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I am submitting herewith a thesis written by Gary Phillip Tanner entitled "Deer, Soybeans and Farmers: A Socio-Economic Study in West Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

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2

DEER, SOYBEANS AND FARMERS: A SOCIO-ECONOMIC STUDY IN WEST TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

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Gary Phillip Tanner

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ABSTRACT

White-tailed deer (Odocoileus virginianus) numbers are expanding rapidly in Tennessee. West Tennessee, currently supporting the highest deer densities, is extensively cultivated for crops susceptible to deer damage. As deer numbers increase, so also does the potential for negative farmer-deer interactions caused by deer crop damage or, indirectly, by the inconsiderate or dangerous behavior of deer hunters. The objectives of this two-part study were to (I) determine how farmers view the expanding deer herd, gauging their estimates of deer damage to their crops and their tolerance of this damage in exchange for the benefits of having deer on their lands and (II) to evaluate a deer repellent on an area where tenant farmers were reporting heavy crop damage by deer. In Part I, questionnaires were mailed to approximately 35% of the farmers in three west Tennessee counties during February and May, 1983. The useable single-mailing response rate (no follow-up mailings) was 35%. Approximately 41% of all respondents reported no damage to their crops, while the remaining 59% reported light to severe damage. The majority of farmers (62%) reported that they enjoyed having deer in their area. Fifteen percent of the respondents felt that deer were a nuisance. Most respondents favored keeping deer at present population levels. For Part II, Hinder, a commercially available repellent, was selected for study. It is EPA-approved for use on vegetable and field crops intended for human

use. In 1982, four 2-ha soybean fields were used to determine Hinder's effectiveness in protecting commercial soybeans from deer damage. One field in each pair was randomly selected for treatment with Hinder, the second served as a control. Two different fields were used in 1983. One portion of each was treated with Hinder; the other portion acted as a control. Neither plant height nor percentage of stems browsed were significantly different on treated vs. untreated fields. A second aspect of the study utilized .004-ha plots planted to soybeans in 4-row strips in a randomized-complete-block design. Distance between blocks ranged from approximately 0.2 km to 2.4 km. Eighty-two plots in 1982 and 92 plots in 1983 were distributed among 6 blocks. One-half the plots were treated with Hinder; remaining plots acted as controls. Plant height was greater ($p < 0.01$) and percentage of stems browsed by deer was lower ($p < 0.01$) on treated plots during the first 3 weeks of growth in 1982 and 2 weeks of 1983. However, all plants were destroyed by deer after treatment was halted at 3 and 4 weeks of those same years. Results indicate that Hinder may be effective as a repellent on small food plots only in initial stages of growth.

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INTRODUCTION

Depredations by white-tailed deer (Odocoileus virginianus) on agricultural crops were a problem for wildlife agencies as early as the 1930's in the United States (Leopold 1933:283), although Biehn (1951) stated that deer damage problems probably existed before 1920. Dahlberg and Guettinger (1956) noted a correlation between increasing incidence of deer damage and higher deer population levels, and Kittams (1939, in Harder 1968) found indications that deer were more likely to locate crops when population levels were high. Thus, Tennessee farmers may perceive as a mixed blessing the recent success of the deer restoration program fostered by the Wildlife Resources Agency (TWRA) as indicated by the many-fold increase in the number of deer taken by hunters in recent years (TWRA 1983).

Early investigations of deer depredations were biologically-oriented assessments of deer damage sustained by farmers (Decker et al. 1983b). The use of questionnaires to study the sociological impacts of deer damage to crops apparently began in the 1960's (McDowell and Benson 1960, Flyger and Thoerig 1962, West 1963). Recently, New York researchers have conducted extensive examinations of the sociological and management implications of deer and deer depredations within the farming community (Brown and Decker 1979; Brown et al. 1977, 1978, 1980; Decker and Brown 1982; Decker et al. 1981, 1983a,b).

Tennesseans reported "slight" crop depredations in "localized" areas, with damage reported by only 20 to 30 individuals in 1977 (Moore and Folk 1978). As there are over 95,000 farms in Tennessee (Tennessee Crop Reporting Service 1982), these figures would indicate that only .02% to .03% of the state's farmers were having problems with deer, a figure likely to be considered insignificant by anyone but an affected farmer. Six percent and 16% of the state's farm acreage is planted to corn and soybeans, respectively (United States Department of Commerce 1981), both of which are heavily used deer foods (Flyger and Thoerig 1962, Klimstra and Thomas 1964, Korschgen 1954, Mustard and Wright n.d.). The extent of land devoted to these crops, in combination with large areas classified as deer habitat in agricultural counties (over 50% of the land area in most counties--TWRA 1983) and an increasing deer population create a potential for a number of negative farmer-deer interactions significantly greater than reported by Moore and Folk (1978).

Utilizing aversive methodologies to prevent deer depredations on crops is not a new strategy. Scarecrows (True 19323b) and bright objects hung from string (True 1932a) have been used since early times. Carbide guns were in use in the early 1930's (True 1932b), and the rope firecracker was being employed by the 1950's (Dermid 1954). Significant herd reductions, suggested by some (Bump 1949, Baynes 1974, Caslick and Decker 1977) as the best or most practical method of deer damage control, may be precluded on recreation areas where deer are a major attraction to both hunting and non-hunting

groups. Electric fences, advocated as effective means of damage reduction (Craven 1980, Palmer and Wingard 1982, Porter 1983), may also be inappropriate on multiple-use public recreation areas.

Deer repellents are the only other aversive methodologies which have had some measure of success in reducing deer depredations. Powell (1949) reported promising results of a repellent in Maine, as did Thompson and Keener (1951) in Wisconsin. Deer damage losses incurred by the timber and fruit industries have prompted intensive research on the use of repellents to protect seedlings and trees from deer browsing (Champagne 1953, Dietz and Tigner 1958, Harder 1968, Robinette and Causey 1978) and standardized methods for testing and evaluating repellents on regenerating timber have been developed (Dodge et al. 1967, Campbell and Bullard 1972, Campbell and Evans 1977, Gauditz 1977). Deer repellent research on agricultural field crops has not produced such recommended procedures.

Tennessee's increasing deer population and concomitant crop damage problems prompted this 2-part research project. Part I was aimed at developing a current appraisal of west Tennessee farmers' attitudes towards deer and deer damage. Part II was an attempt to evaluate a deer repellent, chosen in consideration of the limitations and restriction imposed by its use on crops intended for human use, grown on a multiple-use recreation area.

PART I

AN ASSESSMENT OF FARMERS' ATTITUDES TOWARDS DEER AND DEER DAMAGE IN WEST TENNESSEE

INTRODUCTION

Tennessee's increasing deer population may create new crop damage or hunter-related problems for the state's farm community. Earlier work (Moore and Folk 1978) suggested that deer were not a significant problem for Tennessee farmers. This study was conducted to obtain a current appraisal of farmers' attitudes towards deer and deer damage in west Tennessee, an area with both high deer densities and intensive cultivation of crops highly susceptible to deer depredations.

CHAPTER I

STUDY AREA

This survey of farmers' attitudes towards deer and deer damage was conducted in Henry, Montgomery and Stewart Counties, Tennessee. These are adjacent counties in the northwestern section of the state, bordered to the north by Kentucky (Figure I-1). Rural in nature, the counties are engaged primarily in agricultural activities. Soybeans, corn and wheat are the most extensively cultivated crops. Percentages of the counties' land bases in farms and mean sizes of farms are 22.7% and 60.3-ha. 55% and 62.3-ha. and 60% and 82.6-ha for Stewart, Montgomery and Henry Counties, respectively (U.S. Department of Commerce 1981).

1. Physiography and Climate

Stewart, Montgomery, and a small portion of Henry County are within the Western Highland Rim physiographic region of Tennessee. The Tennessee River serves as the basic western boundary of both Stewart County and the Highland Rim. The topography of this region is typically dissected and rolling. It is underlain by level beds of limestone (Miller 1974).

Henry County is situated almost entirely in the Coastal Plain physiographic province, the geologic formations of which consists of loose unconsolidated sand, clay, and gravel, compared to the harder rocks of the Highland Rim portion of the county

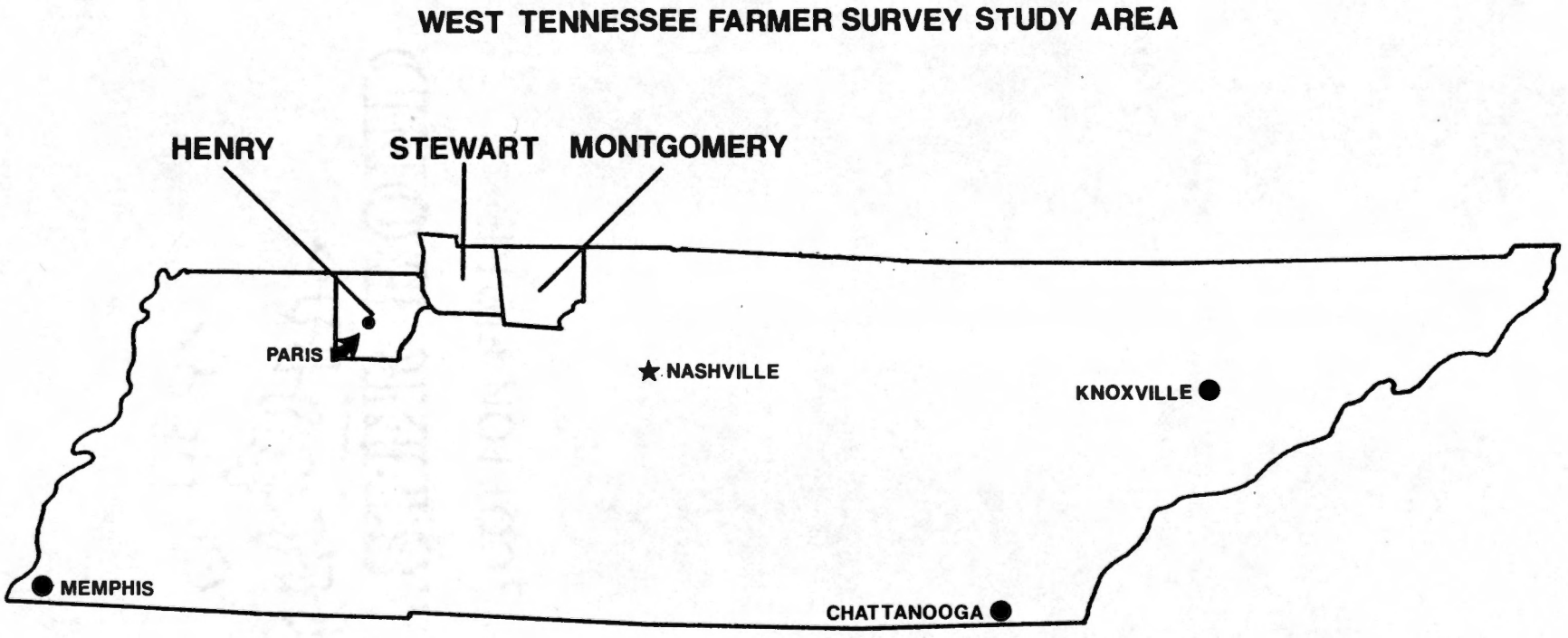


Figure I-1. Location of Henry, Stewart, and Montgomery Counties in west Tennessee.

