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Richard A. Kluender
University of Arkansas at Monticello

Philip A. Tappe
University of Arkansas at Monticello

Michael E. Cartwright
Arkansas Game and Fish Commission

LONG-TERM WHITE-TAILED DEER HARVEST TRENDS FOR THE SOUTHCENTRAL UNITED STATES

R. A. KLUENDER and P. A. TAPPE
Department of Forest Resources
University of Arkansas at Monticello
Box 3468
Monticello, AR 71656

MICHAEL E. CARTWRIGHT
Wildlife Biologist
Arkansas Game and Fish Commission
P.O. Box 720
Calico Rock, AR 72519-0720

ABSTRACT

White-tailed deer herd size across the southcentral states continues to increase. Concurrent with this increase has come a total harvest level increase for most states. Southcentral states have increased bag limits on antlerless deer to insure that herd health is maintained as herd sizes approach total carrying capacity. Harvest growth rates, however, show irregularities from year to year. The cyclic pattern of harvest (and population) growth rate is of shorter duration than would be expected in a large ungulate population. An exogenous influence is suspected. Cyclic patterns in harvest growth rates move opposite the growth rate of epizootic hemorrhagic disease incidence in southcentral counties. Initial results suggest causality between disease incidence and harvest growth rate. As herds approach carrying capacity on many southern sites, management challenges increase.

INTRODUCTION

Harvest data and their interpretation are an integral component of white-tailed deer (*Odocoileus virginianus*) management. Harvest data are usually compiled by state game agencies and used as a basis for recommending future harvest regulations. Recommending and setting harvest regulations are often controversial subjects, especially considering the diversity of public expectations which results from a variety of different attitudes and varying degrees of past management success. Several studies have reported on relatively long-term harvest trends for specific management units and for individual states (Kluender *et al*, 1988; Kammermeyer, 1991; Wilson and McMaster, 1973); however, there have been no region-wide comparisons or analyses of harvest trends in the southcentral region of the United States. Given the importance and success of white-tailed deer populations in the south as a whole, it is desirable to have knowledge of harvest trends not only on a local level, but also on a regional level in order to facilitate evolving management strategies. The objectives of this study were to compare annual white-tailed deer harvest data from seven south-central states and to determine significant trends in yearly harvest.

METHODS

A letter was sent to state deer biologists in each of seven southcentral states (Tennessee, Mississippi, Louisiana, Arkansas, Missouri, Oklahoma and Texas) requesting yearly deer harvest information. Each state responded, although the data available by state varied considerably. Some states were able to provide only total harvest for limited periods of time, while other states were able to provide fairly complete information for harvest by sex for long periods. Because of the variation in data collection formats, Texas and Louisiana could not be included in all of the analyses. For those states with more complete data sets, yearly harvest rates of antlered and antlerless deer (including does and button bucks) were entered separately. Antlerless deer percent of total harvest rate was calculated by year for each state.

A second data set consisted of cross sectional data gleaned from the Appendix of the Proceedings of the 1991 Annual Southeast Deer Study Group meeting. The study year was 1989. These data included variables by state for estimated herd size, total habitat area, total harvest, antlered harvest, antlerless deer harvest, hunting season length and number of hunters. Calculated variables included acres per deer, kill percent of total population, antlered deer percent of total harvest, antlerless deer percent of total harvest, acres per harvested deer, acres per hunter and harvest per hunter. Statistics were compared across states for trends and to determine what factors were consistently associated with high total harvest rates. Data entry and analysis were accomplished with Quattro (Borland, 1991), a spread sheet, and Systat (Wilkinson, 1990), a statistics package.

The time series data were handled in a fundamentally different manner than the cross-sectional data. Data were first plotted over time to determine long-term harvest trends by total and sex group by state; general trends were noted. Next, yearly total harvest, antlered harvest and antlerless deer harvest rates were first differenced to remove long-term trends from the data and to eliminate first order auto-correlation. First differencing is an effective tool in revealing cyclic variability in a time series.

