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Physical Condition and Reproductive Success of White-tailed Deer at Fort Chaffee, AR: A Five-year Study

(TITLE)

BY

Donald A. Phillips

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
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Abstract

A baseline study conducted in 1991 demonstrated that the resident white-tailed deer (*Odocoileus virginianus*) population at Fort Chaffee, Arkansas was in poor condition, with below average reproductive success, body weight, and antler size, and above average parasite load compared to other regional deer populations. Consequently, a management program was initiated in 1991 which included: (1) neutralizing acidic soils, (2) prescribed burning, (3) planting supplemental food plots, and (4) liberalizing the harvest of female adults from the population. The purpose of this study was to monitor changes in the health and reproductive success of the herd as this program was implemented.

I evaluated the physical condition of 2,627 hunter-harvested deer brought to hunter check stations between 1991 and 1995. Reproductive rates, timing of reproduction, disease prevalence and physical condition of the herd were estimated. Condition indices (blood serum parameters, tail fat, kidney fat index, body weight, abomasal parasite counts, ovulation rates and antler measurements) were used to estimate the fitness level of the herd.

The number of permits issued yearly to hunters ranged from 2,370 to 3,617. A strong correlation was found between the number of permits issued and the success rate of hunters, suggesting that high hunter density may force the deer to move more, enhancing success rates. Proportions of harvested deer in each age class changed little over the 5-year period. Adult females comprised the largest class, ranging from 34 to 39% of the harvest each year.

Screening for 7 common disease agents was done. It suggests that the percentage of the herd that carried antibodies for these diseases changed little from 1991 to 1995. A small percentage of deer tested positive for exposure to parainfluenza, epizootic hemorrhagic disease, and leptospira. No other disease antibodies were detected.

Average dressed weights for female adults and yearlings were consistent over the 5-year period, while male yearlings showed a significant increase in body weight. Antlered males showed a significant increase in antler beam diameter. Blood serum parameters suggested an increase in dietary energy and protein over the 5-year period. In addition, kidney fat indexes (KFI) increased significantly from 1991 to 1995 in female adults, and abomasal parasite counts (APC) decreased significantly during this period. The proportion of fawns breeding increased from 1991 to 1995.

Acknowledgments

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Introduction

White-tailed deer are an important natural resource on Fort Chaffee not only for their aesthetic value but for the revenue they generate from hunting permits. Little was known about the deer population on Fort Chaffee until 1991 when a baseline study showed that the population showed signs of poor physical condition due to nutritional stress (Nelson 1992). Hunter-harvested deer were sampled during subsequent hunting seasons to gather the information necessary to evaluate the success of the deer management program. This study was designed to assess whether changes had occurred in the physical condition and reproductive rates of the deer population during the period from 1991 to 1995. During this period the Army implemented a management program intended to improve the condition of the deer population by: (1) thinning the herd (particularly females) to reduce density and balance sex ratios, (2) liming acidic soils to improve nutritional quality of forage plants, (3) fertilizing soils, particularly through prescribed burning, and (4) increasing fall and winter forage by adding food plots.

The specific objectives of this study were to : (1) quantify changes in the physical condition and nutritional status of resident deer population, (2) estimate reproductive rates and the timing of reproduction, (3) evaluate the prevalence of common diseases in the population, and (4) monitor and evaluate changes in the age-structure of the harvest from1991 to 1995.

Methods

Study Area

This study was conducted on Fort Chaffee in western Arkansas. Fort Chaffee is a 29,000 ha military reservation, located 18 km east of Fort Smith, in Sebastian, Franklin, Logan, and Crawford counties. Prior to 1990, the Arkansas Game and Fish Commission (AGFC) had primary responsibility for fish and wildlife management on the reservation through a cooperative agreement with the Department of the Army. That responsibility shifted to the Army in 1990.

The topography of the study area includes low floodplains with elevations near 120 m, gently sloping terraces, and hills with peaks near 300 m elevation. The majority of this land is gently to moderately rolling hills. The climate is one of warm summers and mild winters. Mean annual rainfall is 107 cm with much of the precipitation falling in the spring. Winter is the driest season, but significant droughts often occur in late July and August. Evaporation rates during these months can be as high as 1 cm per day (Cox et al. 1975).

The soils in the area are predominantly of the Leadvale-Taft and Mountainburg-Linker associations. The Leadvale-Taft association occurs on low terraces and the higher parts of valleys, adjacent to hills and ridges. These are moderately to poorly drained acidic soils, low in natural fertility, with a relatively shallow fragipan that restricts the penetration of roots and slows the movement of water through the soil. They are frequently wet, particularly during spring and early summer (Cox et al. 1975). The Mountainburg-Linker soil association is found on hilltops and the sides of low ridges. These soils are well drained, but are usually shallow, droughty, stony, and steep, and of low to moderate fertility. Many of these areas were cleared and used for pasture and hay crops during the first four decades of this century, but have reverted to trees, particularly drought-tolerant oaks, hickories, and pines. The Mountainburg soils, which generally occur on hilltops, respond poorly to fertilization. However, Linker soils on hillsides and benches respond well to fertilization.

Prior to European settlement, the plant communities in the study area were largely of four types: oak-hickory forests, oak-shortleaf pine forests, bottomland hardwood forests, and tallgrass prairie. Oak-hickory forests, typical of the Interior Highlands region (Braun 1950), were found on the rolling hills and ridges. Oak-shortleaf pine forests were found on drier south and west facing slopes. The Arkansas River bottoms and riparian terraces were dominated by ash-maple and cottonwood-willow mixed hardwood forests. The southeastern extent of the tallgrass prairie occurred on the level to gently rolling plains (Braun 1950, Sturdy et al. 1991). Intensive farming and overgrazing severely depleted soil fertility by the time Fort Chaffee was established in 1940.

Although much of the area has been re-vegetated by the Army in the last 5 decades, the nutritional quality of vegetation is still low. Hardwood forest and open, early-successional fields are interspersed across Fort Chaffee providing a suitable mix of habitat to support a large resident deer population. Forage and browse species are abundant, but are likely of poor quality. Summer droughts and a regular schedule of military training lead to frequent fires on the central portion of Fort Chaffee.