(Miller 1974). The topography of the county is nearly level in the western part of the state; the eastern part is much more dissected (Wildermuth et al. 1958).

The climate of the area is warm temperate, with long, hot summers and short, cold winters. Average annual temperature is about 15.5°C, and mean annual precipitation is approximately 127 cm (Austin et al. 1953).

2. Deer Population

As a result of TWRA's restoration program, the deer population level in these counties has grown substantially in recent years. In 1964, 367 deer were harvested in the three counties. By 1982, that figure reached 2,008 deer (TWRA 1983).

The TWRA considers 55% of the three counties as deer habitat. Henry County's Deer Index (total deer kill per 1,000 acres of deer habitat) of 7.50 is the eighth highest of Tennessee's 95 counties. Montgomery and Stewart Counties have lower Deer Indices, ranking in the top 25% and 50% of Tennessee counties, respectively (TWRA 1983).

The projected 1983 prehunt deer population levels were 3500, 5500, and 7900 animals for Stewart, Montgomery, and Henry Counties, respectively (L. Marcum, pers. comm.). Population densities for those same counties are approximately 1 deer per 24-ha, 11-ha, and 7-ha of deer habitat, respectively, placing them in the mid to highest density ranges in Tennessee.

CHAPTER II

MATERIALS AND METHODS

A mail-back questionnaire (see Appendix), similar to the pre-tested survey instrument used in New York by Brown et al. (1980), was used to assess farmers' attitudes towards deer and deer damage in Henry, Montgomery and Stewart Counties, Tennessee, during the spring of 1983. Farmers were systematically sampled from a list of growers of small grain and vegetable crops (i.e., crops highly susceptible to deer damage) maintained by each county's Cooperative Extension Office.

Farmers' responses to questions concerning their attitudes towards deer and deer damage were analyzed by county of residence, percentage of income derived from farming, and hunting and hunter-problem status groups using the Statistical Analysis System (SAS)(SAS Institute 1979) and the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975) computer packages. Analysis of variance and Chi-square tests were used to detect significant relationships between variables. The probability of chance occurrence was not to exceed 0.10. Actual significance levels are reported in appropriate tables.

CHAPTER III

RESULTS

1. Farmers' Characteristics

A plurality of farmers (34.2%) derived more than 75% of their income from farming (Table I-1). Farmers in this group were referred to as "full-time" farmers in New York (Brown et al. 1980). They are similarly considered in this study. A significant difference ($p < 0.01$) was detected in total crop acreage reported by farmers in the five income groups. Farmers deriving increasing amounts of their income from their farms reported increasing farm sizes. Crop acreages reported were typically small, however (Table I-2), compared to those in counties in more western Tennessee (U.S. Department of Commerce 1981).

2. Farmers' Responses

Farmers' perceptions and attitudes toward deer damage to crops, deer population trends, aesthetic values of deer, and past relations with hunters were significantly influenced (or related to) the proportion of their total income which they derived from their farming enterprise.

The proportion of farmers reporting damage to crops was greater in the highest income group (HIG) compared to the lowest income group (LIG) in two questions relating to deer damage to

Table I-1. Percentage of Income Derived from Farming by West Tennessee Farmers.

Percent Income Derived	Percentage of Farmers Reporting	
1-10	19.6	(N=64)
11-25	17.4	(N=57)
26-50	14.7	(N=48)
51-75	14.1	(N=46)
76-100	34.2	(N=112)
	100.0	327

Table I-2. Frequency Distributions of Crop Acreages and Woodlands Reported by West Tennessee Farmers.

Crop	Number of Acres	Percentage Reporting
Soybeans	0	35.1
	1-100	41.8
	101-200	12.9
	201-300	5.1
	301-1000	4.8
	>1000	.3
		100.0
Corn	0	37.2
	1-50	38.5
	51-100	11.4
	101-150	5.4
	151-200	3.3
	201-1000	4.2
		100.0
Wheat	0	48.0
	1-50	27.7
	51-100	10.2
	101-150	4.5
	151-200	4.2
	201-1000	5.1
	>1000	.3
		100.0
Hay	0	35.7
	1-50	43.9
	51-100	12.6
	101-200	4.8
	201-1000	3.0
		100.0
Green Vegetables	0	69.7
	.1-1	20.7
	2-10	8.7
	10-75	.9
		100.0
Tree Fruits	0	79.9
	.1-1	10.2
	2-10	5.7
	11-25	3.6
	26-100	.6
		100.0
Woodlands	0	22.2
	1-50	44.3
	51-100	15.2
	101-150	7.8
	151-200	3.3
	201-400	5.7
	401-1000	1.5
		100.0

crops (Table I-3). Almost 57% of the farmers in the LIG estimated that they sustained no deer damage versus about 31% of the HIG. About twice the proportion of HIG farmers (12.3%) compared to LIG farmers (6.3%) felt that the amount of damage they sustained was unreasonable.

Income-derived-from-farming status also appeared to have an effect upon farmers' estimates of the trend of the deer population level over the past five years, and also upon the future population trend they desired (Table I-4). Nearly 70% of the HIG felt that there were more deer now (1983) than five years ago, compared to about 42% of the LIG. The proportion of HIG farmers favoring some level of decrease in the deer herd was almost twice that of the LIG (35.7% and 18%, respectively).

Concerning the aesthetic appeal of deer, members of the HIG appear much more inclined to regard them as a nuisance (22% of the group) than individuals in the LIG (6.3%). Seventy-five percent of the LIG reported enjoying deer, compared to 56% of the HIG (Table I-5).

The proportion of farmers reporting minor problems in the past with hunters was similar among all income groups (41-46% of each group). However, 21.6% of the HIG reported substantial problems in the past, in contrast to only 12.7% of the LIG (Table I-6).

No significant differences among income groups were detected in responses to questions concerning farmers' hunting status or their "land-posting" status.

Table I-3. The Effect of Percentage of Income Derived from Farming upon West Tennessee Farmers' Estimates and Opinions of Deer Damage.

Farmers' Responses	Percentage Income Derived 1-10%	11-25%	26-50%	51-75%	76-100%
Amount of Deer Damage Sustained	(N=62)	(N=57)	(N=47)	(N=46)	(N=112)
No Damage	56.5	56.1	36.2	32.6	31.3
Light	32.3	33.3	34.0	37.0	42.0
Moderate	8.0	7.0	17.0	15.2	16.1
Substantial	3.2	0.0	8.5	13.0	8.0
Severe	0.0	3.6	4.3	2.2	2.6
	x^2=27.015	DF=16	p=0.041		
Feelings About Deer Damage	(N=63)	(N=56)	(N=45)	(N=43)	(N=106)
Not Aware of Damage	57.1	58.9	37.8	23.3	38.7
Negligible	19.1	17.9	26.6	32.5	26.4
Tolerable	17.5	19.6	20.0	30.2	22.6
Unreasonable	6.3	3.6	15.6	14.0	12.3
	x^2=21.616	DF=12	p=0.042		

Table I-4. The Effect of Percentage of Income Derived from Farming by West Tennessee Farmers Upon Their Opinions on Deer Population Size.

Farmers' Responses	Percentage Income Derived 1-10%	11-25%	26-50%	51-75%	76-100%
Deer Population Trend Seen Over Past 5 Years	(N=64)	(N=57)	(N=48)	(N=46)	(N=112)
More Deer Now	42.2	43.9	62.5	60.9	69.6
Fewer Deer Now	12.5	14.0	6.2	8.7	8.9
Same Number	37.5	36.8	29.2	26.1	17.9
Don't Know	7.8	5.3	2.1	4.3	3.6
	x^2=20.134	DF=12	p=0.065		
Deer Population Trend Desired	(N=61)	(N=54)	(N=47)	(N=46)	(N=112)
Great Increase	19.7	5.6	6.4	4.3	11.6
Moderate	9.8	14.8	10.6	15.2	11.6
Slight	14.8	22.2	6.4	10.9	10.7
Remain the Same	37.7	44.4	42.6	35.1	30.4
Slight	11.5	0.0	10.6	2.1	9.8
Moderate	3.3	11.1	8.5	13.0	11.6
Great Decrease	3.2	1.9	14.9	19.4	14.3
	x^2=41.827	DF=24	p=0.014		

Table I-5. The Effect of Percentage of Income Derived from Farming by West Tennessee Farmers upon Their Opinion of the Aesthetic Value of Deer.

	Percentage Income Derived				
Farmers' Responses	1-10%	11-25%	26-50%	51-75%	76-100%
Opinions about Deer	(N=63)	(N=57)	(N=47)	(N=45)	(N=109)
I Enjoy Deer	74.6	75.5	46.9	57.8	56.0
Enjoy but Worry	6.4	7.0	25.5	11.1	15.6
Deer Are Nuisance	6.3	3.5	17.0	26.7	22.0
No Opinion	12.7	14.0	10.6	4.4	6.4
	x^2=35.437	DF=12	p=0.0004		

Table I-6. The Effect of Percentage of Income Derived from Farming upon West Tennessee Farmers' Perceptions of Past Relations with Hunters.