The need for first differencing is recognized by inspection of the auto-correlation coefficients and the partial auto-correlation coefficients of a time series (Hoff, 1983). A fundamental assumption of time series analysis is that an observation of a variable in time T is a function of its value in time $T\text{-}1$ plus an error term, e, that contains current period influences. This relationship is generally expressed in Equation 1.

$$Y_T \text{-} f(Y_{T\text{-}1}+e_T) \qquad (1)$$

In order to isolate current period information free of past period information, the series is first differenced to leave the pure error series, e_T as in Equation 2.

$$e_T = f(Y_T \text{-} Y_{T\text{-}1}) \qquad (2)$$

This transformation leaves all of the current period information in the data while removing influences of prior time periods. Note that the information contained in this series is the change in the value of a series from one time period to another. It is similar to the periodic growth rate of the series.

RESULTS AND DISCUSSION

CROSS-SECTIONAL DATA:
Deer habitat by state ranged from nine million (OK) to 71.7 million acres (TX) (Table 1). Average habitat was 17.5 million acres per state without Texas included and 39.4 million acres with Texas. Estimated deer populations ranged from a low of 250,000 (OK) to a maximum of 3,500,000 (TX); average estimated population (without TX) was 780,000

Table 1. Southcentral states white-tailed deer harvest statistics for 1989.

VARIABLE	STATE AR	LA	MO	MS	OK	TN	TX
Habitat (M ac.)	28,594	17,000	13,694	20,000	8,949	16,492	71,680
Herd size (M)	700,000	650,000	750,000	1,700,000	250,000	625,000	3,500,000
Area per deer (ac.)	40.8	26.2	18.3	11.8	35.8	26.4	20.5
Total Harvest	113,079	170,000	157,155	262,386	38,341	108,762	477,491
Doe Harvest	34,563	48,000	62,246	72,856	8,535	33,124	221,446
Percent of population harvested (%)	16.15	26.15	20.95	15.44	15.33	17.40	13.64
Hunter density (ac./hunter)	NA	84.99	34.23	100.00	42.12	83.44	127.10
Hunter success ratio (deer/hunter)	NA	0.85	0.39	1.31	0.18	0.55	0.84

animals. Average acres per deer was estimated at 25.7 with a high of 40.9 acres per deer and a low of 11.8 acres per deer. Total harvest ranged from a high of 478,000 in TX to a low of 38,350 in OK. Average harvest amounted to 17.9% of the herd, with a high of 26.2% (LA) and a low of 13.6% (TX). Antlerless deer percent of total harvest ranged from a low of 22.2% (OK) to a high of 46.4% (TX). Hunting density was highest in MO with 34 acres per hunter and lowest in Texas with 127 acres per hunter (based on total deer habitat). Average success rates (total harvest / total number of hunters) varied from a low of 20% in OK to a high of 131% in MS where hunters averaged more than one deer each.

There was a strong correlation between total harvest and total habitat (r=.889), total herd size (r=.983), the number of hunters (r=.721) and hunter density per square mile (r=-.732). Total harvest was also strongly related to the total number of antlerless deer harvested (r=.974) and the percent of total harvest represented by antlerless deer (r=.763).

TIME SERIES DATA:

Generally, harvest increased over time in all southcentral states (Figures 1 and 2). The strongest increases in annual deer harvest took place after 1977 or 1978; however, some states, such as Tennessee and Arkansas, did not begin to significantly increase harvest until the early 1980s. All states that are characterized by significant increases in total deer harvest have had at least 20% of their total harvest in the antlerless deer class. Moreover, states that have consistently harvested more than 100,000 deer annually since 1977 have had at least 30% of the total harvest in the antlerless deer class. Antlerless deer percentages of 35 - 40% are more prevalent in the states with annual harvests over 150,000. Since 1988, antlerless deer have accounted for over 50% of Missouri's harvest of deer. Other states (MS and TX) are not far behind this level.

