Abomasal Parasitism and Physical Condition in Southeastern White-Tailed Deer[1]

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Abstract: The relationship between abomasal parasitism and physical condition was studied in white-tailed deer (*Odocoileus virginianus*) in the Southeast. On both an individual animal and herd basis, the level of abomasal parasitism was inversely related to physical condition. Differences ($P \leq 0.05$) in physical condition were noted among herds in each of 3 abomasal parasite count (APC) categories (namely, <500, 500–1,500, >1,500). The relationship between abomasal parasitism and herd physical condition was not cause and effect; rather, both parameters were reflective of the status of deer density relative to habitat carrying capacity. Present data verify that APC values are indicative of overall herd health. Instances in which APC data can be of particular value in deer management are discussed.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 36:436–444

A novel method based on the level of infection with abomasal parasites (Eve and Kellogg 1977) was described for appraising the status of white-tailed deer (*Odocoileus virginianus*) populations in relation to habitat carrying capacity. Three broad categories of values were developed for interpreting abomasal parasite count (APC) data: (1) APC of <500 indicating a herd below carrying capacity with a population increase being appropriate;

[1] This study was supported by an appropriation from the Congress of the United States. Funds were administered and research coordinated under the Federal Aid in Wildlife Restoration Act (50 Stat. 917) and through Contract Numbers 14-16-0008-707, 14-16-0008-777, 14-16-0009-78-023, and 14-16-0009-80-008, Fish and Wildlife Service, U.S. Department of the Interior.

(2) APC of 500–1500 indicating a herd near carrying capacity with a cessation in population growth being appropriate; and (3) APC of >1500 indicating a herd in excess of carrying capacity with a population reduction being appropriate. These divisions were not precise transition points but rather were general guidelines for interpretation of APC data. Eve and Kellogg (1977) further noted that high APC values were associated with an increased likelihood of losses from various disease agents and provided specific examples as typical cases in point. Finally, the recommendation was made that APC data should be used to "complement, but not replace, standard methods for evaluating white-tailed deer herds" (Eve and Kellogg 1977:176).

Well recognized changes occur in both the habitat and deer population as the number of deer approaches and exceeds habitat carrying capacity (Eve and Kellogg 1977). One of those parameters inherent to deer *per se* is overall physical condition. Stockle et al. (1978:277) aptly stated that physical condition in white-tailed deer "portrays changing environmental and physiological demands" and "provides information on which management policies are based."

This report provides information on (1) the relationship of abomasal parasitism and physical condition in individual white-tailed deer and (2) the relationship of herd APC values to herd health status as indicated by physical condition of animals in the herd.

Sincere gratitude is extended to numerous sportsmen and personnel of state fish and wildlife agencies in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, and West Virginia for assistance during these studies. Past and present co-workers contributed immensely during data collection phases. Special thanks are extended to Dr. D. W. Hayne, Institute of Statistics, North Carolina State University, for statistical consultation and to D. L. Adams, P. E. Hale, and J. L. Rakestraw for assistance in data compilation and analyses.

Methods

Information used in this study was derived in large part from the same groups of deer studied by personnel at our regional wildlife disease laboratory during the past 20 years (Prestwood et al. 1973, Pursglove et al. 1974, Eve and Kellogg 1977, Pursglove 1977, Stockle et al. 1978, Davidson and Prestwood 1979, Davidson et al. 1980), although additional animals collected since these studies also were included. Procedures for deer collection, necropsy (Nettles 1981), and parasite recovery and enumeration were as described previously (Prestwood et al. 1973, Eve and Kellogg 1977, Prestwood and Pursglove 1981). Methods of evaluating physical condition were those described by Stockle et al. (1978).

Information on abomasal parasitism and physical condition was divided into 2 subsets of data. One subset comprised of 1,033 deer collected from 77 counties in 13 southeastern states during the period of July, 1961, through December, 1975, was used to evaluate the relationship of abomasal parasite burdens and physical condition in individual deer. The sample size per location ranged from 5 to 72 deer, and collections were made throughout the year. The number of abomasal parasites and a coded numerical value for physical condition, namely, 1 = poor, 2 = fair, 3 = good, and 4 = excellent (Stockle et al. 1978), were entered on computer cards. To determine frequency distributions, parasite burdens were grouped into 23 frequency classes with class intervals of 200 parasites. Cumulative frequency curves were constructed for each physical condition category.

