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**PUBLIC TOLERANCE OF DEER IN A SUBURBAN ENVIRONMENT:
IMPLICATIONS FOR MANAGEMENT AND CONTROL**

by Nancy A. Connelly, Daniel J. Decker, and Sam Wear*

ABSTRACT

A mail survey of residents in suburban northern Westchester County, New York was conducted to determine the nature and extent of deer damage in the county, the importance of deer damage relative to other deer-human interactions, and residents' perceptions of costs and benefits associated with the deer herd. The estimated cost of damage to plantings was quite high, \$6.4 million to \$9.5 million (depending on the type of assumptions concerning nonrespondents). Most respondents used some form of deer damage control (estimated to cost \$1.2 to \$1.8 million/year), but few people reported their problems to officials. Although these costs were high, health and safety risks were of greater concern to county residents than damage to plantings. Deer have many positive values, but a rough economic cost/benefit analysis showed that currently the perceived costs (risk of Lyme disease or vehicular accidents, cost of damage) outweigh the benefits. Educational-communications programs which address concerns such as deer-vehicle collisions or Lyme disease would be most beneficial in improving attitudes toward deer.

INTRODUCTION

As suburban areas of the eastern U.S. expand, habitat for white-tailed deer (*Odocoileus virginianus*) is changing. Deer numbers are increasing and expansion of populations into suburban and urban areas is occurring

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(Flyger et al. 1983). The coexistence of deer and humans in suburban areas frequently results in conflicts due to deer damage to yard and garden plantings, deer-vehicle collisions and other problems.

Farmers' tolerance of white-tailed deer in rural areas has been examined (e.g., Brown et al. 1980, Decker et al. 1984, Flyger and Thorig 1962, Porath et al. 1984, Stoll and Mountz 1983, Tanner and Dimmick 1984), but few studies have examined suburban residents' tolerance of deer. One study examined deer-human interactions associated with the deer herd on Seatuck National Wildlife Refuge in Islip, New York (Decker and Gavin 1987). In that situation there was a small deer herd which had recently (mid '70's) started to move off the refuge into residential areas. The study concluded that deer caused Islip residents problems such as damage to yard plantings and anxiety over Lyme disease, but at the same time, most people enjoyed having deer around (Decker and Gavin 1987).

The situation in Westchester County, New York is different than in Islip. Deer have been present in Westchester County for most of this century. However, since the mid '70's there has been a marked reduction in deer habitat due to commercial and residential development. Thus, as deer habitat is destroyed, deer density on the remaining habitat may be increasing (Glenn Cole, 1987, pers. comm.). Furthermore, in some areas the quality of habitat may improve on land adjacent to developed areas, but deer may move from such land into residential developments where they may cause problems.

These factors have led to increased deer-human conflicts in terms of vehicular collisions and damage to commercial and residential landscaping. Also, Lyme disease has become a serious

public health problem in certain areas. Although deer have been implicated, their role in the transmission of Lyme disease is not well understood. Reported cases have increased county-wide from 175 in 1984, 381 in 1985, 293 in 1986, to 253 for Jan.-July 1987 (Westchester County Dept. of Health, 1987, pers. comm.).

This paper will present the results of a study of property owners in Westchester County designed to examine the nature and extent of deer damage in the county, steps already being taken by residents to alleviate the problems, residents' attitudes about damage and control, the importance of deer damage relative to other deer-human interactions, and residents' perceptions of costs and benefits associated with the deer herd. We will attempt to present information useful to wildlife managers responsible for deer management in suburban environments and Extension personnel responsible for education of publics about management of deer.

STUDY AREA

The study area was the portion of Westchester County generally north of Interstate Highway 287 (Fig. 1). The interstate highway may be a significant barrier for deer, largely preventing them from entering the more densely developed, southern portion of the county. Thus, residents in the southern portion of the county were not contacted because of the low likelihood of exposure to deer in their neighborhoods. For sample selection purposes the southern boundary of the study area was moved slightly north to the political boundaries of the Towns of Mount Pleasant and North Castle west of the Town of Harrison.