	Percentage Income Derived				
Farmers' Responses	1-10%	11-25%	26-50%	51-75%	76-100%
Farmers' Relations with Hunters	(N=63)	(N=54)	(N=45)	(N=46)	(N=111)
No Problems	44.4	50.0	24.4	34.8	32.4
Minor Problems	42.9	44.4	44.5	41.3	46.0
Substantial Problems	12.7	5.6	31.1	23.9	21.6
	x^2=17.225	DF=8	p=0.028		

Negative past interactions with hunters appeared to be very influential in determining the posting status of farmers' lands and their feelings about deer and deer population trends (Table I-7). Over 75% of the farmers reporting substantial problems with hunters in the past had posted their land, compared to 32.5% of those with no previous problems. Deer were considered a nuisance by 36% of those with substantial hunter problems, compared to only 6.7% of the "no-problem" group. Farmers reporting substantial problems with hunters were much more likely to favor some level of decrease in the deer population than "no-problem" farmers (51.6% and 18.3% of the two groups, respectively).

Significant differences were indicated in opinions about deer and deer population trends between hunting and non-hunting farmers (Table I-8). Hunting farmers were more likely to favor an increase in the deer population level and had more positive feelings about the aesthetic value of deer than non-hunting farmers.

Farmers' responses were also analyzed by grouping them according to the percentage of their croplands they reported as bordered by woods. Farmers indicating a low (0-25%) proportion of their land bordered by woods reported less crop damage than farmers reporting a high proportion (76-100%) of wooded borders in two different questions (Table I-9).

Only the responses concerning the recent trend of the deer population appeared to differ significantly among counties. Farmers in Stewart County were more likely to feel that the deer population

Table I-7. The Impact of Past Experience with Hunters upon West Tennessee Farmers' Attitudes Towards Deer and Deer Hunting on Their Lands.

	Farmers' Experience with Hunters		
Farmers' Responses	No Problems	Minor Problems	Substantial Problems
Deer Population Trend Desired	% (N=120)	% (N=146)	% (N=62)
Great Increase	14.2	9.6	3.2
Moderate Increase	13.3	12.3	9.7
Slight Increase	15.0	14.4	6.5
Remain the Same	39.2	39.0	29.0
Slight Decrease	5.0	7.5	12.9
Moderate Decrease	7.5	10.3	11.3
Great Decrease	5.8	6.9	27.4
	x^2=35.025	DF=12	p=0.0005
Opinions about Deer	% (N=120)	% (N=143)	% (N=61)
I Enjoy Deer	67.5	65.7	40.9
Enjoy but Worry	10.8	12.6	19.9
Deer Are Nuisance	6.7	14.0	36.0
No Opinions	15.0	7.7	3.2
	x^2=37.488	DF=6	p=0.0001
Posting Status	% (N=120)	% (N=140)	% (N=61)
Yes, Land Posted	32.5	59.3	75.4
No, Land Not Posted	67.5	40.7	24.6
	x^2=34.657	DF=2	p=0.0001

Table I-8. The Influence of Hunting Status upon West Tennessee Farmers' Opinions on Deer Population Size and Aesthetic Value.

Farmers' Opinion	Farmers' Deer Hunting Status: Hunted in 1982	Hunt, but Not 1982	Do Not Hunt
Deer Population Trend Desired	(N=95)	(N=43)	(N=192)
Great Increase	15.8	16.3	6.3
Moderate Increase	24.2	9.3	6.8
Slight Increase	16.8	18.6	9.9
Remain the Same	29.4	37.2	41.0
Slight Decrease	5.3	2.3	9.9
Moderate Decrease	3.2	11.6	12.0
Great Decrease	5.3	4.7	14.1
	x^2=44.889	DF=12	p=0.0001
Opinions about Deer	(N=93)	(N=43)	(N=190)
I Enjoy Deer	81.7	67.4	51.0
Enjoy but Worry	8.6	9.3	16.3
Deer Are Nuisance	7.5	14.0	19.5
No Opinion	2.2	9.3	13.2
	x^2=26.931	DF=6	p=0.0001

Table I-9. The Influence of the Proportion of Their Croplands Bordered by Woods upon West Tennessee Farmers' Perceptions of Deer Damage to Crops.

Farmers' Responses	Proportion of Wooded Border 0-25%	26-50%	51-75%	76-100%
Amount of Deer Damage Sustained	(N=90)	(N=84)	(N=99)	(N=49)
No Damage	56.7	34.7	35.3	38.8
Light	32.2	38.1	37.3	40.8
Moderate	7.8	19.1	16.2	4.1
Substantial	3.3	4.8	6.1	14.3
Severe	0.0	2.4	5.1	2.0
	x^2=27.043	DF=12	p=0.007	
Feelings about Deer Damage	(N=87)	(N=82)	(N=94)	(N=49)
Not Aware of Damage	59.7	37.8	38.3	32.7
Negligible	20.7	28.1	21.3	30.6
Tolerable	16.1	25.6	25.5	24.5
Unreasonable	3.5	8.5	14.9	12.2
	$x^2$18.937	DF=9	p=0.025	

had remained the same for the last five years than Henry or Montgomery County farmers, who believed that their numbers had increased. Overall, almost 58% of the farmers felt the population had increased (Table I-10).

Approximately 41% of all respondents reported no damage to their crops, 50% reported light to moderate damage, and 9% reported substantial to severe damage (Table I-11). Over 10% felt that the damage sustained was unreasonable. The majority of farmers (62%) reported that they enjoyed having deer in their area, but 15.4% felt that deer were a nuisance. A slight plurality of the farmers wanted the deer population level to remain the same (Table I-12).

Table I-10. The Influence of County of Residence upon West Tennessee Farmers' Assessments of Recent Deer Population Trends.

Deer Population Trend Seen in Past 5 Years	County of Residence (N=162) Henry	(N=43) Montgomery	(N=133) Stewart	(N=338) All Counties
More Deer Now	64.8	55.6	37.2	57.7
Fewer	4.3	15.1	13.9	9.8
Same Number	27.2	23.3	44.2	27.8
Do Not Know	3.7	6.0	4.7	4.7
	x^2=20.091	DF=6	p=0.003	

Table I-11. Responding West Tennessee Farmers' Opinions about Amount of Deer Damage Sustained and Estimates of Amount of Crop Damage by Deer.

Farmers' Responses	Percentage of Farmers Reporting 10 20 30 40 50 60	%	N
Farmers' Opinions about Amount of Damage Sustained			
Not Aware of Damage	++++++++++++++++++	43.2	139
Negligible	+++++++	24.2	78
Tolerable	++++++	22.4	72
Unreasonable	++	10.2	33
		100.0	322
Farmers' Estimates of Crop Damage by Deer			
No Damage	++++++++++++++++	41.0	137
Light	+++++++++++++++	37.4	125
Moderate	+++	12.6	42
Substantial	+	6.6	22
Severe Damage	+	2.4	8
		100.0	334

Table I-12. Responding West Tennessee Farmers' Opinions about Deer and Opinions on Future Population Trend.

Farmers' Responses	Percentage of Farmers Reporting 10 20 30 40 50 60	%	N
Farmers' Opinions about Deer			
I Enjoy Deer	++++++++++++++++++++++++++	62.0	206
Enjoy but Worry	+++	13.0	43
Deer Are Nuisance	++++	15.4	51
No Opinions	++	9.6	32
		100.0	322
Farmers' Opinions on Future Deer Population Size			
Great Increase	++	10.3	34
Moderate	+++	12.1	40
Slight	+++	12.9	43
Remain the Same	++++++++++++++++	37.1	123
Slight	+	7.6	25
Moderate	++	9.4	31
Great Decrease	++	10.6	35
		100.0	331

CHAPTER IV

DISCUSSION

The objective of this study was to develop a current appraisal of the attitudes of farmers in three west Tennessee counties towards deer and deer damage. Of primary interest were responses related to farmers' perceptions of deer damage to their crops, their feelings about having deer in their area and the future trend of the deer population in their county.

Fifty-nine percent of the farmers surveyed in west Tennessee incurred some level of deer damage to their crops. Almost 70% of the farmers deriving 75-100% of their income from their farm ("full-time" farmers) indicated that deer had damaged their crops to some extent, and over 12% of that group felt that the amount of damage was unreasonable. It must be emphasized that these are farmers' qualitative estimates of damage, not objective appraisals. However, it was the farmers' perceptions and estimates that were of primary interest in this study.

Decker and Brown (1982) found that 68% of the full-time fruit growers they surveyed in New York (a group noted by Decker et al. (1981) to be most sensitive to deer damage in New York) reported deer damage to their crops. Oddly, while 37.3% of that group felt the damage was unreasonable, only 10.5% felt that deer were a nuisance. By contrast, 22% of the full-time Tennessee farmers, and over 15% of all farmers surveyed in this study, felt

that deer were a nuisance. Fifty-nine percent of the New York fruit farmers wanted some level of decrease in the deer population, compared to 35.7% of the full-time Tennessee farmers. Decker and Brown (1982) felt that the high proportion of New York fruit farmers desiring a population reduction was attributable to the impact of significant crop losses due to deer depredations.

Interesting dichotomies occur in the statistics presented above (e.g., the percentage of New York farmers that felt that the damage they sustained was unreasonable was over three times that of the Tennessee farmers, but more than twice the percentage of Tennessee farmers felt that deer were a nuisance). Nonetheless, a pervasive theme occurs: farmers growing high risk crops are concerned and sensitive about deer and deer damage problems, whether they are in the North or the Mid-South.

The observation that Tennessee farmers who derived higher levels of income from their farm were more intolerant of deer and deer damage than their counterparts in lower income groups corresponds with that of Kellert (1981), based on his studies of Americans' attitudes towards wildlife. He stated, ". . . somewhat discouragingly, a direct relationship was found between size of private property ownership, economic dependence on the land, and a willingness to sacrifice wildlife and natural habitat protection to maintain or enhance various human benefits."

Significant yearly increases in the deer population level may have affected the number of deer damage complaints reported between 1978 (Moore and Folk 1978) and 1983 (this study). The

annual deer harvest in the three counties doubled between 1978 and 1982 (TWRA 1983). However, some of the disparity in damage reported to our survey and that reported to Moore and Folk (1978) may be related to farmers' attitudes regarding the agencies conducting the study. Kirby et al. (1981) stated that "farmers . . . have not aligned themselves with wildlife agencies because of uncertainty about whether agency staffs can understand farmers' problems and values." Karbon and Trent (1977, in Kellert 1981) concluded that staff of the Department of Natural Resources (Wisconsin) were often inaccurate in assessing citizens' concerns and views about wildlife. Thus, farmers in Tennessee may have been less reluctant to report problems to an agency with which they shared a working relationship (the Agricultural Experiment Station) than one less familiar to them (TWRA).