The second data subset comprised of 301 deer from 52 collections in 44 counties in 11 southeastern states and Oklahoma during the period of July, 1961, through August, 1979, was utilized to evaluate relationships between herd APC values and physical condition of animals in the herd. This subset was limited to information obtained between the dates of July 10 and September 20 as recommended (Eve and Kellogg 1977) for highest reliability of APC values. The minimum sample size was 5 animals per location. Herd APC values were categorized as suggested by Eve and Kellogg (1977) (namely, <500, 500–1500, >1500) and the number of animals in each physical condition category was tallied in a 3×4 contingency table and tested with the Chi square test. Mean herd physical condition ratings were calculated for each of the 52 collections. Herds were then stratified by APC category, and those in each APC category were tested for differences in mean physical condition ratings by a pooled *t*-test. Statistical analyses were performed using the Statistical Analysis System (SAS) programs (Service 1972).

Results

Abomasal parasites recovered consisted of 9 species, namely, *Apteragia odocoilei, A. pursglovei, Ostertagia mossi, O. dikmansi, O. ostertagi, Haemonchus contortus, Trichostrongylus askivali, T. axei,* and *T. dosteri.* The prevalence and distribution of these parasites have been presented in earlier reports (Prestwood et al. 1973, Pursglove et al. 1974, Pursglove 1977, Davidson and Prestwood 1979, Davidson et al. 1980, Prestwood and Pursglove 1981). Data on physical condition from 440 deer used in this study have been presented by Stockle et al. (1978).

Of the subset of 1,033 deer collected throughout the year, 66 (6.4%)

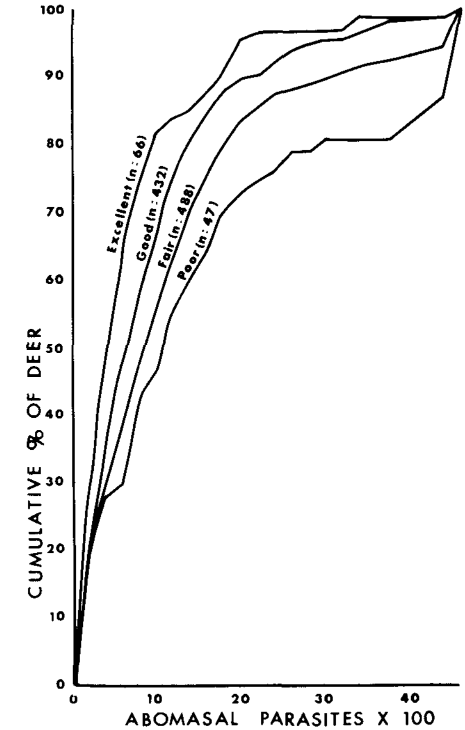

Figure 1. Cumulative percentage of deer in each of 4 physical condition categories tallied at successive abomasal parasite burdens.

were rated in excellent condition, 432 (41.8%) in good condition, 488 (47.2%) in fair condition, and 47 (4.6%) in poor condition. Stratification by physical condition revealed that abomasal parasitism was inversely related to host physical condition. This relationship is evident from cumulative percent frequency curves of total abomasal parasites from deer in each physical condition category (Fig. 1).

Of the subset of 301 deer collected during late summer, the distribution of deer in each physical condition category was markedly different for herds within each APC category (Fig. 2). The Chi square test on these data revealed a difference in observed versus expected frequencies ($\chi^2 = 105.053$; $\chi^2_{0.9995} = 24.103$, df $= 6$). This difference was attributable to overrepresentation by the higher physical condition categories in herds with low (<500) APC values and overrepresentation by the lower physical condition categories in herds with high (>1500) APC values. Comparison of mean herd physical condition values for each APC category disclosed differences ($P < 0.05$) among all 3 APC categories (Table 1). Herds with low APCs

(<500) had the highest mean physical condition values, and herds with high APCs (>1500) had the lowest mean physical condition values.

Discussion

Deer with higher physical condition ratings are likely to have fewer parasites, and conversely, deer with lower physical condition ratings are likely to have more parasites (Fig. 1). Since the comparison of abomasal parasitism and physical condition in individual animals was made irrespec-

Table 1. Comparison of Mean Physical Condition Ratings of 52 Deer Herds Stratified by Abomasal Parasite Count (APC) Categories

Herd Physical Condition[a]	APC Category <500 ($N = 4$)	500–1,500 ($N = 33$)	>1,500 ($N = 15$)
Range	2.0–3.8	1.6–3.2	1.0–3.0
Mean	3.1500	2.4484	2.1667
SD	0.4875	0.1817	0.2007
t values[b]	[—— 2.9064 ——] ($P < 0.01$)	[—— 2.0569 ——] ($P < 0.05$)	
	[—— 3.3771 ——] ($P < 0.01$)		

[a] Numerical physical condition ratings for individual deer were: 1 = poor, 2 = fair, 3 = good, and 4 = excellent as delineated by Stockle et al. 1978.
[b] Values calculated for columns indicated by brackets.