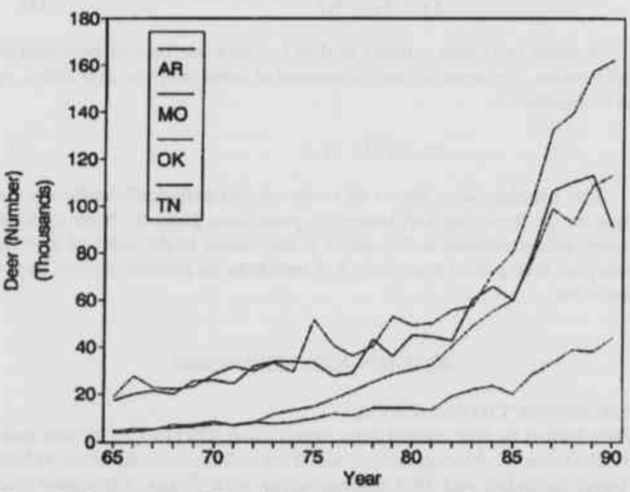

Figure 1. Long term white-tailed deer harvest rates for Arkansas (AR), Missouri (MO), Oklahoma (OK) and Tennessee (TN).

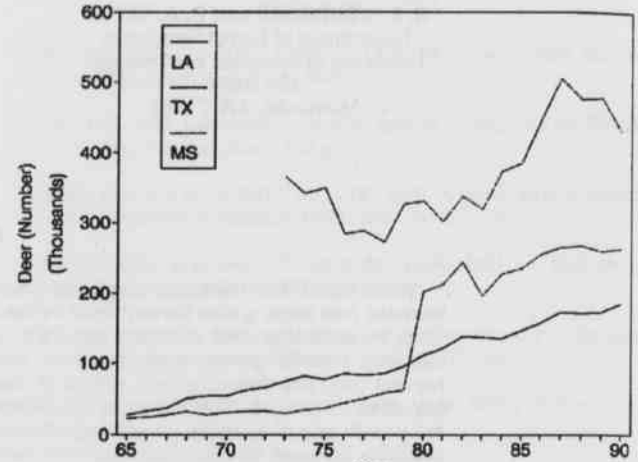

Figure 1. Long term white-tailed deer harvest rates for Arkansas (AR), Missouri (MO), Oklahoma (OK) and Tennessee (TN).

The trend to increase the numbers of harvested antlerless deer is a sharp departure from deep seated conventional wisdom. The move to increase doe harvest has been at the instigation of deer biologists who recognize that, with growing herd sizes, antlerless deer must be harvested at an increasing level to insure herd health as herds approach carrying capacity. Doe harvest is also critical to maintaining herds at acceptable levels to minimize the problems at the deer-human interface such as crop depredation and deer-vehicle collisions (Wigley *et al*, 1990).

The first differenced time series for total harvest and antlered harvest for most states showed strong cyclical patterns (*e.g.* Oklahoma, Figure 3). Usually the pattern repeated on a four year cycle, although one series varied on a three year cycle. Cycles were roughly coincident for all of the states, but only three (AR, TN, and OK) are depicted in Figure 4 for clarity. The same cyclic pattern was present in the antlerless as well as the antlered portion of the harvest; however, the pattern in the antlerless deer harvest is not as clear. Note also that the amplitude of the cyclic pattern has increased over time. This increasing variance is at least somewhat attributable to the total harvest level over time.

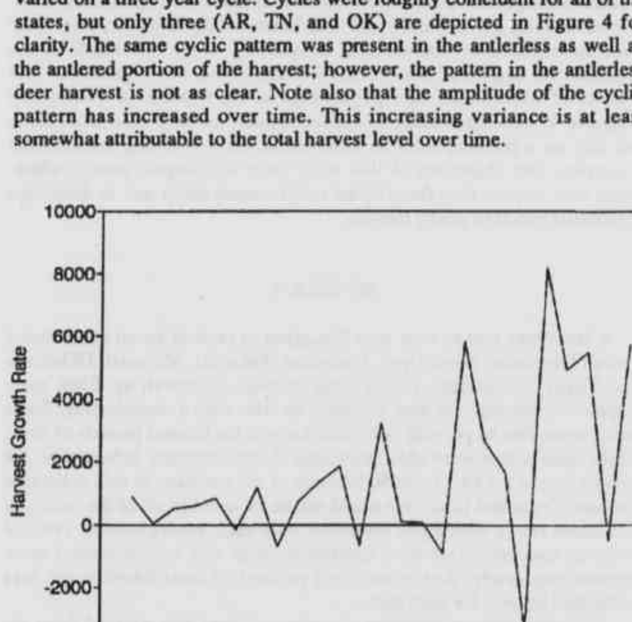

Figure 3. First differenced harvest data for Oklahoma showing year harvest growth rate.