Farmers that had a history of problems with hunters expressed significantly more negative attitudes towards deer than their peers with no such previous problems. As Burger and Teer (1981) noted, "Wildlife was a nuisance to some ranchers (farmers) because it forces them to deal with people who wish to hunt." Conversely, it is not surprising to find that west Tennessee farmers that were also deer hunters were more likely to favor an increase in the deer population level, and had more positive feelings about deer, than their non-hunting neighbors.

Characterizations of deer damage to crops in Pennsylvania (Thomas 1954), Maryland (Flyger and Thoerig 1962), and North

Carolina (DeCalesta and Schwendeman 1978) revealed that fields having the greatest proportion of forested edge to crop area received the heaviest deer damage. This conclusion is supported by the response of west Tennessee farmers to questions concerning their estimates of fields bordered by woods and the amount of deer damage to crops they had sustained. Cross-tabulation of the responses revealed that farmers reporting the highest percentages of fields bordered by woods observed the greatest amount of deer damage.

Stewart County farmers were more inclined to feel that the deer population level in their county had remained constant for the past five years, compared to farmers in Henry and Montgomery Counties. A partial explanation for this may reside in the facts that Stewart County has the fewest and smallest farms, and also the least dense deer herd.

CHAPTER V

CONCLUSIONS

Brown et al. (1978, 1979) cited the inequities of "management on the principle of least complaint" (i.e., deer may be managed in order that wildlife agencies receive the fewest farmer complaints about deer). Their data indicated that farmers in New York may be interested in having more deer in their areas than management by least complaint suggests. In western Tennessee, however, farmers may actually be sustaining more damage than is perceived by deer managers, so that "least complaint" management is working against these farmers in a manner diametrically opposed to the New York farmers.

The incentives for a farmer to cope with wildlife are ethereal and sometimes unrecognized: aesthetic values, sporting opportunities, perhaps an important source of food, and an occasional opportunity to lease hunting privileges. The disincentives, however, are glaring and many: damage to crops and/or livestock, nuisance animals, negative interactions with fellow citizens (e.g., hunters, animals'-rights groups) and the myriad social, legal and economic entanglements that may arise from these problems.

Considering the financial difficulties of the farming community today, efforts should be made to ensure that farmers do not bear an additional or excessive burden of damage to their crops by a deer herd managed for other special interest groups. Farmers'

attitudes and assumptions merit close inspection and consideration, since it is evident from this survey that they may be paying an unwanted price for the recreational opportunities of others.

POSTSCRIPT

Deer eat peas,

And so do I,

I don't eat deer,

But some are gonna die.

--Anonymous west Tennessee Farmer
1983

APPENDIX



DEER POPULATION
AND
DAMAGE SURVEY

DEPARTMENT OF FORESTRY, WILDLIFE,
AND FISHERIES
INSTITUTE OF AGRICULTURE
UNIVERSITY OF TENNESSEE
E11-2215-00-002-83

DEER POPULATION AND DAMAGE SURVEY

Research conducted by the
Department of Forestry, Wildlife
and Fisheries
University of Tennessee
Institute of Agriculture
Knoxville, Tennessee

This study is concerned with the effects of deer on your farm, and the number of deer you would like to have in the area in which your property is located.

The code number on the back of the questionnaire is for our reference and indicated the general location of your land in _____ County.

Would the household head please complete this survey at your earliest convenience, seal it (postage has been provided), and drop it in the nearest mailbox? Your responses will remain confidential and will never be associated with your name.

The Institute of Agriculture does not discriminate on the basis of race, sex, color, religion, national origin, age, handicap, or veteran status in provision of educational opportunities or employment opportunities and benefits.

THANK YOU FOR YOUR COOPERATION.

DEER POPULATION AND DAMAGE SURVEY

First, please describe your land:

_1 Please indicate how many acres of your land(owned or leased by you) were in the following crops in 1981 to help us group different kinds of farms together for our results.

Crop	Acres
Soybeans	_____
Corn	_____
Wheat	_____
Hay	_____
Green vegetables	_____
Other farm crops	_____
Woodlands	_____
Tree fruits	_____

_2 What percent of your property lines (owned or leased) are bordered by woods (approximate estimate)?

___0-25% ___26-50% ___51-75% ___76-100%

How many deer are in your area?

_3 What is the largest number of deer you or your family have seen on your land (owned or leased) at any one time in the past 12 months?

number of deer _____

_4 Over the past 5 years, what trend have you seen in the deer population in the area of your land?

___more deer now than 5 years ago

___fewer deer now than 5 years ago

___about the same number of deer as 5 years ago

___don't know

Please describe any deer damage you incurred within the past 12 months:

_5 How would you describe the amount of damage to your crops or woods within the past 12 months?

___none
___light damage
___moderate damage
___substantial damage
___severe damage

_6 Please indicate below crops damaged by deer within the past 12 months and give us your best guess as to the dollar value of any losses. Please indicate also your estimate of the percent of crop value damage.

Crop damaged	Estimated amount of damage	% of crop value lost
_____	$_____	_____%
_____	$_____	_____%
_____	$_____	_____%

_7 What percent of the total value of all your crops listed in question number 1 was lost to deer?

_____%

8 How do you feel about the amount of damage your land received from deer in the past 12 months?

___not aware of any damage

___negligible damage

___the amount of damage was tolerable in exchange for having deer around

___the amount of damage was unreasonable

Deer Damage Control Measures:

9a Have you ever taken any steps to control deer damage to your crops?

___YES ___NO(If NO, please go to question 10)

If "YES" , what have you done and how much did you spend for materials and labor?

Control	Cost($)
___Chemical repellents	_____
___Build or maintain deer fences:	
maintenance	_____
construction	_____
___Devices to scare deer	_____
___Other (specify:_____	
_____	_____
_____)	

9b Which of these methods have you used in the past 12 months?

Control	Check (✓) if used in past 12 months
Chemical repellents	_____
Fence construction	_____
Fence maintenance	_____
Devices to scare deer	_____
Other (specify:_____	_____
_____)	

10 Did you have any notable crop damage caused by wildlife other than deer in the past 12 months?

____YES ____NO

If "YES", please list those wildlife species:_____ _____

_____

11 Which wildlife species, including deer, caused you the most crop damage during the past 12 months? (Please list only one wildlife species):

_____ _____

12 Generally, how do you feel about having deer in your area?(Check one)

___I enjoy having them around

___I could enjoy them, but I worry about them damaging my crops

___They're a nuisance; I could get along without any deer

___No particular feelings about deer

13 Please indicate below whether or not you would like the deer population in your area to increase, decrease, or remain the same: (Check one)

___greatly increase deer populations

___moderately increase deer population

___slightly increase deer populations

___leave deer populations similar to present levels

___slightly decrease deer populations

___moderately decrease deer populations

___greatly decrease deer populations

In what other ways are you affected by deer?

14 Do you hunt deer?

___Yes, I hunted deer in 1982

___Yes, but not in 1982

___No, I don't hunt deer

15 Within the past 2 years, have you had problems with hunters, littering or damaging your property, fences, etc. during deer hunting season?

___No problems

___Only minor problems

___Yes, hunters have done substantial damage

16 Was your property posted during deer hunting season in 1982?

____YES ____NO(If NO, go to question 17)

If YES, why did you post your property? (Check all that apply)

___I like to know who is using my property

___I wanted to reserve the property for family hunting

___I'm afraid someone might get hurt on my property

___I've had problems with hunters in the past

___Other (Please specify)_____

_____

_____

(Circle the most important reason why you posted)

Did you post with "Hunting by permission Only" notices?

____YES ____NO

17 Which of the following groups would you usually allow to hunt deer on your property?(Check all that apply)

___No one

___Your family

___Friends and neighbors

___Strangers who ask

To interpret your answers to previous questions better, we need some background information on how much you depend upon your rural property (owned or leased) for a living. The following information will be kept strictly confidential, and cannot be associated with your name.

18 Do you live on your farm or rural property?

____YES ____NO

19 Approximately what percent of your household's net income was derived from the sale of agricultural or timber products in 1981?

___Less than 10 percent

___10-25 percent

___26-50 percent

___51-75 percent

___76-100 percent

20 Please indicate what town or city your farm or rural property is nearest to:

Town or City_____

Please use this space for any additional comments you wish to make:

THANK YOU FOR YOUR COOPERATION

PART II

AN EVALUATION OF A METHOD FOR REDUCING WHITE-TAILED DEER DEPREDATIONS ON SOYBEANS

INTRODUCTION

Management practices on the Land-Between-the-Lakes Wildlife and Recreation Area (LBL) in western Tennessee and Kentucky by the Tennessee Valley Authority (TVA) have greatly increased the deer population level on that area. Tenant farmers on LBL report increasing losses to deer depredations. Fifty-nine percent of the responding farmers surveyed in surrounding counties reported light to severe deer damage to their crops (Tanner and Dimmick 1983). The area's wildlife managers have difficulty maintaining food plots for bobwhite quail (Colinus virginianus) because of deer damage to those plots. Soybeans and corn, the most extensively cultivated crops on LBL, are very important quail foods in Tennessee (Eubanks and Dimmick 1974) and are also heavily used deer foods (Flyger and Thoerig 1962, Korschgen 1954, Klimstra and Thomas 1964, Mustard and Wright n.d.). This 2-year, 2-part field evaluation of a repellent was conducted in response to the situations and problems inherent at LBL, and it was designed with previous characterizations of deer damage to crops and with a variety of testing methods in mind.

CHAPTER I

STUDY AREA

LBL is situated in western Kentucky and Tennessee between Lake Barkley (formerly the Cumberland River) to the east and Kentucky Lake (formerly the Tennessee River) to the west (Figure II-1). It encompasses about 68,800-ha, approximately one-third of which is in Stewart County, Tennessee; the remaining two-thirds are in Trigg and Lyon Counties, Kentucky. Experimental areas were located in both states (Figures II-2 and II-3).

1. Vegetation

Eighty-five percent of LBL is wooded, with the remaining 15% in open lands (TVA 1973). Approximately 90% of the forested land is occupied by oak-hickory hardwoods. Bottomland hardwoods constitute about 4% of the forested areas; the remaining wooded area is in pine and cedar. Species of both the red and white oak groups (Quercus spp.) are common, along with hickories (Carya spp.), sweetgum (Liquidambar styraciflua), blackgum (Nyssa sylvatica), elms (Ulmus spp.), maples (Acer spp.), and yellow poplar (Liriodendron tulipifera).