Beginning in 1990, a more active habitat management program for deer and other wildlife species was introduced. Approximately 10,800 ha were managed by prescribed burning on a three-year rotation (3,600 ha/yr). Wildlife habitat was further improved by planting food plots. Winter food plots were planted in clover and wheat; spring plots in millet, milo and lespedeza. Approximately 80 ha of food plots were planted each year. In addition to the food plots, areas of pronounced soil disturbance due to military activities were reseeded to grasses and legumes as conditions permitted (Sturdy et al. 1991).

Data Collection and Analysis

Fort Chaffee was divided into compartments and hunters were assigned to these compartments to distribute hunting pressure evenly across the area. All hunters were required to check harvested deer at a check station during the regular shotgun and muzzleloader hunts from 1991 to 1995. All deer were sexed, aged using the tooth wear and replacement method (Severinghaus 1949), and weighed on a platform balance to determine dressed body weight during each of the 5 years of the study. Tail fat was subjectively measured by palpating the covering of fat over the vertebrae at the base of the tail. Tail fat was graded as bony, lightly padded, and heavily padded. Females were checked for lactation, and male antler measurements were taken on all antlered males. All tines greater than 2.5 cm in length were counted as points. Beam circumference of the main beam was measured 2.5 cm from the base of the antler, and antler spread was measured at the widest point of the rack using a steel metric tape to the nearest 0.1 cm.

During the 1991 and 1995 seasons, hunters were asked to bring antlerless deer in whole. These deer were weighed to the nearest kg (whole body weight). They then had the body cavity opened using a sharp knife and the chest cavity was split open with shears. All internal organs were removed and deer were reweighed (dressed body weight).

Several vials (about 40 ml) of whole blood were removed from the body cavity using clean 20 ml test tubes. This blood was placed on ice and centrifuged within 30 minutes of collection at 2000 RPMs for 10 minutes. The serum was then decanted, put into screw-cap vials, labeled and sent to Saint Mary's Hospital in Russellville for serum chemistry analysis. Twenty-three blood serum parameters were measured but only the following were used for this study: blood urea nitrogen (BUN), glucose, total protein, albumin, calcium, phosphorus, alkaline phosphastase, cholesterol, triglyceride, and albumin/globulin ratio. Another 5 ml sample of serum from the deer was sent frozen to the Southeastern Cooperative Wildlife Disease Study Laboratory at the University of Georgia for antibody screening. These samples were screened for 7 common diseases of deer including brucellosis, bovine viral diarrhea (BVD) virus, infectious bovine rhinotracheitus virus, parainfluenza 3 virus, epizootic hemorrhagic disease (EHD) virus serotypes I and II, and leptospirosis.

Both kidneys and the adhering perirenal fat deposits were removed from the body cavity, placed in ziplock bags, numbered and placed on ice. These were kept frozen until measurement of perirenal kidney fat and calculation of the kidney fat index (KFI) could be conducted (Riney 1955, Warren and Kirkpatrick 1982). Kidneys were defrosted, the fat on both ends of the kidneys was trimmed (Riney 1955), and the kidneys were separated from the fat deposits along the dorsal line (Dauphine 1975). Kidneys and kidney fat were weighed separately to the nearest 0.1 g. The gross kidney fat was calculated as the total weight of fat surrounding both kidneys (Dauphine 1975). The kidney fat index was calculated as the weight of trimmed kidney fat divided by the weight of the kidneys all multiplied by 100 (Riney 1955).

Abomasums were processed using a technique outlined by Eve and Kellogg (1977). Abomasums were collected by separating the abomasum from the small intestine and the omasum. Care was taken to keep the contents of the abomasum intact. Abomasums were placed into large ziplock bags, labeled and placed on ice. To collect the abomasal parasites the abomasum was split lengthwise and all the contents were rinsed into a large bowl. The mucosal lining was gently scraped with a knife to ensure that all nematodes embedded in the mucosa were collected. All contents were then poured into a 3.8 L jug. Eight ounces of 10% formalin were added, and the jug was filled to the top with water.

Each jug was then poured through a No. 100 20 cm brass sieve, rinsed well and the contents were flushed into a 1 L Erlenmeyer flask. The solid materials were diluted to 1 L with water and suspended by agitating the solution. Two 50 ml aliquots were removed, placed into a screw-cap container and stained with 1% rose bengal to facilitate the counting of parasitic nematodes (Jeter and Bartush 1981). Each 50 ml sample was placed into a gridded petri plate and nematodes were counted using 40x magnification through a dissecting microscope.

Female reproductive tracts (ovaries, oviducts, uterus and cervix) were removed from whole females carcasses. These were labeled and placed in 10% formalin for fixation and preservation (Golley 1957). In the laboratory, ovaries were thinly sliced using a sharp razor blade. All corpora albicantia (CA) and corpora lutea (CL) were counted for both the left and right ovaries (Teer et al. 1965). CL larger than 3mm in diameter were recorded as CL of pregnancy (CLP); while CL smaller than 3mm in diameter were considered accessory CL (CLA) (Mansell 1971). The presence of one or more CLP was evidence of current pregnancy, while CA's were evidence of pregnancy and ovulation rates in the previous year (Woolf and Harder 1979). Each uterus was then carefully opened with a scalpel and drained into a dissecting tray for examination. Macroscopic embryos were counted, measured and sexed (if sufficient development had occurred). The age of each embryo was estimated using crown-rump length (Hamilton et al. 1985), these ages could be used to back date embryos to the conception date.

All data were analyzed using the SAS statistical software package (SAS institute 1987). Differences in mean body weights of each class, and differences in mean antler measurements among years were tested using ANOVA with tukey's mean comparison test to find differences of means. Differences in mean serum values, ovulation rates, KFI's and APC's were tested using a 2-sample t-tests. The Chi-square test was used to test for differences in the frequency of deer in each tail fat category, and the frequency of yearling males with branched ("forked") versus unbranched ("spike") antlers. An a=0.05 was used as the significance level in all statistical procedures.

Results and Discussion

Many approaches have been used by wildlife managers to assess the physical condition of deer including: body mass, age-specific reproduction, kidney fat, blood chemistry, male antler dimensions (mass, beam diameter, points), and abomasal nematodes. These are generally related to age, the quality of habitat, the quality and quantity of forage and the density of the population.

Knowledge of the age of white-tailed deer is invaluable to assess the fitness and well-being of an animal, and to group it with similar aged animals for comparison. Consequently, aging deer accurately is important in studies of condition and age-structure. Aging deer by tooth wear and replacement is the best and most commonly used technique available. However, previous studies have shown that some biases in aging may occur. Chaplin and White (1969) found very little difference in tooth wear among individuals of the same cohort up to 48 months. DeYoung (1989) found that yearlings were most often aged correctly by tooth replacement. But he believed that aging of older deer by wear often biased age-classes toward the middle age-classes. I followed standard procedures for aging deer, but this potential bias should be noted.