The northern portion of the county consists largely of suburban residential communities for the Greater New York Metropolitan Area. Less than 4% of the land area is devoted to agriculture. There are 8 small cities and villages (<20,000 people) in northern Westchester County with high-density, small-lot zoning; some have well-defined downtown areas. These

urban areas have a population density of about 3,000 people/sq. mile (based on 1986 population estimates). Conversely, the remaining portion of northern Westchester County is less densely populated (610 people/sq. mi.) and has larger-lot zoning. We will refer to this area as suburban/rural. People owning land in this area were more likely to have contact with deer on their property than those living in the urban areas. Thus, two demographic categories of interest emerged: (1) urban--those selected city and village jurisdictions, and (2) suburban/rural--all remaining less populated areas (Fig. 1).

METHODS

A sample of 500 property owners was systematically selected from the residential property tax rolls for towns in each stratum (suburban/rural and urban areas). A self-administered, mail-back, booklet-format questionnaire was developed for this study based on the questionnaire used by Decker and Gavin (1985) in Islip, New York. Questions addressed the following specific information needs of this study:

- (1) characteristics of property owners and their property;
- (2) perceptions of deer and deer damage to yard plantings;
- (3) economic impact of deer damage to yard plantings;
- (4) actions taken in response to deer damage; and
- (5) underlying beliefs and attitudes about wildlife.

The mail survey was implemented by the Westchester County Department of Planning in early spring 1987. A procedure using up to 3 follow-up mailings to nonrespondents was employed. In addition, telephone interviews were conducted with 38 nonrespondents to assess nonresponse bias.

The data were weighted to reflect the proportion of residential properties in each stratum. Analysis was conducted using the SPSSX computer program package (SPSS Inc. 1983).