Open lands are commonly inhabited by fescue (Festuca elatior), lespedezas (Lespedeza spp.), white clover (Trifolium repens), broom sedge (Andropogon virginicus), beggar ticks (Bidens spp.), and

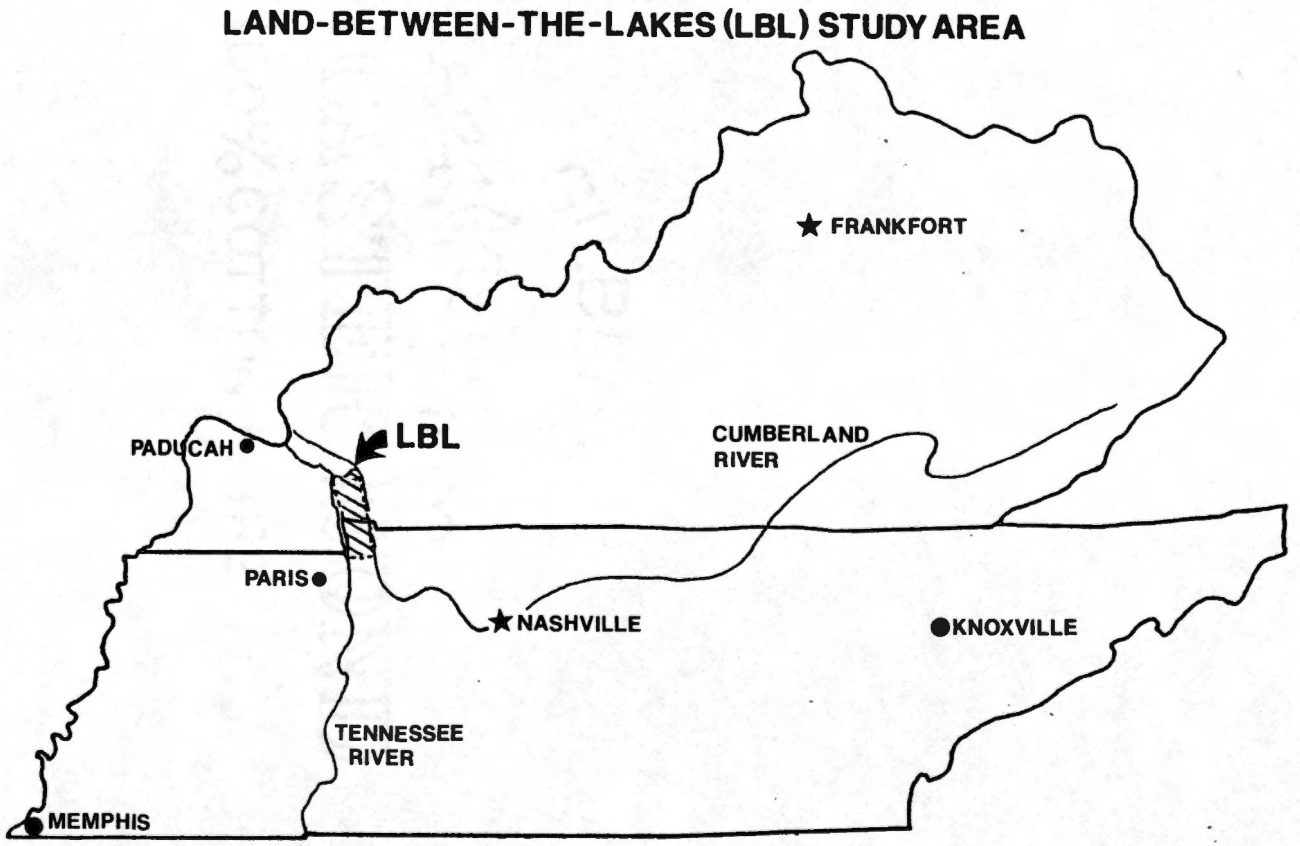


Figure II-1. Location of Land-Between-the-Lakes in Stewart County, Tennessee and Lyon and Trigg Counties, Kentucky.

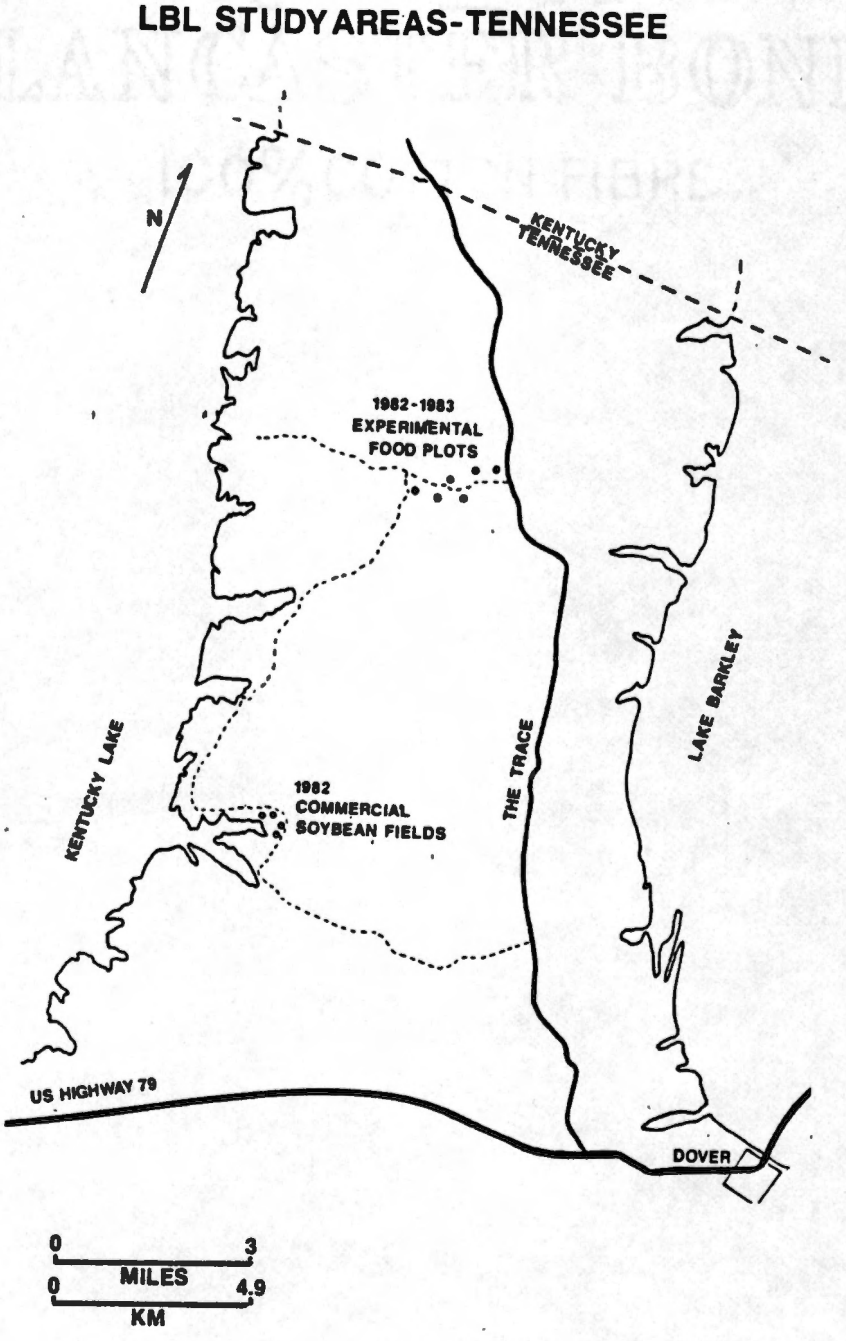


Figure II-2. Location of 1982 commercial soybean fields, and 1982-83 experimental food plots on LBL, Stewart County, Tennessee.

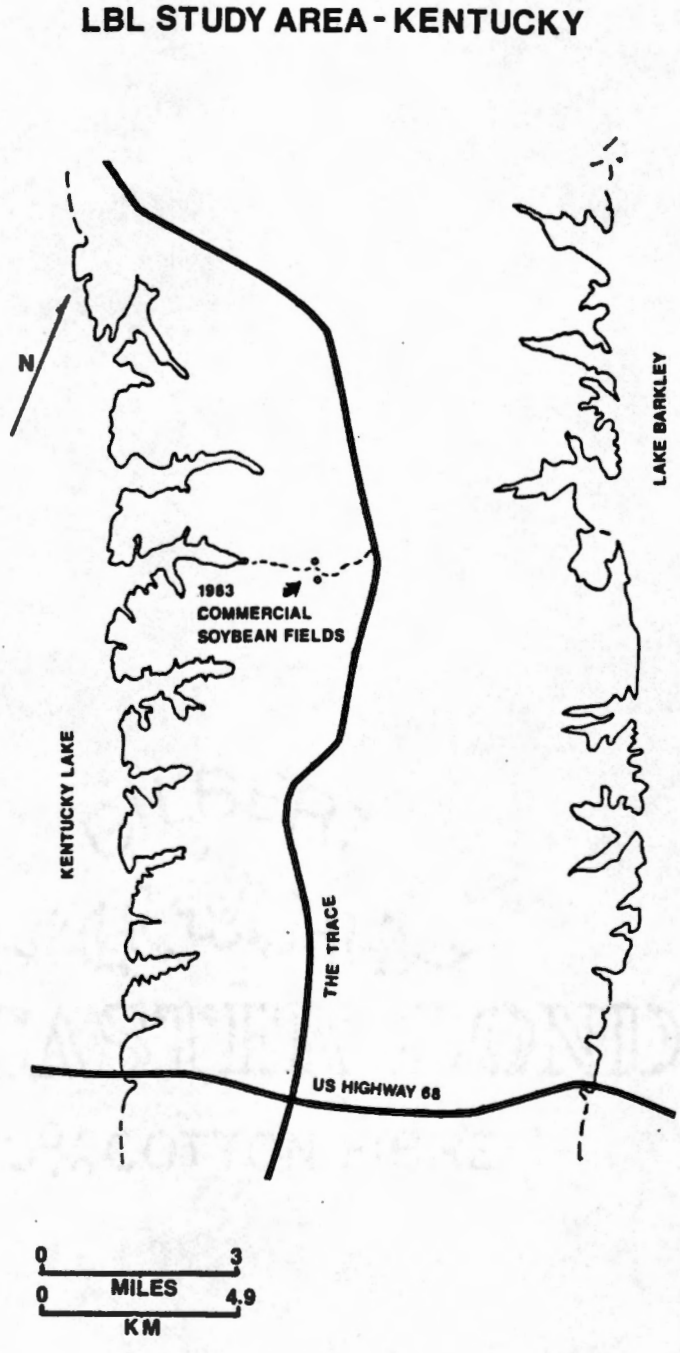


Figure II-3. Location of 1983 commercial soybean fields on LBL, Lyon County, Kentucky.