Deer Harvest

Hunters harvested a total of 2,627 deer during the 5-year study (Table 1). The largest harvest was in 1991 when 736 deer were killed. Total number of permits issued varied from 3,136 to 3,617 during the first 4 years. Hunter success varied from 13.6% to 20.3% during that time. In 1995, the number of permits was reduced to 2,370 and success fell to 11.2% (Table 2). The decreased success was most likely associated with the fewer number of hunters moving the deer. As the number of hunters decreased, the deer were probably not pushed as hard and fewer were seen by hunters. The number of deer harvested in each compartment varied annually in part due to the number of permits issued for each compartment. The majority of the harvest each year came from the large compartments of 5, 6 and 6A (Table 3; Fig.1).

The proportion of fawns harvested remained fairly constant (10-15% for females, 11-14% males) throughout the study (Table 1). Across all years, adult females comprised the largest age-class harvested (37.0%). The large harvest of this class was consistent with the goal of reducing the proportion of adult females in the population and balancing the sex ratio. Coincidentally, the proportion of adult males in the harvest rose steadily from 13% in 1991 to 19% in 1995. Although hunters have periodically expressed the opinion that the liberalized harvests initiated in 1991 were too heavy, this view is not supported by the high, consistent proportion of adult females in the harvest. The low harvest and hunter success in 1995 was due apparently to the low numbers of permits issued, not over-harvest. This is supported by the high positive correlation ($r=0.925$ $p<0.05$) between the number of permits issued and hunter success rates (Fig. 1).

Disease Status

Hemorrahagic disease (HD) caused by virus stereotype I or II is the most important viral disease affecting white-tailed deer in the United States (Nettles and Stallknecht 1992). Fischer et al. (1995) suggested that more than 14,000 deer in a relatively small area of Missouri were killed due to hemorrhagic disease between August and October 1988. Population immunity to particular stereotypes can vary greatly, and immunity to one stereotype does not allow immunity for the other in white-tailed deer (Stallknecht et al. 1995). Stallknecht et al. (1991) found that without repeated exposure, immunity is very short-lived, especially in populations with an old-age structure.

The tongue and mouth of all harvested deer on Fort Chaffee were inspected for ulcers, and the hooves for signs of sloughing, in both 1991 and 1995 to assess the prevalence of HD. These lesions can be variable depending on the virulence and duration of infection (Nettles and Stallknecht 1992). Animals with the acute form of HD may have hemorrhages in the heart, rumen, intestines and necrosis or ulceration on the dental pad, tongue and palate. In the chronic form of the disease, sloughing on the hoofs is typical. For both 1991 and 1995 no ulcers were found in the mouths or on tongues of harvested animals. In 1991, 10 deer (1.4%) were found to have signs of sloughing on the hooves. No sloughing of hooves was found in 1995.

Serum screening for 7 common diseases of deer in 1995 showed that 9% of the sample tested positive for leptospirosis, 18% for parainfluenza 3 virus, and 18% for EHD serotype II. No deer tested positive for exposure to brucellosis, BVD, IBR, or EHD virus serotype I. These results were similar to those recorded in 1991. No antibodies were found for brucellosis, BVD, IBR, or EHD serotype I in 1991. Leptospirosis was found in 8% of that sample, while EHD serotype II and parainfluenza 3 virus were found in 10% and 15% of the sample, respectively. The prevalence of HD in Fort Chaffee deer in 1991 and 1995 was higher than in deer sampled in the Ozark mountain region, but lower than in a population sampled in the Mississippi Delta region of the state (D. Stallknecht, pers. comm.)

Nutritional Status

Body weight is one of the oldest methods of directly assessing deer condition and indirectly assessing habitat quality (Park and Day 1942, Severinghaus 1955). Body weight is often the only good index of condition available to wildlife managers, and if taken consistently can be a good indicator of annual changes in range condition (Brown 1984). Studies indicate that the largest white-tailed deer are found on the most fertile soils (Sweet and Wright 1953, Steen 1955, Harlow and Jones 1965, Thorsland 1966, Wesley et al. 1969, Moore 1976). Jacobson (1984) found that soil nutrients, especially phosphorous, were correlated highly to deer body size in all age-classes. Fawn weights also reflect the nutritional plane of the mother and intake of dietary energy by the fawn (Rawson et al. 1992). The fawns on the highest energy level grow faster and reach a larger size in adulthood. Nelson and Woolf (1985) found that fawns whose mothers were on higher nutritional planes were born larger and grew faster, and suggested that this growth was related to the fertility of the soil.

Two trends were evident in the body weights of deer of Fort Chaffee between 1991 and 1995. First, the mean weights of yearling and adult males tended to increase . Male yearlings were significantly larger (F=3.33 p=0.01) in 1995 than in 1991, and male adults were significantly larger (F=4.07 p=0.003) in 1993 than in 1991 (Table 4). Second, 1994 appeared to be a poor year for growth and weight gain for all age-classes, perhaps due to the drought that occurred that year. We found that female fawns were significantly larger (F=6.03 p=0.0001) in 1992, 1993, and 1995 than in 1994. Male fawns were significantly larger in 1992 than in 1991 and 1994 (F=3.78 p=0.0052). Weights for adult and yearling females did not differ among years.

Antler measurements can also be useful indicators of habitat quality (Johnson 1937, Park and Day 1942, Severinghaus 1955). Cowan and Long (1962) found that the number of tines was lower, and the beam diameters and spread of racks were smaller in males inhabiting poorer habitat. French et al. (1956) found that body growth showed a stronger positive correlation with diet than did antler growth. However, males on high quality feed produced larger branching antlers, more tines, longer main beams and greater beam diameters, than males on poor quality feed. Deer on low energy, low calcium and phosphorous, and low protein diets were stunted in size and weight and produced spike antlers. Gore (1984) and Scribner et al. (1984) stated that white-tailed deer, especially yearlings, had a much greater tendency to produce spikes (no tines) in poor quality habitats. Jacobson (1984) found that soil nutrients were significantly correlated with yearling antler measurements, but not for adults.

