adult male to adult male rutting behavior were more common than adult male to adult male socializing.

Group leadership

Group leadership may take a variety of forms, depending on the response of certain stimuli in the environment. Leuthold (1977) determined the primary function of individualized leadership particularly in closed groups is probably the maintenance of a stock of knowledge about the environment, which, through the successive leaders, is perpetuated by tradition within the group (or population). Such knowledge may concern the fixed points on the home range (i.e. sources of waters, minerals, etc.) the distribution of food, routes for daily movements and or seasonal migrations, but also the degree of danger posed by different predators, including man, under different circumstances, in fact any relevant information about the environment, in the widest possible sense, that is acquired by learning (Leuthold 1977). Either a dominant male or female in the group, depending on the previous social learning and habits of the herd, may initiate these responses

Females were the first to respond when the group became alarmed. Females would lead the group into the forest area as a perceived threat approached. Females would also lead the group out of the forest once the perceived threat had dissipated. Males were the last to respond to group movements or to become alarmed at human

disturbances. One calf was observed nursing in the forest at the time of a human disturbance. The rest of the group ran to the location of the calf and mother in the forest.

Mating behavior

Several different systems have evolved to maximize male access to females, all of which include competition between males (Fisher 1999). Ungulates have displayed varying mating systems, whether on leks or within groups. These mating systems may be continuous from season to season, or with groups that mate during only one season, they may change from one year to the next. The lower success rates of red lechwe mating attempts in herds does not appear to result from avoidance of non-lekking inferior males by females, but rather, as a direct result of disruptions by harassing males (Fisher 1999).

Mating, resting, and grazing behavior were observed equally in forest habitats and open grassland. Mating behavior and grazing occurred at the same time at the same location within groups. This behavior was atypical for the red lechwe. The species is known for mating on leks and away from the rest of the herd to avoid harassing males. Not only was disruption of female red lechwe mating attempts more likely in herds, but there was also costly and potentially dangerous harassment of oestrous females by competing males (Fisher 1999). On lek territories, female red lechwe spent more time lying, were chased shorter distances, less frequently, and achieved higher mating rates than oestrous females in herds (Fisher 1999). As a result of these higher frequencies of harassment of oestrous females by non-territorial males in herds, estrous females that mated in herds received lower ejaculation rates than those mating on leks (Fisher 1999).

Thus an average female would be expected to receive about three times as many successful matings by settling on a lek than remaining in a herd (Fisher 1999). This lower mating success rate in herds could represent a cost to females that are sexually receptive for short periods (Fisher 1999)

For example, if a few sexually receptive females failed to mate during their 24-h oestrous period because they did not travel to the lek, selection would be expected to favor female preferences for mating on leks, although no studies have been undertaken to test this hypothesis (Fisher 1999). By forming lek territories away from feeding areas, lek males attract females that leave feeding areas (Nefdt 1995). However, this is a group selectionist argument and does not explain why disproportionate numbers of oestrous females travel to leks, nor why non-oestrous females use the same feeding areas as males throughout the year (Nefdt 1995). Another reason for females settling on leks stems from observations that males clump near 'hotspots' through which large numbers of females are likely to pass and settle (Nefdt 1995).

When the breeding season is limited, the intensification of mating drive is more evident in male animals. This provides the phenomenon of rutting (Fraser 1968). Violent rutting behavior was observed by the dominant males for the first part of spring, on occasions leaving one male unable to exit the habitat quickly because of exhaustion. In these cases, the dominant male would perform mating behavior in front of the competing male while not allowing any competitive behavior to pursue. The dominant male would perform genital stimulation or mounting attempts on females nearby in the group. Genital stimulation is evidenced by nuzzling, nudging and licking about the perineal region in the precoital behavior (Fraser 1968).

False mounting attempts are commonly seen in male ungulates (Fraser 1968). In these, the animal mounts apparently normally but quickly dismounts without showing any forelimb clasping or thrusting movements (Fraser 1968). These male-to-male mounting attempts were frequent and may end with violent rutting behavior on DD Ranch. Often, males would be grazing together, and one would turn and attempt to mount the other male. This behavior was not reciprocated, but rather abruptly stopped, as one male would attempt to gouge the other with his horns.