Johnson grass (Sorghum halepense). About 2,000-ha of LBL are actively farmed.

2. Physiography and Climate

The topography of the study area ranges from narrow creek bottoms to rolling hills. The commercial soybean field studies were conducted in narrow bottoms surrounded by woods on well-drained silt loam soils. They were cultivated by tenant farmers. The small food plots, planted expressly for this study, were established in old fields that were bordered by woods and maintained by occasional mowing. They were on slightly to severely eroded, well-drained cherty loam soil (Austin et al. 1953).

The climate of the region is warm temperate with long, warm summers (mean temperature about 26°C) and moderately cold winters (mean temperature about 4°C). The average frost-free period is 191 days. The annual rainfall is fairly well distributed throughout the seasons, averaging almost 125 cm (49 inches) for the year. Spring rains frequently delay crop planting, but seldom reduce yields significantly (Austin et al. 1953).

3. Deer Herd

The TVA began development of LBL as a multiple-use resource in 1964, with increased sport-hunting opportunities as a primary objective. The deer population was exceedingly low on LBL when it was created. No quantitative population estimates are

available, but TVA deer-hunt records portray the dramatic increase in LBL deer numbers since the mid-1960's.

The first deer hunt on LBL was an archery hunt restricted to the Kentucky portion in 1965. Twenty deer were harvested. The first gun hunt was in Kentucky also; 257 hunters harvested 30 deer.

By 1982, both portions of LBL had 9-day gun hunts. In Kentucky, 7,900 hunters took 710 deer, and in Tennessee, 5,270 hunters harvested 854 deer. The 52-day archery season (approximately 12,400 hunters participating in all) saw 244 and 369 deer taken in the Kentucky and Tennessee portions, respectively, for a total of 2,177 deer harvested.

The 1982 pre-hunt density was estimated to be one deer per 12-14-ha in Kentucky and 8-10-ha in Tennessee, placing them in the highest density range of the region.

CHAPTER II

MATERIALS AND METHODS

1. Deer Repellent

Hinder (Leffingwell Chemical Co., a business of Uniroyal, Inc.), a commercially available odor repellent, was selected for this study on the basis of its Environmental Protection Agency (EPA) label for use in Kentucky and Tennessee on vegetable and field crops intended for human use. It was the only appropriately labeled repellent available in commercial quantities at the time this study was initiated. Harris et al. (1983) reported that Hinder "showed promise" as a deer repellent in a penned-deer study in Pennsylvania, but later work at the same facility (Palmer et al. 1983) refuted that early conclusion.

Hinder is a solution of 15% ammonium soaps of higher fatty acids acting as active ingredients; the remaining 85% of the product consists of inert ingredients. The 1:20 Hinder:water mix recommended by the manufacturer was used for all aspects of this study except for the last 3 weeks of the 1983 small food plot experiment when the concentration was increased to 1:18. All experimental treatments were applied with a backpack sprayer (Solo Jetpak-425 Knapsack Sprayer) as a moderate covering spray that approximated the manufacturer's recommended application rate of 100 gallons of Hinder mix per acre.

2. Commercial Soybean Field Study

In 1982, four approximately 2-ha fields were used to determine Hinder's effectiveness in protecting commercial soybean (var. Bay) crops from deer browsing. They were adjacent fields, separated into pairs by a larger (8-ha) field and bordered by woods (Figure II-4). One field in each pair received two regularly scheduled spray treatments at 1-week intervals, commencing just after plant emergence, with three repeat sprays due to rain (Table A-1, Appendix). The remaining field in each pair acted as a control. Hinder was applied to field edges, as recommended by Klimstra and Thomas (1964) and deCalesta and Schwendeman (1978). It was applied to the first meter of the border vegetation and outer six rows of beans on one field, and to the first meter of border vegetation only on the second field.

Ventilated one-gallon plastic jugs, intended to serve as repellent scent stations and filled with a 1:4 Hinder:water mix, were placed at approximately 30-m intervals around the perimeter of the treated fields. The jugs were refilled as needed due to evaporation throughout the treatment period.

Two different soybean (var. Essex) fields were utilized for the commercial aspect of the study in 1983 (Figure II-5). A 1-ha field was divided into two parts with one part receiving weekly spray treatment of Hinder for 2 weeks (Table A-2, Appendix) to the outer 8 rows of soybeans; the other part served as a control. In a second 3-ha field, two .4-ha plots were established along

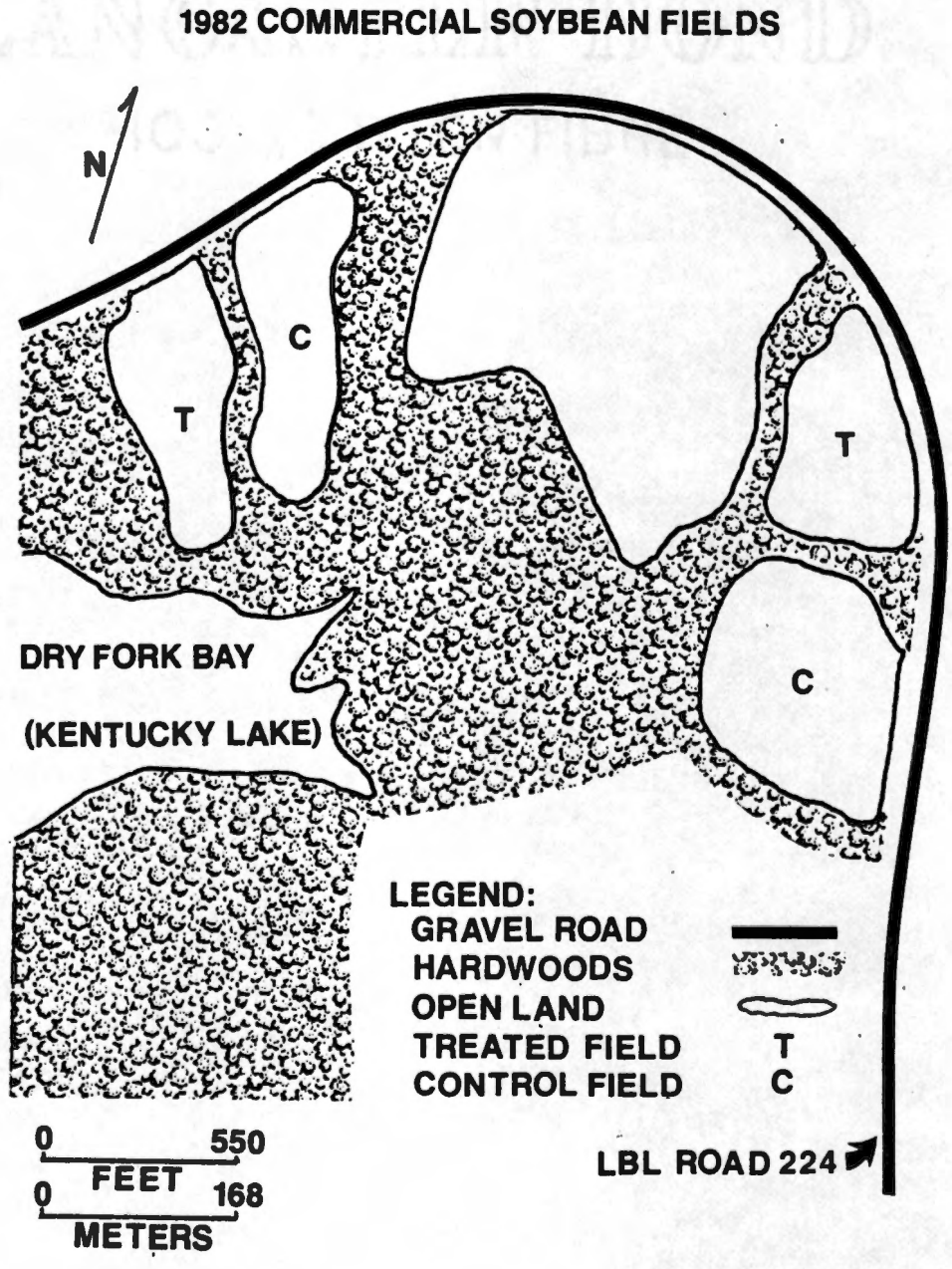


Figure II-4. Arrangement of 1982 commercial soybean fields, Dry Fork Bay, LBL, Stewart County, Tennessee.