In my study the proportion of yearling males with forked antlers tended to increase each year, presumably due to lower population density, decreased competition for food and improved habitat quality (Fig 1). In 1991, only 31.1% of the yearlings had forked antlers, in 1992 the percentage rose to 36.6%, and during the last 3 years over 47% were forked. Although this was not a significant increase, the trend towards fewer spike bucks could be an indication of healthier deer. Although the proportion of adult males in the harvest increased across the years, the number of antler points and main beam length on these males did not differ significantly (Table 6). However, the mean beam circumference of both yearling and adult males did increase significantly after 1991 (Table 6).

The kidney fat index (KFI) was devised by Riney (1955) to measure fatness of red deer (*Cervus elaphus*), and was expressed as the weight of perirenal fat as a percentage of kidney weight. Since then, KFI has been used to measure the condition of white-tailed deer (Ransom 1967) and other cervids. KFI has been used because of its ease and reliability of relating kidney fat to body fat over a large range of nutritional conditions (Riney 1955; Ransom 1965; Anderson et al. 1969; Smith 1970; Dauphine 1971, 1975). Kie et al. (1983) found KFI to be a good measure of physical condition at levels greater than 15%. Below 15% bone marrow fat is metabolized and a consistent decrease in KFI was not seen. Dauphine (1975) found that the weight of kidneys fluctuated up to 45% seasonally in caribou (*Rangifer tarandus*), and cautioned that comparisons should be made only for deer harvested in the same season. He also suggested that KFI could be replaced with the simple weight of gross perirenal fat, if specimens were grouped by age or size classes, thus eliminating the problem of comparing different body sizes.

We measured KFI's in only the adult and yearling female classes to monitor annual changes in body fat. These classes were selected because they are the classes least affected by the timing of the hunting season. Fawns tend to put most net energy into growth, and generally have low fat reserves even on high planes of nutrition. During the rut males have high levels of activity lead to rapid depletion of fat as the fall progresses. Consequently, adult and yearling females appear to be the best indicators of annual changes in fat reserves. The KFI's of females increased significantly from 1.2 in 1991 to 2.9 in 1995 ($T=6.05$ $p=0.0001$), suggesting higher levels of body fat and net energy in 1995.

Riney (1955) suggested that as a deer fattens they lay down fat sequentially in the bone marrow, then kidneys, the omentum, and finally along the back and tail. Fat reserves are then used in the opposite order with the fat along the back being used first. Consequently, tail fat can be used to estimate the deer's condition in the last few weeks prior to harvest. No significant differences were found within age/sex groups from among years, although adult males tended to have less tail fat each year. In 1991 only 52.7% of the adult males were classified as bony while 91.8% of the adult males harvested in 1995 were bony (Table 5). Although insignificant this trend of the percentage of males becoming bony could be explained by one of three possibilities. First, since male weights are up, males could be putting more energy into growth than laying down fat reserves. Secondly, since there are proportionally more adult males in the population, rutting behavior is increased, depleting fat reserves. This could also be explained by differences in the timing of the rut.

Blood serum parameters have been useful indicators of nutritional status. Bahnak et al. (1979) found that physical condition can be assessed from blood parameters, especially with respect to protein intake, using mean levels of BUN and total protein in blood stream. Seal et al. (1972) found that deer on better diets had higher levels of BUN, albumen, cholesterol, potassium, and phosphorous. Kie et al. (1983) found that only blood urea nitrogen (BUN), creatinine, iron, albumin, alkaline phosphatase, and hemoglobin differed between nutritional levels. Seal et al. (1972) suggested that BUN was positively correlated with the nutritional status of pregnant white-tailed deer, especially protein intake. However elevated BUN levels can be an indicator of either a diet high in protein (Seal et al. 1972, and 1978, Bahack 1979), or protein catabolism associated with severe starvation (DeCalesta et al. 1975, Bahack 1979). The deer on Fort Chaffee were not starving as indicated by body weights and levels of fat, so any increase in BUN was likely associated with higher protein intake.

We found two general trends in the blood parameters from 1991 to 1995 on Fort Chaffee (Table 8) . First, the intake of digestible energy appeared to be higher in1995 than in 1991. Albumin levels rose significantly ($t=6.62$; $p<0.05$), and triglyceride levels rose although not significant ($t=0.46$; $p<0.05$). Secondly, intake of protein may have increased by 1995 as indicated by a rise in total serum protein ($t=0.92$; $p<0.05$), phosphorous levels ($t=0.755$; $p<0.05$), and BUN, although none of these were significant.

Abomasal parasite counts has been used as an index of deer condition, especially in southeastern states, since the 1970's (Eve and Kellogg 1977). A negative correlation has been found between the mean number of abomasal parasites and the physical condition of a deer population. This relationships is thought to occur because the stress of malnutrition leads to reduced immune capacity, and increased susceptibility to parasites. Very high APC numbers usually precede mortality, but are generally not the primary disease agent (Eve and Kellogg 1977). Deer in the Southeast generally carry numbers of abomasal parasites that are subclinical, but as deer density increases APC's increase (Eve and Kellogg 1977). Typical late values in late summer range from 0 to 500 for populations below carrying-capacity, 1000-1500 for populations at or near carrying-capacity, and 1500 or greater in populations that exceed carrying capacity (Eve 1981). Eve and Kellogg (1977) and Davidson et al. (1982) suggested that APC's are very valuable when used together with other fitness indicators and when monitored at regular intervals to detect overcrowding and reduce the chances of population collapse.

The mean APC level was lower in 1995 compared to1991, decreasing from 415 to 313 ($t=7.93$ $p=0.001$). Together with higher weights, fat levels, and serum values, this index adds evidence that the Fort Chaffee deer population was in better physical condition in 1995 than at the beginning of the study.

Reproductive Status

Harder (1984) stated that by far the most efficient method to determine reproductive performance was to conduct fetal counts by examining the uterus. Mortality *in utero* rarely happens, therefore these counts can be used to estimate live births. Woolf and Harder (1979) used counts of corpora albicantia (CA) and corpora lutea (CL) to estimate ovulation and pregnancy rates for deer. They found that fawn pregnancy was only common in herds where reproduction was high. Cheatum (1949) estimated that CA persist for 8 - 12 months following pregnancy. Subsequent studies have found that approximately 15% of CA persist 2 - 3 years (Golley 1957, Mansell 1971). Therefore, CA counts may over-estimate true ovulation rates.