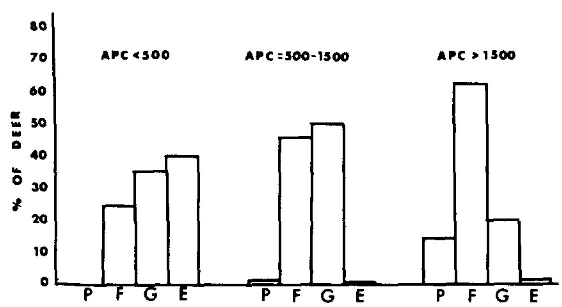

Figure 2. Proportion (%) of deer in each of 4 physical condition categories within each of 3 herd abomasal parasite count (APC) categories. Physical condition categories are: P = poor, F = fair, G = good, and E = excellent.

tive of known seasonal changes in these parameters, this relationship can be considered as the general, overall association of abomasal parasitism and physical condition.

This relationship should not be interpreted as cause and effect, because with the exception of the large stomach worm (*Haemonchus contortus*), abomasal parasites of deer are not highly pathogenic (Prestwood and Kellogg 1971, Prestwood et al. 1973, Eve and Kellogg 1977, Davidson et al. 1980, Prestwood and Pursglove 1981). Rather, both the level of abomasal parasitism and physical condition in deer are indicative of the status of the herd with regard to carrying capacity. The association of the level of abomasal parasitism with the status of deer populations in regard to carrying capacity was delineated as the basis of the APC concept by Eve and Kellogg (1977). Physical condition in deer has long been accepted as being reflective of habitat quality, whether physical condition is judged *en toto* (Stockle et al. 1978, Kistner et al. 1980) or by any of several condition indices (Harris 1945, Cheatum 1949, Riney 1960, Ransom 1965, Anderson et al. 1972, Pojar and Reed 1974). The influence of the status of deer density in relation to habitat quality on both APC values and indices of body condition has been previously illustrated by a 4-year investigation conducted by Osborne et al. (1979). APC values were inversely related to diet quality and kidney fat indices and were directly related to deer density. Similarly, indicators of body condition increased with an improvement in diet quality and a decline in deer density.

Since wildlife managers are concerned with the health status of the entire herd rather than the individual animal, a more meaningful comparison is the relationship between herd APC values and the proportion of animals in the herd in various physical condition categories. This comparison (Fig. 2, Table 1) portrays herds with high APCs (>1500) as being skewed toward lower physical condition categories versus herds with low APCs (<500) that are skewed toward higher condition categories. Animals from herds with moderate APCs (500–1500) were located in positions of intermediate physical condition. The present study thus provides confirmation of Eve and Kellogg's (1977) assertion that APC values are indicative of overall herd health.

As pointed out by Eve and Kellogg (1977), APC data can be used to augment other methods of appraising deer populations and in certain situations can be of particular value. For example, since white-tailed deer have an annual fat cycle that reaches its highest peak in fall and early winter (Mautz 1978, Stockle et al. 1978, Kistner et al. 1980) and since the vast majority of information on deer herd health is collected during hunts at this annual peak, conclusions deduced from these data may not be indicative of herd health during more critical periods of the year. Within a short period of time, abundant fall mast can temporarily boost nutrition sufficiently to allow animals in marginal physical condition to acquire relatively large fat deposits. Recent studies further suggest that lipogenesis in white-tailed deer may occur obligatorily, even when deer are on marginal or inadequate diets (Verme and Ozoga 1980*a*, 1980*b*).

This situation places the wildlife biologist in a dilemma from 2 perspectives. First, trends in other parameters of herd health such as body weight, antler development, reproductive rates, and even physical condition, usually become apparent slowly over a number of years and very likely only after the deer herd has had considerable impact on the habitat (Eve 1981). Concurrent or periodic monitoring of APC values along with these parameters may allow biologists to detect impending overpopulation at an earlier stage, since abomasal parasites have high reproductive potentials and thus capable of responding quickly to changes in host density. Second, since almost all "hands on" contact by the public with deer occurs during fall hunting seasons, biologists often encounter difficulty in conveying the concept that there are more deer than the range will support when it is obvious that the deer have substantial fat reserves and nutritious mast is abundant. This situation has been alluded to during other investigations on physical condition (Hesselton and Sauer 1973, Verme and Ozoga 1980*b*). In this instance, APC values can be of great importance in changing public attitude as was noted by Monschein (1977) and Jeter (1979).

An additional example of the usefulness of APC data is that high APCs often presage mortality and provide an indication of the ease and rapidity of transmission of disease agents in the herd (Eve and Kellogg 1977). A recent study (Davidson et al. 1980) revealed that APCs have particular merit with regard to detection of a haemonchosis/malnutrition syndrome that is a frequent disease problem in overpopulated southeastern coastal plain areas.

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