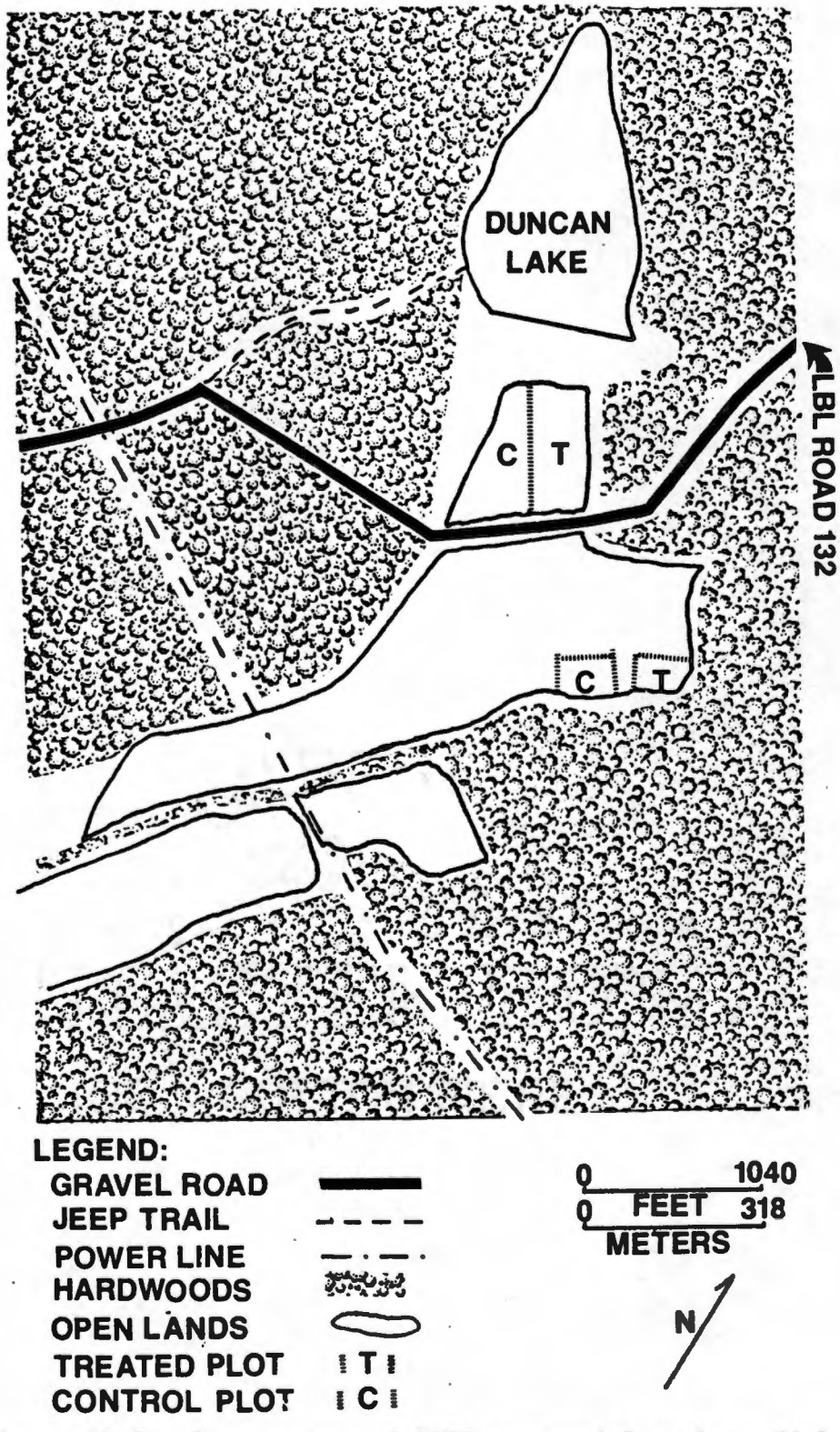


Figure II-5. Arrangement of 1983 commercial soybean fields, Duncan Bay, LBL, Lyon County, Kentucky.

a wooded field edge. One plot received spray treatment identical to that of the first field, the other acted as a control. Ventilated plastic jugs were not used in 1983.

All fields in the commercial study were inspected after each regularly scheduled spray treatment in both years. Contiguous, 7-m long, 4-row-wide plots were laid out along the perimeter of each field. Ten percent of these plots were randomly selected to be sampled for percentage of plants browsed by deer (total number of plants browsed by deer divided by total number of plants available) and plant stem height, a method similar to that of deCalesta and Schwendeman (1978). Only the interior five meters of the two center rows of a plot were sampled. Individual plot design was after that recommended by LeClerg (1971).

3. Food Plot Study

The second aspect of this study utilized .004-ha plots, intended to simulate quail food plots planted to soybeans in a randomized-complete-block design (Sokal and Rohlf 1981). Distance between blocks ranged from approximately .2 to 2.4 km (Figure II-6). The plots were approximately 5 by 10 m in size, containing four 8-m long rows of beans (var. Bay in 1982, essex in 1983). The plots were modeled after those suggested by LeClerg (1971).

In 1982, 82 plots were distributed among six blocks. One-half the plots were treated twice, once at plant emergence and again 1 week later (Table A-3, Appendix); remaining plots served

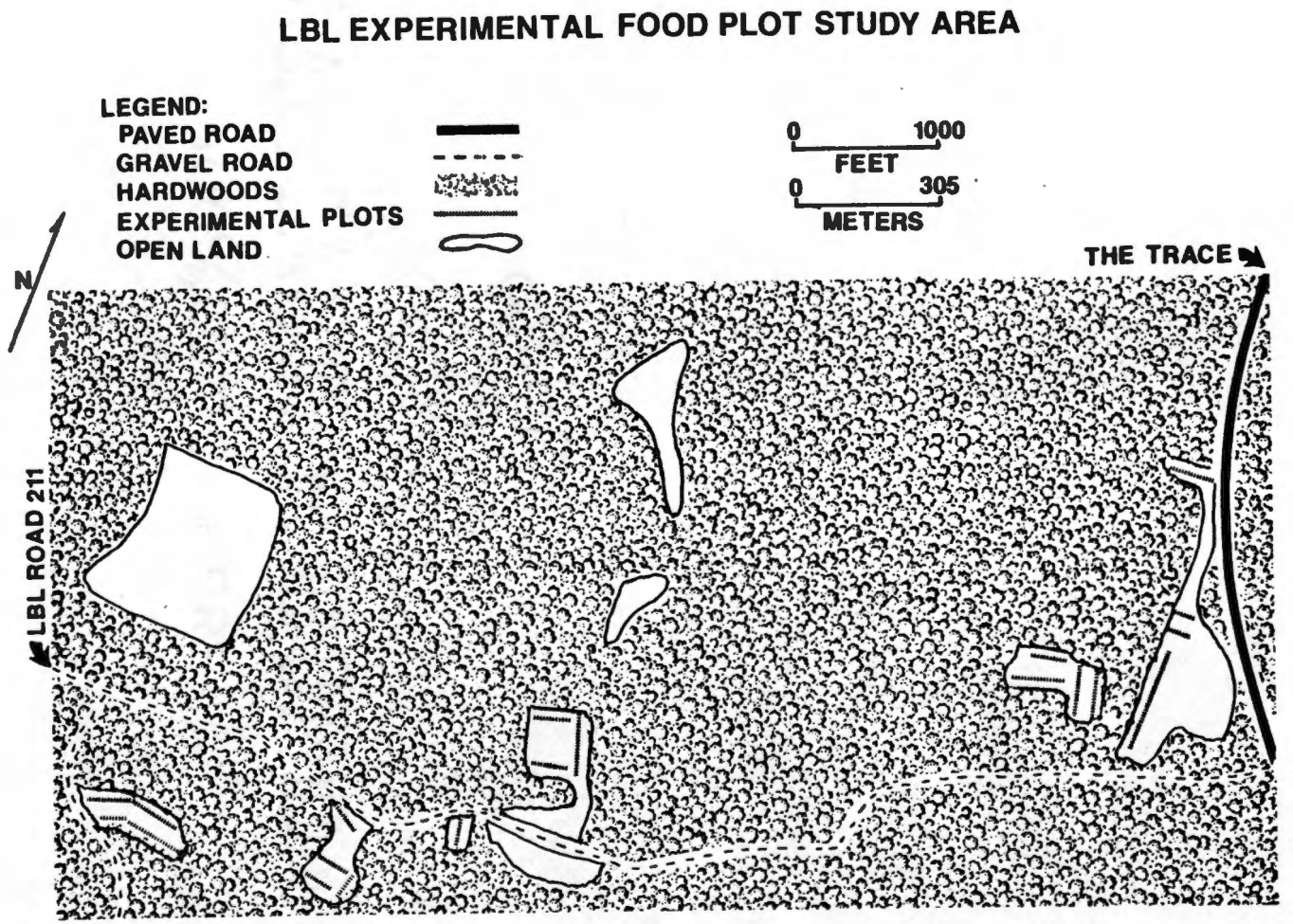


Figure II-6. Arrangement of 1982-83 experimental food plots, LBL, Stewart County, Tennessee.

as controls. Ninety-two plots were established on the same six blocks in 1983. Experimental plots (one-half of the total) were treated at 2-day intervals for 4 weeks, untreated plots again serving as controls (Table A-4, Appendix). All plots in both years were sampled weekly in the same manner as those in the commercial field study.

4. Analysis of Data

Data were stored on a magnetic disc and were edited using The University of Tennessee DEC-System-10 Computer. Analysis was conducted using the Statistical Analysis System (SAS) (SAS 1979) package on The University of Tennessee IBM Series 3071 computer. Analysis of variance (ANOVA) and student's t-test were used to detect significant differences in stem height and in plants-browsed on treated versus untreated plots for both aspects of the study. Data recorded as percentages were subjected to arcsine transformation to provide for independence between variances and means, an assumption underlying the use of analysis of variance and the t-test (Sokal and Rohlf 1981).

CHAPTER III

RESULTS

Hinder's efficacy in preventing deer depredations to soybeans was evaluated on commercial soybean fields and small food plots during 1982 and 1983. Soybean plant stem height and percentage of plants browsed by deer on treated and untreated plots were examined weekly during the treatment period.

1. Commercial Soybean Fields

In 1982, neither plant height nor percentage of stems browsed in the commercial soybean fields were significantly different in treated versus untreated fields during the treatment period when data were submitted to t-test analysis. Mean plant height in sample plots was 5 cm for all fields in the second week after planting, and 9 and 10 cm in untreated and treated fields, respectively, during the third week. The percentage of sampled plants damaged by deer in untreated fields averaged 9% and 52% in weeks two and three, respectively, compared to 4% and 31% in treated fields for the same periods. One treated field lagged far behind the others in plant development due to fescue sod problems, contributing to the lower percentage of stems browsed in the treated fields. The fields were harvested before final field production estimates could be generated.

Deer did not browse any portion of either field used in 1983 during the treatment period; differences in plant height and final yield estimates were not examined.

2. Small Food Plots

In the food plot study, plant height was greater ($p < 0.01$) on treated than on untreated plots for the first 3 weeks of growth in 1982 and the first 2 weeks of growth in 1983. Untreated stems were typically 2 to 4 cm tall when all leaves and the stem tip were browsed by deer, killing the plant. Treated plants often reached 10-15 cm before they were browsed by deer.

The mean percentage of plants in treated food plots damaged by deer was significantly lower ($p < 0.01$) than untreated plots during the same time periods. After one week of growth, only about 29% of the treated plants in 1982, and 22% of them in 1983 were damaged by deer, compared to 78% and 98% in the untreated plots. By the second week of growth, 100% of the plants in all untreated plots had been damaged by deer in both years, versus 30% and 85% of the treated plants in 1982 and 1983, respectively (Table II-1).

Treatment was discontinued after the second week of growth in 1982; all plots were completely destroyed by deer within 7 weeks of plant germination. The treatment period was extended in 1983; 98% of the treated plants were damaged by deer by the end of the third week of growth and all plots were destroyed by deer before treatment was discontinued at the end of the fourth week.

Table II-1. Descriptive Statistics for Food Plot Study, 1982-1983, at LBL.