The close proximity of mating pairs to the rest of the herd contradicts earlier findings (Williamson 1990) that red lechwe habitat use was highly selective. These observations demonstrated that while for predator defense, the lechwe are selective for the dense brush habitat, that grazing, mating, rutting, and resting behaviors all occurred in the same habitat.

Relations with other species

Most ungulates share their habitat, to a greater or lesser degree, with a variety of other animals in which a multitude of relations may exist (Leuthold 1977). Such relations can be broadly categorized from the point of view of the ungulate as positive, neutral, or negative (Leuthold 1977). Positive relationships stem from gaining or maintaining a direct or indirect benefit from the association. Neutral relationships consist of neither losses nor gains. A relation may be termed neutral when there is no evidence of agonistic behavior toward another species (Leuthold 1977). However, when another species is sharing grazing land, it is difficult to determine whether the neutral response is in fact to the detriment of the ungulate losing viable grazing land (Leuthold 1977). When this grazing area is large enough to share between a few or many species, this neutral

behavior would persist. However, once the area of viable food becomes small, the previously neutral behavior toward another species may become negative. It is therefore necessary to comparatively observe reactions through time in order to avoid overgeneralizing behavior between species.

The red lechwe were observed engaging in their everyday activities more often in the forest habitat. This habitat consisted of dense brush and trees surrounding open field areas. The red lechwe were observed only once drinking water from the catfish pond. On one occasion male rutting and chasing behavior was also observed in the pond, but no other activities near the water were observed. This demonstrates the change in habitat preference between the African red lechwe and those observed on DD Ranch. Male mating and display behaviors were more violent than those reported for the species in Africa. The red lechwe displayed differences in habitat preference and behavior on DD Ranch in Bastrop County. Further study into the mating behaviors of the red lechwe in comparison to their physiology would be valuable to demonstrate any correlations in size and displays of dominant males. Comparisons between the management programs used by DD Ranch for the control of violent mating behavior, feeding habits, which may increase the size of the red lechwe, and behavioral observations would provide a link to the current research on the red lechwe on Texas ranches compared to populations in Africa. This observational study has provided insight on the habitat and behavioral changes in different populations of the red lechwe.

MANAGEMENT IMPLICATIONS

Change in habitat preference, based on human interaction with the red lechwe, is an important aspect of population management. Rather than spending time hidden in the depths of the grasslands, the young red lechwe were taken into the dense brush areas, where they were nursed and protected. The preference for water habitat in Africa serves as a great defense from red lechwe's natural predators. In Texas, however, the primary defense from predators is dense brush.

Although the availability of habitat in which to roam is greatly reduced on DD Ranch compared to Africa, the red lechwe at DD Ranch did not migrate. The red lechwe herds were most often observed in the same open grassland fields and in dense brush at the outlying edges of these fields. The habitat necessary to sustain a population of red lechwe in Texas is much different than one would assume from their preferences in Africa.

The amount of human interaction between the red lechwe and personnel of DD Ranch, is primarily related to supplemental feeding and habitat maintenance. The same humans who dispense their supplemental feed of 20% protein pellets three times per week also accompany hunters to the same fields. This apparently leads to a predation response, which in turn creates the need for management of dense brush as an escape cover for red lechwe on Texas ranches.

The violent rutting displays demonstrated by males, may be caused by the lack of roaming space typical for such a herd, in addition to the low number of available females for mating. Within each herd, only one male will be the territorial male capable of reproduction with females in the herd, while the bachelor male has no choice but to stay

within vicinity of this male with no herd of his own. Rivalries between these males would be consistent each year, getting more powerful and violent as each year passes. The great availability of resources, however, should help the herd to grow in size so that it may eventually split with two territorial males.

The red lechwe on DD Ranch are given food supplements of protein pellets three times per week, and in dry or stressed conditions, they are also given alfalfa hay once per week. This diet has created healthy, dominant males, which are growing larger in size than those reported in Africa. The females are fecund. The management plan of DD Ranch has been successful in establishing a healthy herd with males having horns larger than any of their counterparts in Africa, and females capable of reproducing at a rate to sustain the herd.

The findings of this research suggest that habitat preference of the red lechwe is different in Texas than in Africa. The red lechwe are not as specific in locating habitat to carry out behaviors, as they use the same space for all of their everyday activities and behavior. The typical social organization of the red lechwe is comprised of adult female groupings with an undynamic organization and adult male to adult female interaction.

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