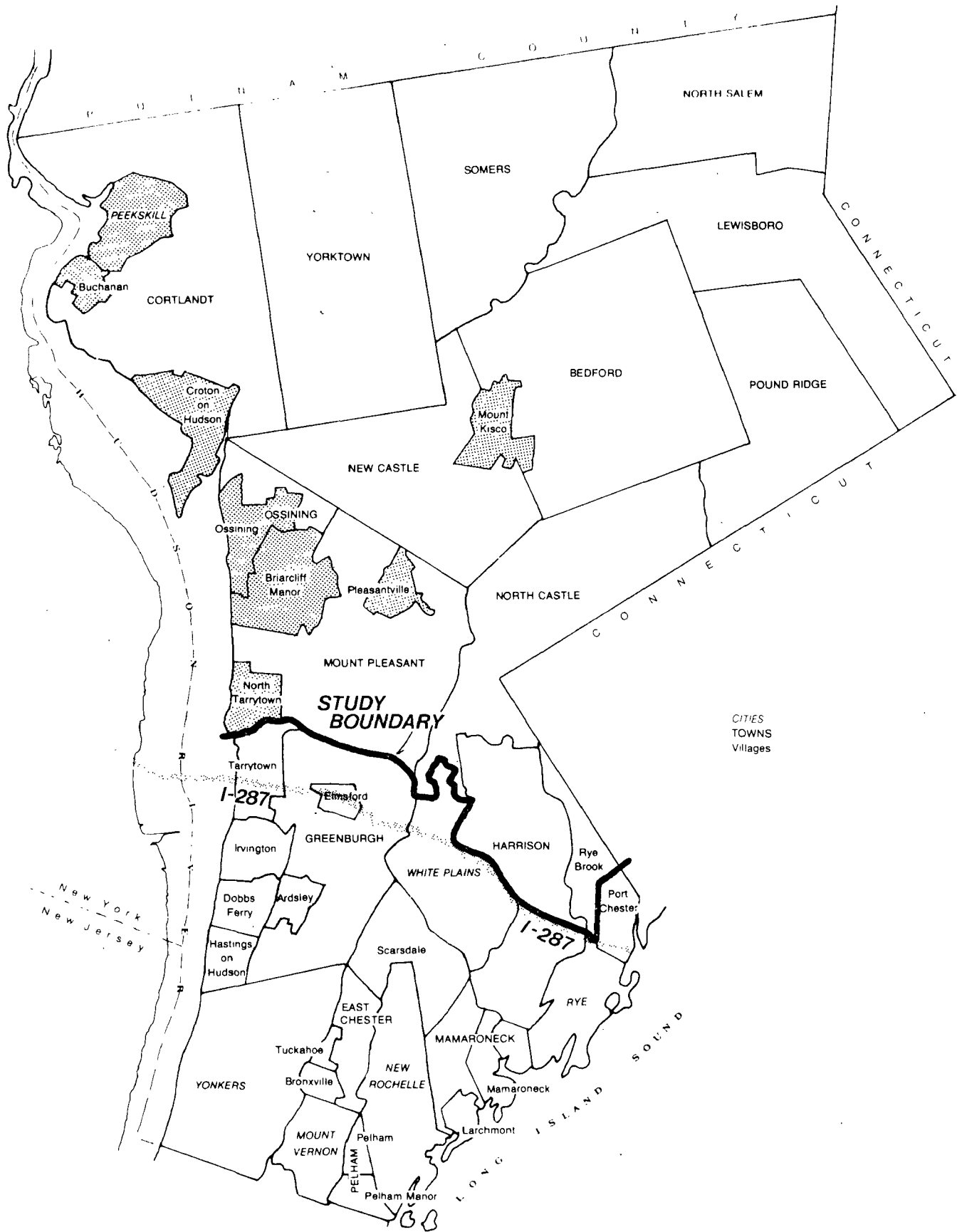


Figure 1. Location of study area in northern Westchester County (urban areas are shaded).

RESULTS AND DISCUSSION

Survey Response

The survey of 1002 households had 34 undeliverable questionnaires and 684 useable responses, for an adjusted response rate of 70.7% of deliverable questionnaires. Of the respondents, 361 were in the suburban/rural stratum and 310 were in the urban stratum (13 were unclassifiable because of obliterated identification numbers). The telephone follow-up of nonrespondents indicated these people differed little from the mail-survey respondents. Based on the similarity between respondents and nonrespondents, weighting for nonresponse bias was considered unnecessary.

Nature and Extent of Deer Damage

In northern Westchester County most residents had shrubs or other woody ornamentals (90%) as well as flowers (69%), and vegetable gardens (47%), while suburban/rural residents were more likely than urban residents to have fruit trees on their property (47 vs. 35%). Two-thirds of the suburban/rural respondents (66%) had seen a deer or evidence of deer feeding on their property in the last year, whereas less than one-third (28%) of urban respondents reported a similar experience. Of those who had seen deer on their property, 75% incurred damage to plantings regardless of whether their property was in the suburban/rural or urban area. Overall, 43% of respondents reported some type of plant damage.

Among Westchester County residents who experienced deer damage, reports of damage to shrubs/ornamental woody plants was most common (81%), followed by vegetable gardens (53%), fruit trees (52%), and flowers (48%). For respondents with damage to a particular category of plants, the mean percent of plants damaged was as follows: flowers - 52%, garden vegetables - 51%, shrubs/ornamental woody plants - 33%, and fruit trees - 26%. Sixty percent of respondents with damage to flowers, 57% with shrub damage, 56% with vegetable damage and 35% with fruit tree damage

either had replaced or needed to replace plants that were damaged.

Average costs of replacement for the categories of plants were \$94 for garden vegetables, \$102 for flowers, \$156 for fruit trees, and \$635 for shrubbery (i.e., per individual reporting damaged plants needing replacement). Replacement-cost estimates averaged \$34 per fruit tree and \$47 per shrub or woody ornamental plant. These estimates were similar to the replacement costs typical of Westchester County nurseries and landscaping services; fruit tree estimates were slightly lower, shrubs slightly higher. (Estimates of replacement costs for fruit trees and shrubbery, in particular, may not reflect replacement of what was actually lost, but rather putting in young stock that may take some years to reach the same level of maturity as those damaged.) The average costs of replacement were used to estimate the total cost of replacement for the northern portion of the county. In this estimate, 4 assumptions were made: (1) respondents' estimates of replacement cost were reasonably accurate, (2) damage not severe enough to require replacement was not reported, (3) those who said a plant type needed replacement but did not provide a cost estimate sustained an average replacement cost for that plant type, and (4) all members of the sample who had plants in need of replacement responded. An alternative to assumption 4 is that nonrespondents sustained deer damage to the same extent as respondents. This may be valid in that we found no difference between respondents and a sample of nonrespondents (surveyed by telephone) in terms of the percent with deer damage. Results will be presented for each of these 2 alternative assumptions.