Date	Plot Type	N	Mean Height (cm)	Minimum Height (cm)	Maximum Height (cm)	Percentage Stems Damaged
1982						
5 June	Treated	41	6	4	9	29
	Untreated	41	4	2	7	78
11 June	Treated	41	12	4	17	30
	Untreated	41	6	2	9	100
1983						
23 June	Treated	46	6	3	9	22
	Untreated	46	4	1	7	98
30 June	Treated	46	11	2	15	85
	Untreated	46	4	1	8	100
7 July	Treated	46	13	2	25	98
	Untreated	46	4	1	8	100

CHAPTER IV

DISCUSSION

The purpose of this study was to evaluate Hinder's effectiveness as a deer repellent on commercial soybean fields and small soybean wildlife food plots. The objectives were to examine the extent of deer damage to treated and untreated fields and plots during initial stages of plant growth and to generate final yield estimates that would reflect the effect of the repellent upon final soybean production.

1. Commercial Soybean Fields

Hinder was not effective in preventing deer depredations on the commercial soybean fields used in this study. Neither plant height nor percentage of stems browsed was significantly different in sample plots on treated versus untreated fields during the first three weeks of growth. The fields used in 1982 were harvested before repellent effects on final yield could be determined, and the fields originally chosen for use in 1983 were not used due to problems caused by late spring rains. Other fields were substituted, but they were not browsed by deer during the treatment period.

This aspect of the study was designed with previously reported characterizations of deer damage to crops in mind. Flyger and Thoerig (1962), Klimstra and Thomas (1964), and deCalesta and Schwendeman (1978) noted that deer depredations to soybeans in

Maryland, Illinois, and North Carolina, respectively, were most numerous and most destructive during the first three weeks of growth; greatest damage occurred during the first week. An 80% reduction in yield occurred when deCalesta and Schwendeman (1978) simulated deer damage to soybeans in the first week of growth. Simulating hail damage to soybeans, Weber and Caldwell (1966) detected a 16% reduction in yield in plants cut off below the unifoliate leaves in the first week. Gibson et al. (1943) concluded that complete defoliation in early growth stages had a significant negative impact on yield in defoliation studies in North Carolina. However, deCalesta and Schwendeman (1978), Camery and Weber (1953), and Todd and Morgan (1972) found that defoliations in later stages of plant growth had significantly less effect on bean production. Therefore, Hinder treatment was discontinued after the second week of growth to determine if plants in this study could sustain browse damage after that time and still be productive.

The lack of any significant differences in the parameters examined in treated versus untreated fields during the sample period, and the fact that the fields were harvested before final yield data could be obtained made resolution of this question infeasible in 1982. The fields selected for treatment in 1983 were not browsed by deer during the sample period, rendering them inappropriate for further investigation.

The ventilated plastic jugs utilized in 1982 were intended to serve as "scent stations" from which a concentrated Hinder odor

would emanate. It was hypothesized that this would decrease deer-use of fields so treated. However, in that year's small plot study, untreated plots in a 4-row strip of soybeans approximately 200 m long were browsed up to the first plants of contiguous treated plots, indicating that there may be very little (if any) odor drift of Hinder. This observation, and the fact that there were no significant differences in the measured parameters between treated and untreated fields in 1982, led to the decision not to use the jugs in 1983.

Deer damage to soybeans in initial stages of growth in this study was characterized by complete defoliation of the plant, repeated browsing on any resprouting leaves, and concomitant plant demise. Because different plots within the fields were examined during each sample, the period of greatest browse activity during this growth phase (2 weeks post-emergence) was not determined. However, browsing was characterized by complete defoliation during both weeks, rendering moot any effort to delineate a "most damaging period."

The habitat surrounding the experimental fields and the size of those fields may have contributed to Hinder's apparent ineffectiveness at LBL. Examinations of deer damage to crops in Pennsylvania (Thomas 1954), Maryland (Flyger and Thoerig 1962), and North Carolina (deCalesta and Schwendeman 1978) revealed that fields having the greatest proportion of forested edge to crop area received the heaviest deer damage. The fields at LBL were

in narrow creek bottoms and were bordered on at least three sides by dense woods. Flyger and Thoerig (1962) found that smaller Maryland soybean fields (2.5-ha or less) sustained greater damage than larger fields (4-ha or more); fields in this study approximated the smaller Maryland fields in size.

Porter (1983) noted that questions concerning the effects of deer density on food supplies are difficult to answer. McCullough (1979) stated that with greater densities, one would predict greater pressure on vegetation. If the deer herd at LBL is at or above the carrying capacity of the area, a situation of unusually intense pressure on food resources may exist. This intense pressure may also have contributed to Hinder's apparent ineffectiveness. This problem, in concert with the aforementioned field situations, may have set the stage for an unusually difficult situation in which to evaluate Hinder's effectiveness.

2. Small Food Plots

Hinder was effective in controlling deer damage to small soybean food plots only during initial stages of growth. Only 29.3% and 21.7% of the plants in treated plots were damaged by deer at the end of the second week of growth in 1982 and 1983, respectively, compared to damage to 78% and 98% of those in untreated plots for those same years.

In 1982, treatment was discontinued after the third week of growth to see if plants at LBL could sustain browse injury after

that time and still be productive, as was indicated by deCalesta and Schwendeman (1978) and Flyger and Thoerig (1962). All plots on LBL were destroyed by deer within 1 month of the last treatment with Hinder.

Treatments of the food plots were greatly intensified in 1983 to determine what application regime would be necessary, regardless of economic considerations, to produce a bean crop on the plots. In spite of the increased number of treatments and an increased concentration of Hinder (to 1:18 from 1:20 parts Hinder-to-water) after the first week, 98% of the treated plots were severely damaged or destroyed by the end of the third week. Plant leaves showed signs of "burning" when treated every other day at the increased concentration; therefore, no further increases in application or concentration were made.

Factors similar to those in the commercial field study (i.e., surrounding habitat, plot size, and deer density) may have added significantly to Hinder's week-by-week decrease in effectiveness on the small food plots. Deer damage to individual plants was also similar to that described for the commercial field study.

CHAPTER V

SUMMARY AND CONCLUSIONS

The effectiveness of Hinder in preventing deer damage to commercial soybean fields and small soybean "quail food plots" on LBL was evaluated in May-June, 1982 and June-July, 1983. Plots and fields were sampled weekly during the treatment period to determine if any significant differences existed in plant height or percent of stems browsed by deer on treated versus untreated areas.

Hinder was not effective in repelling deer from commercial soybean fields during initial stages of growth; final yield data are unavailable to assess its impact on bean production. In the small food plot study, it was only effective during the first three weeks of growth in 1982 and the first two weeks of 1983. After those points, virtually all small food plots were destroyed by deer.

Field evaluations of repellents are logistically difficult to perform, but they are the ultimate test of a product's effectiveness. Problems arise simply by virtue of the fact that the researcher is at the mercy of the vagaries of local weather and unregulated animal behavior. Spring rains may delay or prevent previously selected field planting (as occurred in this study) or summer drought may negate an entire early season effort by significantly reducing or eliminating harvest.

Utilizing the services of independent farmers can also create problems. Justifiably, farmers are concerned first about their own livelihood, secondly about the interests of the researcher. The farmer must be given every opportunity to communicate problem situations to the researcher. Experience gained in this study indicates that this means constant attempts at communication by the researcher to the farmer. In both years of this study, farmers failed to communicate problem situations, resulting in costly wasted efforts and inconclusive results. The use of the personnel of the researcher's own affiliated farm or experiment station would be a highly desirable alternative to independent farmers.

Deer density on the area selected for repellent evaluation may play a significant role in the outcome of the experiment. The deer population at LBL is among the densest in the region; this atypical situation may appear to provide the "acid test" of a repellent's effectiveness, but in fact it does not approximate the deer pressure most often occurring on Tennessee soybean fields, and may have resulted in an unrealistic appraisal of Hinder's effectiveness. Researchers may be better advised to utilize areas with moderate deer densities when attempting to evaluate repellent effectiveness in the field.

Data gathered during this study also indicated the importance of monitoring repellent effects during the entire growth period for multiple years. The 1982 small plot data revealed that Hinder was effective in repelling deer during the first three weeks of

growth, and literature reports noted that soybeans were able to sustain browse injury after that time and still be productive. When treatment was stopped after three weeks of growth in this study, however, all plants were destroyed by deer within 1 month. Any conclusions about Hinder's effectiveness based on early season data would have been erroneous.

Because of the problems and situations cited above, this study's contribution to the fields of wildlife management and deer damage control may not be whether or not Hinder was an effective deer repellent, but rather that the information obtained will add to the knowledge concerning the manner in which sound field evaluations of repellents should be conducted.

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APPENDIX

Table A-1. Chronology of Events on Commercial Soybean Fields at LBL, 1982.

Date	Event
17 May	soybeans planted
21 May	plants emerge
22 May - AM	scheduled Hinder treatment; jugs placed on fields
- PM	rain
23 May	respray due to rain
27 May - AM	sample
- PM	rain
28 May - AM	respray due to rain
- PM	rain
29 May	scheduled spray treatment
31 May	rain
1 June	respray due to rain
3 June	sample

Table A-2. Chronology of Events on Commercial Soybean Fields at LBL, 1983.

Date	Event
12 July	soybeans planted
17 July	plants emerge
19 July	spray treatment
22 July	sample
26 July	spray treatment
27 July	sample

Table A-3. Chronology of Events on Small Food Plots at LBL, 1982.

Date	Event
24 May	soybeans planted
29 May	plants emerge
31 May	spray treatment
3 June	sample
4 June	spray treatment
11 June	sample

Table A-4. Chronology of Events on Small Food Plots at LBL, 1983.

Date	Event
13 June	soybeans planted
17 June	plants emerge
18 June - AM	spray treatment
- PM	rain--.15 inch
19 June	respray due to rain
20 June	respray due to heavy deer damage, PM, 19 June
23 June - AM	sample
- PM	spray treatment
25 June	spray treatment
27 June	spray treatment--Hinder concentration to 1:18
28 June - AM	rain--.4"
- PM	respray
29 June	rain--.1"
30 June - AM	respray
- PM	sample
2 July	spray treatment
3 July - AM	rain--.5%
- PM	respray
4 July	rain--1.1"
5 July	respray
7 July	spray treatment
7 July	sample
9 July	spray treatment
11 July	spray treatment
13 July	spray treatment
15 July	spray treatment
16 July	sample

VITA

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