The beginning of the breeding season on Fort Chaffee was estimated by back-aging fetuses to the dates of conception. Earliest conception occurred on October 7, but significant numbers of adult and yearling females did not breed until after October 29. The peak of breeding occurred between November 8-20, based on the age of fetuses and the percentage of does with CLP. In contrast, only 1 of 16 (6%) fawns in the sample had bred by the end of December. Prior studies have shown that fawns frequently breed later than older deer (Roseberry and Klimstra 1970, Wilson 1971). The breeding on Fort Chaffee coincides closely with breeding on Holla Bend NWR, located 150 km east of Ft. Chaffee (Nelson 1992). Research conducted there showed that mating rarely occurred before October 28, with peak breeding occurring during mid- to late-November (Nelson and Johnson 1990).

Over the past 30 years substantial evidence has accumulated to indicate that nutrition is the primary determinant of reproductive performance in deer (Verme 1969, Woolf and Harder 1979). Dietary energy intake and not protein intake influences ovulation rates (Murphy and Coates 1966). Studies have shown that does on higher nutritional planes 6 to 8 weeks before breeding produce significantly more offspring. These does produce more twins, and yearlings are also more productive. Richter and Labisky (1985) found that a doe's productivity was linked to its nutritional plane, but was also affected by deer density. The higher reproductive rates found in 1995 appear to be further evidence that the deer population was in improved condition.

Pregnancy rates in 1991 for fawns, yearlings, and adults were 17%, 98%, and 99% respectively (Nelson 1992). In 1995,100% of both the adults and yearlings were pregnant and 25% of the fawns were pregnant. The mean number of ova shed per ovulating doe in these age-classes were 1.00, 1.26, and 1.87, respectively in 1991. In 1995, the mean number of ova shed per ovulating doe in the same age-classes was 1.00, 1.50, and 2.22. Both female adults ($t=11.5$ $p=0.001$)and female yearlings ($t=7.16$ $p=0.001$) showed significantly higher ovulation rates in 1995.

Management Implications

Nearly all of the indicators of herd health that were measured during this study suggested that the physical condition and natality rates of Fort Chaffee deer have improved from 1991 to 1995. Although body weights showed few significant trends, KFI's increased significantly among yearling and adult females, and APC's decreased over the study. The percentage of spike racks on yearling males declined, while the mean beam diameter of yearling and adult males increased. Serum chemistry data suggested that the intake of digestible energy and protein may have been higher in 1995, suggesting better nutrition. Finally, reproductive rates were higher in 1995 as indicated by a higher percentage of females fawns breeding, and higher ovulation rates among yearlings and adults. While it is difficult to prove causality, it appears likely that the improved condition of the herd is due in part to reduced density and/or improved habitat.

I suggest that the area be further managed to increase the quality and quantity of forage preferred by deer. Care should be taken not to destroy any endangered species or habitats. Short (1975) recommended that areas be managed to retain fungi, hard and soft mast, desirable evergreens, food plots containing fertilized plantings of cool season herbs. This mix is desirable because it improves the digestible dry matter and energy available to deer. Short (1975) suggested that the best way to allow "deer to enter the late autumn in good condition is to provide foods of good nutrition during the late summer and early autumn when deer deposit sustaining fat reserves." Woolf (1979) found that deer prefer forage that is natural seasonal forage. This was found to be the case especially in fall and winter, but in critical periods of fat deposition in summer, deer diets include up to 65% supplemental foods such as green and dry grasses and sedges. Also quality and quantity of deer browse decreases with forest succession from young deciduous stands to mature conifers (Cowan et al. 1950, Halls and Alcaniz 1968, and Halls and Epps 1969). Consequently, maintaining the current program of prescribed burning appears to be a key strategy for retarding succession and providing quality forage.

The Arkansas Game and Fish Commission (pers. comm.) have reported that levels of potassium, phosphorous, and calcium in plant matter increase after burning of food plots. These increases seem to peak about 2 years after burning. It would then be advisable to have a 2-year burning rotation of food plots. This would increase the nutrients available to the deer. The process of liming the acidic soils should also be continued to help to make nutrients available to plants.

The higher percentage of adult males harvested most likely shows a better balance of the sexes in the herd. This is consistent with the goal of reducing the female proportion of the herd but should be monitored carefully so that it is not reduced too low. Continued monitoring of the herd at deer check stations should be continued, with more extensive data on reproduction and physical condition collected every 5 years. The easiest of these indices to monitor are body weight and antler measurements. Caution should be exercised in attempting to manage the Fort Chaffee population primarily for trophy deer. The inherent limitations of soil nutrients, and difficulty prohibiting poaching probably means that good management should focus on maintaining balanced sex-age ratios, healthy individuals, and high natality rates.

Literature Cited

Anderson, A. E., D. E. Medin, and D. P. Ochs. 1969. Relationships of carcass indices in 18 wintering mule deer. Proc. Western Assoc. Game and Fish Commissioners. 49:329-340.

Bahnak, B. R., J. C. Holland, L. J. Verme, and J. J. Ozoga. 1979. Seasonal and nutritional effects on serum nitrogen constituents in white-tailed deer. J. Wildl. Manage. 43:454-460.

Braun, E. L. 1950. Deciduous forests of eastern North America. MacMillan Publishing Co., New York. 596pp.

Brown, R. D. 1984. The use of physical and physiological indices to predict the nutritional condition of deer - a review. Pages 52-63 in P. R. Krausman and N. S. Smith, eds., Deer in the southwest: a workshop. School of Renewable Natural Resources, Univ. of Arizona, Tucson.

Chaplin, R. E. and R. W. G. White. 1969. The use of tooth eruption and wear, body weight and antler characteristics in the age estimation of male wild and park Fallow deer (*Dama dama*). J. Zool. 157:125-132.

Cheatum, E. L. 1949. The use of corpora lutea for determining ovulation incidence and variations in the fertility of white-tailed deer. Cornell Vet. 39:282-291.

Cowan, L. McT., W. S. Hoar, and J. Hatter. 1950. The effect of forest succession upon the quantity and upon the nutritive values of woody plants used as food by moose. Can. J. Res. 28:249-271.

Cowan, R. L., and T. A. Long. 1962. Studies on antler growth and nutrition of white-tailed deer. Proc. Natl. White-tailed Deer Dis. Symp. 1:54-60.

Cox, J. B., B. A. Garner, and F. M. Vodrazka. 1975. Soil survey of Sebastian County, Arkansas. USDA Soil Conservation Service and Forest Service. 66pp.