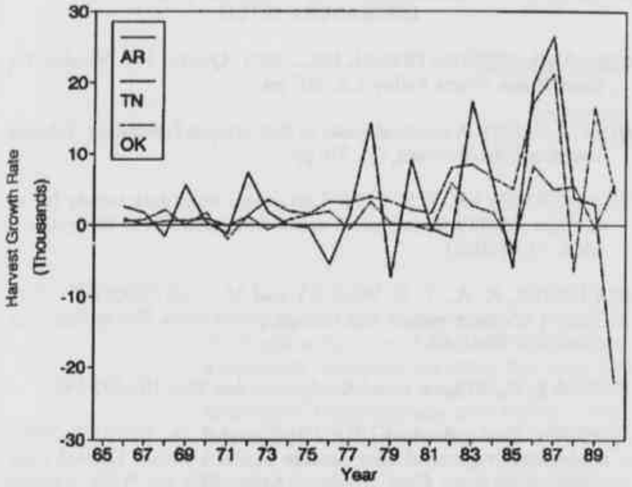

Figure 4. First differenced harvest data for Arkansas (AR), Tennessee (TN) and Oklahoma (OK) showing yearly harvest rate and coinidence of growth rate cyecles.

A major question arises about the meaning and cause of the cyclic nature of the first differenced state harvest series. Two general hypotheses arise: first, that the cycle is human induced. At least two possibilities exist in this category. One is that the cycle is a result of the quasi-political process of setting season lengths, *i e.*, biologists and commissioners operating in concert across state lines or regionally purposefully "hit the herd hard" every two, three or four years. However, state differences in management objectives mitigate against this reasoning. Another is that the cycle is a result of fluctuations in hunting effort region wide. This hypothesis is weak, however, because over-all harvest levels have typically risen consistently for long periods while the number of hunters in many states have actually decreased somewhat since 1980 (Kluender *et al*, 1988).

The second major hypothesis is that the cycle is a biological phenomena, and that the observed cycle represents the removal of the harvestable portion of a regularly eruptive biological population. A high linear correlation (r=0.983) between total harvest and population supports the hypothesis that harvest represents a relatively fixed proportion of the total population, regardless of population size. Recall that the average harvest percent of total population for the southcentral states is 17.9% (sd=4.3). Since yearly harvest is a function of the population and the proportional harvest by state is relatively consistent over time regardless of population size, then harvest numbers probably reflect the underlying population of active, healthy deer during hunting seasons. Accepting the proposition that we are dealing with a cycling biological phenomena, the question arises as to the cause of the observed cycles. Note that these cycles appear to be more reminiscent of the short cycles characteristic of many small mammal populations (relatively *r*-selected species) then of the relatively longer cycles observed in a few larger mammals (relatively *K*-selected species) (Pianka 1970).

Possibilities for the apparent population cycle include regional weather patterns which include rain fall that produces cycles in mast and forage production and hence recruitment and fawn survival. A second possibility is the cyclic eruptive nature of epizootic hemorrhagic disease (HD) in the southern United States. Figure 5 shows the incidence level of HD by year with the number of southern counties affected by the disease. When first differenced data for HD cycles is plotted with first differenced data of total harvest in most of the southern states a strong negative correlation between the disease and harvest change is noted. Tennessee is used here as an example (Figure 6). Note that when HD incidence is on the upswing (*i.e.*, peak years for disease outbreak, harvest is lowered significantly). In years when HD is at low levels we note a significant increase in harvest levels.