Replacement costs for each plant type were calculated by multiplying the mean cost of replacement by the number of people who needed to replace that plant type, then expanding the total cost for the sample households to represent all northern Westchester

County households. This was done for each plant type and then summed for an estimate of total replacement costs due to deer damage of \$6.4 million (assuming nonrespondents had no deer damage) or \$9.5 million (assuming nonrespondents had deer damage). The 90% confidence interval around these estimates was \$4.2 million to \$8.6 million for the former and \$6.3 million to \$12.7 million for the latter. Replacement costs for shrubbery contributed the most to this estimate (approximately 85%).

Another cost of deer damage was that for control. Fifty-two percent of respondents with plant damage used some method of deer damage control, with fencing and repellents reported most frequently. Expenditures of up to \$2,500 were reported for control over the 12 months preceding the survey, but most people reported much lower costs (median = \$45). By expanding to the county population under the 2 alternative assumptions discussed above, an estimated \$1.2 or \$1.8 million dollars was spent on deer damage control during the year preceding the survey. Thus, the estimated costs of deer damage incurred plus control measures totalled about \$7.6 or \$11.3 million (90% confidence intervals of \$5.2 to \$10.1 or \$7.7 million to \$15.0 million).

Few respondents who had observed deer feeding or found evidence of such activity on their property reported damage to any official (4%). More respondents sought information on deer damage controls (30%). Retailers of control supplies and landscaperservices were cited most often as sources of information (54% and 47%, respectively). Commercial pest control operators and friends were also frequently cited as sources of information (21% and 23%, respectively).

Attitudes About Deer Damage

Striking differences occurred between the suburban/rural and urban residents (who had seen deer or deer sign on their property) in their impressions of the severity of deer

damage. Eighty percent of the urban residents described the level of damage as light or none compared with 57% of the suburban/rural residents (Fig. 2). The greatest percentage of both urban and suburban/rural residents felt their damage was tolerable, but more suburban/rural than urban felt their damage was unreasonable (Fig. 3).

Average dollar estimates for plant replacement between those reporting tolerable versus intolerable damage (means: \$343 vs. \$994; medians: \$100 vs. \$400) indicated that intolerance of deer damage was associated with considerably higher amounts of damage. Seventy-five percent of those with tolerable damage reported estimates below \$220 while 75% of those with intolerable damage reported estimates above \$220 (Fig. 4). Therefore, for the majority of respondents with damage, \$220 may represent a threshold of damage tolerance.

Residents' Concerns and Attitudes About Deer

Health and safety risks associated with deer were more important concerns to residents than deer damage. Overall, 2 to 3 times more respondents expressed concerns about deer-vehicle collisions and Lyme disease than about plant damage (Table 1). Even among those who reported deer damage, deer-vehicle collisions and Lyme disease were listed more often than damage as a primary deer-related concern. Those who had never seen a deer on their property or who had seen deer but reported no plant damage were more concerned about deer-vehicle collisions than Lyme disease, while those who experienced deer damage were 1 1/2 times more likely to have Lyme disease than deer-vehicle collisions as their primary concern. Thus, from the perspective of a "primary" concern, even for respondents who experienced deer damage to plantings, such damage was a minor consideration compared with the personal health and safety of respondents and their families.