Dauphine, T. C., Jr. 1971. Physical variables as an index to condition in barren-ground caribou. Trans. N. E. Sect. Wildl. Soc. 28:91-108.

Dauphine, T. C., Jr. 1975. Kidney weight fluctuations affecting the kidney fat index in caribou. J. Wildl. Manage. 39: 379-386.

Davidson, W. R., J. S. Osborne, F. A. Hayes. 1982. Abomasal parasitism and physical condition in southeastern white-tailed deer. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies. 36:436-444.

DeCalesta, D. S., J. G. Nagy, and J. A. Bailey. 1975. Starving and refeeding mule deer. J. Wildl. Manage. 39:663-669.

DeYoung, C. A. 1989. Mortality of adult male white-tailed deer fawns in south Texas. J. Wildl. Manage. 53:513-518.

Eve, J. H. and F. E. Kellogg. 1977. Management implications of abomasal parasites in southeastern white-tailed deer. J. Wildl. Manage. 41:169-177.

Eve, J. H. 1981. Management implications of disease. Pages 413-423 in W. R. Davidson (ed.), Diseases and parasites of white-tailed deer. Misc. Publ. no. 7, Tall Timbers Research Sta., Tallahassee, Fl.

Fischer, J. R., L. P. Hansen, J. R. Turk, M. A. Miller, W. H. Fales, and H. S. Gosser. 1995. An epizootic of hemorrhagic disease in white-tailed deer (*Odocoileus virginianus*) in Missouri: necropsy findings and population impact. J Wildl. Disease. 31:30-36.

French, C. E., L. C. McEwen, N. D. Magruder, R. H. Ingram, and R. W. Swift. 1956. Nutritive requirements for growth and antler development in the white-tailed deer. J. Wildl. Manage. 20:221-232.

Golley, F. B. 1957. An appraisal of ovarian analysis in determining reproductive performance of black-tailed deer. J. Wildl. Manage. 21:62-65.

Gore, H. G. 1984. Potential impact of liberalized regulations to promote spike buck harvest. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 38:33-42.

Halls, L. K. and R. Alcaniz. 1968. Browse plants yield best in forest openings. J. Wildl. Manage. 32:185-186.

Halls, L. K. and E. A. Epps. 1969. Browse quality influenced by tree overstory in the south. J. Wildl. Manage. 33:1028-1031.

Hamilton, R. J., T. L. Ivey, and M. L. Tobin. 1985. Aging fetal white-tailed deer. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 39:118-123.

Harder, J. 1984. Reproduction of white-tailed deer in the north central United States. Pages 23-35 in R. L. Hine and S. Nehls, eds. White-tailed deer population management in the north central states. North Central Section of the Wildlife Society.

Harlow, R. F. and F. K. Jones. 1965. The white-tailed deer in Florida. Fla. Game and Fresh Water Fish Comm. Tech. Bul. No. 9. 240pp.

Jacobson, H. A. 1984. Relationships between deer and soil nutrients in Mississippi. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies. 38:1-12.

Jeter, L. K. and W. S. Bartush. 1981. Staining techniques to facilitate counts of abomasal parasites. Proc. Ann. Conf. S. E. Assoc. of Fish and Wildl. Agencies 35:139-141

Johnson, F. W. 1937. Deer weights and antler measurements in relation to population density and hunting effort. Trans. N. Am. Wildl. Conf. 2:446-457.

Kie, J. G., M. White, and D. L. Drawe. 1983. Condition parameters of white-tailed deer in Texas. J. Wildl. Manage. 47:583-594.

Mansell, W. D. 1971. Accessory corpora lutea in ovaries of white-tailed deer. J. Wildl. Manage. 35:369-374.

Moore, W. G. 1976. White-tailed deer investigations: a six year summary. S. Carolina Div. Wildl. and Freshwater Fish. Typescript. 32pp.

Murphy, D. A., and J. A. Coates. 1966. Effects of dietary protein on deer. Trans. N. Am. Wildl. and Nat. Resour. Conf. 31:129-139.

Nelson, T. A., and A. Woolf. 1985. Birth size and growth of deer fawns in southern Illinois. J. Wildl. Manage. 49:374-377.

Nelson, T. A. 1992. Physical condition and reproductive performance of white-tailed deer on Fort Chaffee. Unpublished report to the Environmental Branch of the Army. 90pp.

Nelson , T. A. and M. W. Johnson. 1990. Fecundity of male white-tailed deer on Holla Bend National Wildlife Refuge. Proc. Arkansas Acad. Sci. 44:83-85.

Nettles, V. F., and D. F. Stallknecht. 1992. History and progress in the study of hemorrohagic disease of deer. Trans. N. Amer. Wildl. Nat. Resource Conf. 57:499-516.

Park, B. C., and B. B. Day. 1942. A simplified method for determining the condition of white-tailed deer herds in relation to available forage. U.S. Dept. Agric. Tech. Bull. 840. 60pp.

Ransom, A. B. 1965. Kidney and marrow fat as indicators of white-tailed deer condition. J. Wildl. Manage. 29:397-398.

Ransom, A. B. 1967. Reproductive biology of white-tailed deer in Manitoba. J. Wildl. Manage. 31:114-123.

Rawson, R. E., G. D. DelGiudice, H. E. Dziuk, and L. D. Mech. 1992. Energy metabolism and hematology of white-tailed deer fawns. J. Wildl. Disease. 28:91-94.

Richter, A. R., R. F. Labisky. 1985. Reproductive dynamics among disjunct white-tailed deer herds in Florida. J. Wildl. Manage. 49:1985.

Riney, T. 1955. Evaluating condition of free-ranging red deer (*Cervus elaphus*) with special reference to New Zealand. New Zealand J. of Science and Technology 36:429-463.

Roseberry, J. L., and W. D. Klimstra. 1970. Productivity of white-tailed deer on Crab Orchard National Wildlife Refuge. J. Wildl. Manage. 34:23-28.

SAS Institute inc. 1985. SAS users guide: basics, version 5 addition. SAS institute, Cary, NC. 1290pp.

Scribner, K. T., M. H. Smith, P. E. Johns. 1984. Age, condition, and genetic effects on incidence of spike bucks. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies. 38:23-32.

Seal, U. S., L. J. Verme, J. J. Ozoga, and A. W. Erickson. 1972. Nutritional effects on thyroid activity and blood of white-tailed deer. J. Wildl. Manage. 36:1041-1052.