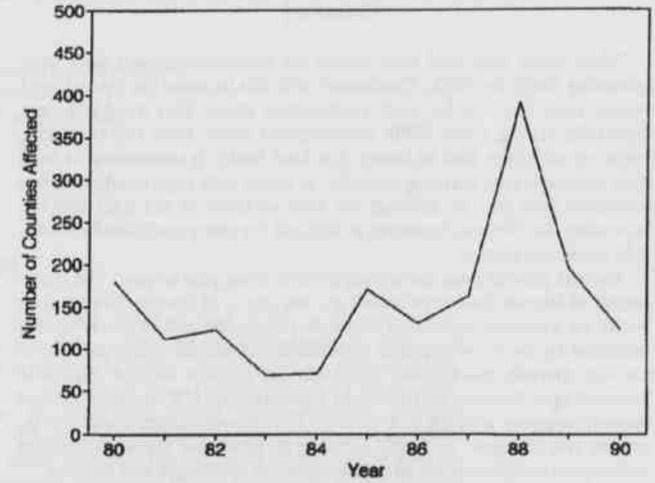

Figure 5. Yearly number of southern counties with confirmed epizootic hemorrhagic disease (HD) cases.

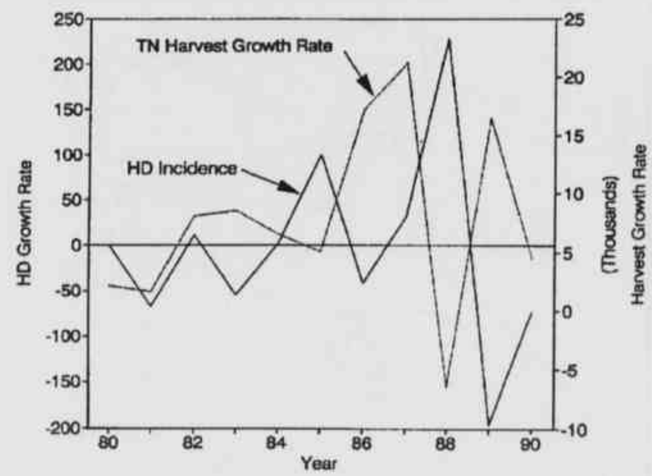

Figure 6. First differenced harvest data for Tennessee and first differenced series of epizootic hermorrhagic disease incidence in the south, showing a strong negative correlation.

While HD outbreaks do not prove causality of lowered harvest levels, the strong negative correlation between the events does strongly suggest a relationship. If we accept that the reduction in harvests on a cyclical basis may be caused by HD, then it appears that the disease might be much more virulent and devastating than had been previously suspected. Sudden drops in harvest levels of up to 10,000 harvested animals mark the first differenced harvest data of many states (*e.g.*, TN, AR, MS). If this drop is equivalent to the average portion (17.8%) of the herd that is harvested, the total drop in active, healthy, deer during fall hunting season due to HD may be as high as 60,000 deer in a single state. This is equivalent to over one third the yearly legal harvest per year in many southcentral states.

If late summer, pre-hunting season HD epidemics are eliminating this many deer from potential harvest in peak years, managers will find it exceedingly hard to wisely structure hunting regulations. This is compounded by the fact that season dates are customarily set far in advance of actual seasons. Clearly, more research is needed to confirm the degree and extent of HD influence on deer harvest.

SUMMARY

White-tailed deer herd sizes across the southcentral states have been increasing since the 1960s. Concurrent with this increase has come a total harvest level increase for most southcentral states. This trend has been especially strong since 1980. Southcentral states have increased bag limits on antlerless deer to insure that herd health is maintained as herd sizes approach total carrying capacity. In states with large yearly harvests antlerless deer tend to account for 40% or more of the total harvest. Increasing doe harvest, however, is difficult for many traditionally bucks-only hunters to accept.

Harvest growth rates show irregularities from year to year. The cyclic pattern of harvest (and population) growth rate is of shorter duration than would be expected in a large ungulate population and is closer to that exhibited by more r-controlled populations. Observed cyclic patterns in harvest growth rates move opposite the growth rate of epizootic hemorrhagic disease incidence in southcentral US counties. Initial research suggests a strong link between HD disease incidence and harvest growth rate changes. As herds continue to grow and approach carrying capacity on many southern sites, management challenges will increase.

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