Seal, U. S., M. E. Nelson, L. D. Mech, and R. L. Hoskinson. 1978. Metabolic indicators of habitat differences in four Minnesota deer populations. J. Wildl. Manage. 42:746-754.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Manage. 13:195-215.

Severinghaus, C. W. 1955. Deer weights as an index of range conditions on two wilderness areas in the Adirondack region. NY Fish and Game J. 2:154-160.

Short, H. L. 1975. Nutrition of southern deer in different seasons. J. Wildl. Manage. 39:321-329.

Smith, N. S. 1970. Appraisal of condition estimation methods for East African ungulates. E. Afr. Wildl. J. 8:123-129.

Stallknecht, D. E., M. L. Kellogg, J.L. Blue, J. E. Pearson. 1991. Antibodies to bluetongue and epizootic hemorrhagic disease viruses in a barrier island white-tailed deer population. J. Wildl. Diseases 27:668-674.

Stallknecht, David E., V. F. Nettles, E. A. Roller, III, and E. W. Howerth. 1995. Epizootic hemorrhagic disease virus and bluetongue virus serotype distribution in white-tailed deer in Georgia. J. Wildl. Diseases 31:331-338.

Steen, M. O. 1955. Not how much but how good. Mo. Conserv. 1:1-4.

Sturdy, J. C., W. Johndrow, and C. Reames. 1991. U.S. Army Garrison, Fort Chaffee, Arkansas: Integrated Natural Resource Management Plan (INRMP). Department of the Army. 147pp.

Sweet, J. C. and C. W. Wright. 1953. A comparison of weight and antler development between white-tailed deer in northern and southern New Jersey. N.J. Outdoors 3:3-8.

Teer, J. G., J. W. Thomas, and E. A. Walker. 1965. Ecology and management of white-tailed deer in the Llano Basin of Texas. Wildl. Monographs. 15:1-62.

Thorsland, O. A. 1966 Nutritional analyses of selected deer food in South Carolina. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. Proc. 20:84-104.

Verme, L. J. 1969. Reproductive patterns of white-tailed deer related to nutritional plane. J. Wildl. Manage. 33:881-887.

Warren, R. J. and R. L. Kirkpatrick. 1982. Evaluation of the nutritional status of white-tailed deer using fat indices. Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 36:463-472.

Wilson, S. N. 1971. Some characteristics of white-tailed deer reproduction in Arkansas. M. S. Thesis, Univ. of Arkansas. 52pp.

Wesley, D. E., J. L. Baker, J. F. Kennamer, and L. R. Shelton. 1969. A comparison of size and reproductive characteristics in two white-tailed populations. J. Miss. Acad. Sci. 16:132-136.

Woolf, A., and J. D. Harder. 1979. Population dynamics of a captive white-tailed deer herd with emphasis on reproduction and mortality. Wildl. Monographs. 67:1-54.

Table 1. Number of deer in each sex-age class harvested during the firearm deer season on Fort Chaffee, AR, 1991-1995.

Class	1991	1992	1993	1994	1995	Total
Female Adult	265(36%)	241(37%)	158(37%)	215(39%)	92(35%)	971(37%)
Female Yearling	74(10%)	49(8%)	26(6%)	47(8%)	24(9%)	220(8%)
Female Fawn	77(11%)	74(12%)	65(15%)	57(10%)	29(11%)	302(12%)
Male Adult	93(13%)	100(16%)	66(16%)	86(15%)	49(19%)	394(15%)
Male Yearling	122(17%)	101(16%)	47(11%)	80(14%)	41(16%)	39(15%)
Male Fawn	105(14%)	81(13%)	61(14%)	72(13%)	30(11%)	349(13%)
Total Harvest	736	646	423	557	265	2627

Table 2. Number of permits issued to hunters and hunter success during firearm season on Fort Chaffee, AR, 1991-1995.

Year	Total permits	Total Harvest	Hunter success
1991	3617	736	20.3%
1992	3496	646	18.5%
1993	3136	423	13.5%
1994	3374	557	16.5%
1995	2370	265	11.2%
Total	15,993	2,627	16.4 %

Table 3. Percent of harvest by compartment for all years.

Compartment	1991	1992	1993	1994	1995	Total
1	8.4	8.6	5.3	2.0	13.2	7.1
2	0.0	0.3	0.0	0.5	0.0	0.2
3	1.2	1.2	2.9	1.6	0.4	1.5
4	2.4	1.5	2.4	1.1	3.4	2.0
4A	8.0	3.4	9.4	4.5	8.7	6.4
5	35.9	33.5	32.4	21.9	26.8	30.9
6	14.5	18.4	16.2	16.2	12.1	15.8
6A	12.9	12.3	12.3	25.1	12.0	15.3
7	5.0	7.4	5.3	4.8	4.5	5.6
7A	5.7	8.6	8.5	12.6	6.8	8.5
8	2.4	1.4	1.9	3.6	1.1	2.0
9	3.4	3.2	3.4	6.1	11.0	4.7

Table 4. Percent prevalence of disease found in sampled deer on Fort Chaffee. Sample size for 1991 was 40 and 11 for 1995.

Disease Assay	1991	1995
Brucellosis	0	0
Bovine viral diarrhea virus (BVD)	0	0
Infectious bovine rhinotracheitus virus (IBR)	0	0
Parainfluenza 3 virus	15	18
Bluetongue virus (BTV)	0	0
Epizootic Hemorrhagic Disease virus (EHDV)	10	18
Leptospira	8	6

Table 5. Average dressed weight for each age class, 1991 to 1995. Standard error shown in parentheses. Mean weights followed by different letters differ at alpha = 0.05. Refer to Table 1 for sample sizes for each age class.

	Female			Male		
Year	Fawn	Yearling	Adult	Fawn	Yearling	Adult
1991	43 (0.75)a,b	69 (0.70)a	79 (0.45)a	47 (0.65)b	77 (0.75)b	98 (1.29)b
1992	45 (0.86)a	70 (1.51)a	79 (0.56)a	52 (0.91)a	79 (1.05)a,b	98 (1.42)a,b
1993	45 (0.95)a	70 (1.58)a	79 (0.65)a	49 (1.17)a,b	81 (1.33)a,b	104 (1.84)a
1994	41 (0.85)b	68 (1.11)a	78 (0.52)a	47 (1.07)b	79 (0.89)a,b	103 (1.23)a,b
1995	45 (1.38)a	69 (0.94)a	80 (0.86)a	50 (1.69)a,b	81 (1.24)a	104 (2.14)a,b

Table 6. Mean antler dimensions for adult and yearling males harvested on Fort Chaffee, 1991-95. Standard errors are shown in parenthesizes. Means followed by different letters differ at α=0.05.

Year	Adults			Yearlings		
	# points	beam diameter	beam length	# points	beam diameter	beam length
1991	7 (0.21)a	1.9 (0.37)a	17.9 (4.4)a	3 (0.13)a	1.7 (0.06)a	5.6 (0.62)a
1992	7 (0.18)a	3.3 (0.07)b	15.0 (3.9)a	3 (0.16)a	2.1 (0.05)b	6.9 (0.29)a
1993	8 (0.17)a	3.3 (0.07)b	16.0 (3.3)a	3 (0.23)a	2.1 (0.07)b	7.4 (0.34)a
1994	8 (0.18)a	3.4 (0.07)b	17.0 (3.3)a	3 (0.20)a	2.1 (0.07)b	7.9 (0.28)a
1995	6 (0.37)b	3.1 (0.10)b	14.9 (3.6)a	3 (0.26)a	2.0 (0.05)b	7.8 (0.42)a

Table 7. Percent of adult female and male deer that were considered bony, lightly padded, or padded based on tail palpation of tail fat, 1991-1995 harvested from Fort Chaffee AK.

	Adult Females				Adult Males			
Year[1]	N	Bony	Lightly Padded	Padded	N	Bony	Lightly Padded	Padded
1991	264	3	20	77	91	53	40	8
1993	157	6	16	78	65	83	15	2
1994	213	6	23	72	86	84	16	0
1995	92	5	28	66	49	92	6	2

[1]Tail fat was not recorded for deer harvested in 1992.

Table 8. Mean values for selected blood serum parameters from samples taken in 1991 (n=40) and 1995 (n=11).

Blood Serum Parameter		
Test	1991	1995
BUN (mg/dl)	14.1	14.5
Total Protein (g/dl)	6.9	7.5
Albumin (g/dl)	2.6	3.7
Albumin:globulin ratio	0.61	0.97
Phosphorous (mg/dl)	13.1	14.3
Triglycerides (mg/dl)	128	146
Calcium (mg/dl)	10.7	8.5
Cholesterol (mg/dl)	56	57

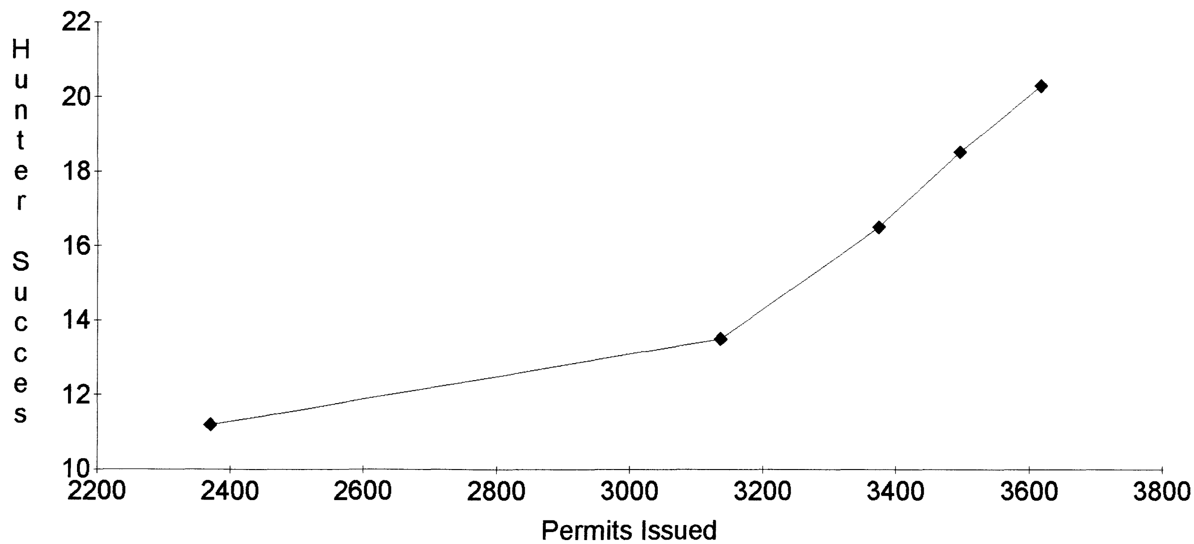

Figure 1. Correlation between number of permits issued and hunter success on Fort Chaffee, AR, 1991-1995.

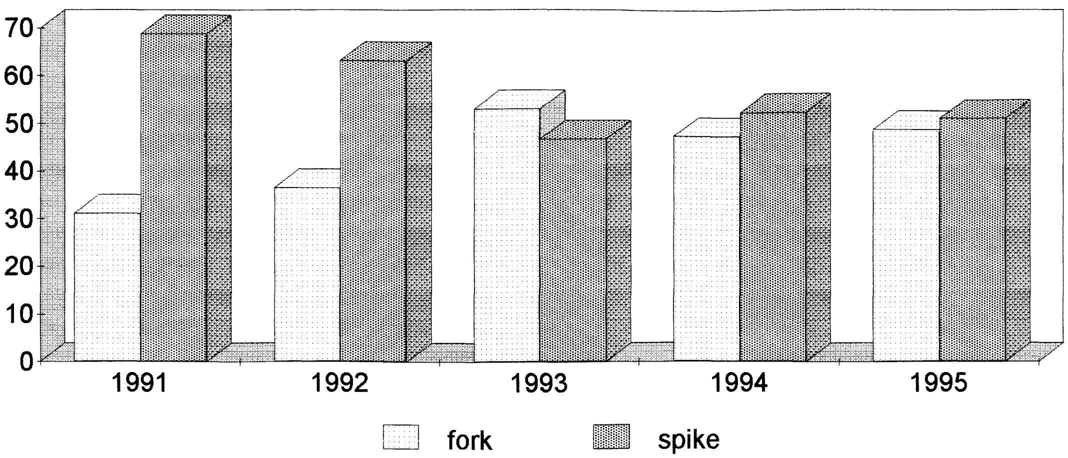

Fig.2. Percentage of yearling males with forked (branched) versus spiked (unbranched) antlers at Fort Chaffee, AR, 1991-1995.