The pervading attitude toward deer among respondents was favorable; 85% enjoyed having deer in their

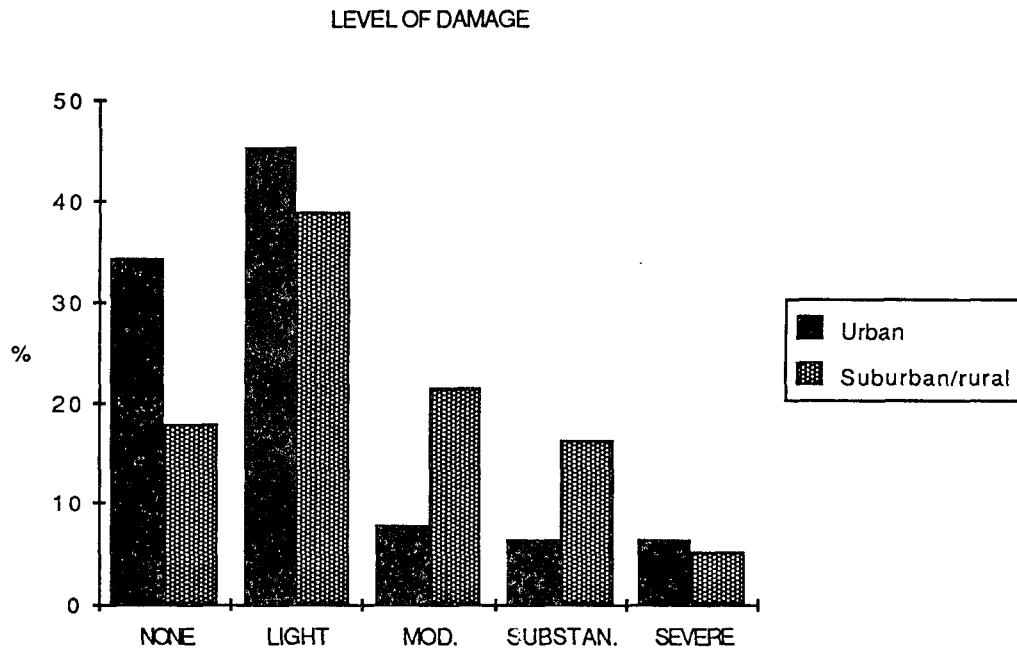


Figure 2. The level of deer damage reported by respondents who had seen deer or deer sign on their property.

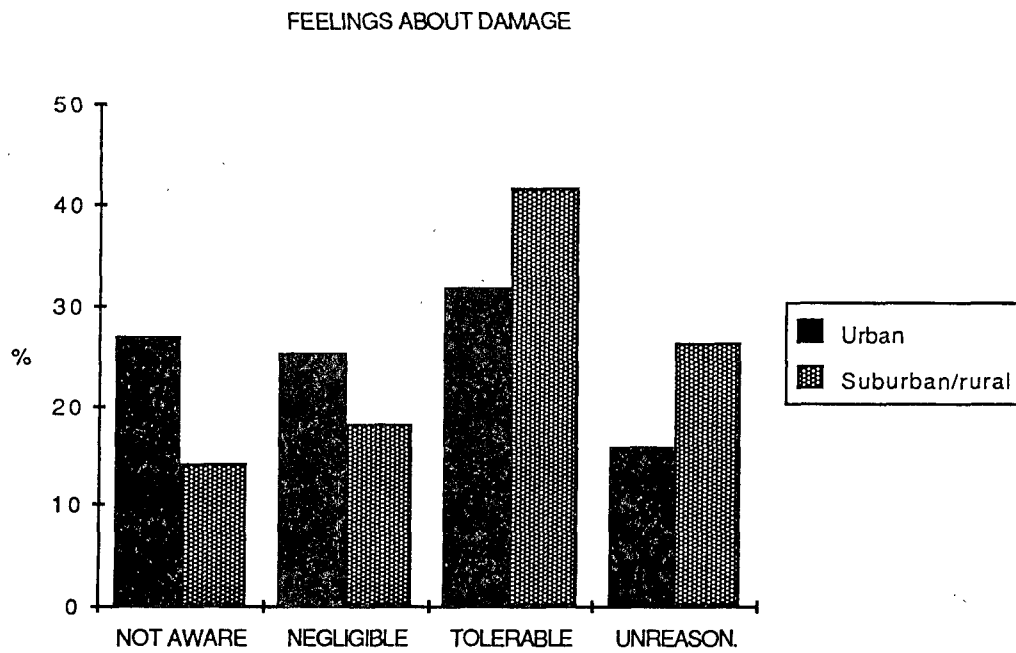


Figure 3. Respondents' feelings about deer damage by survey strata.

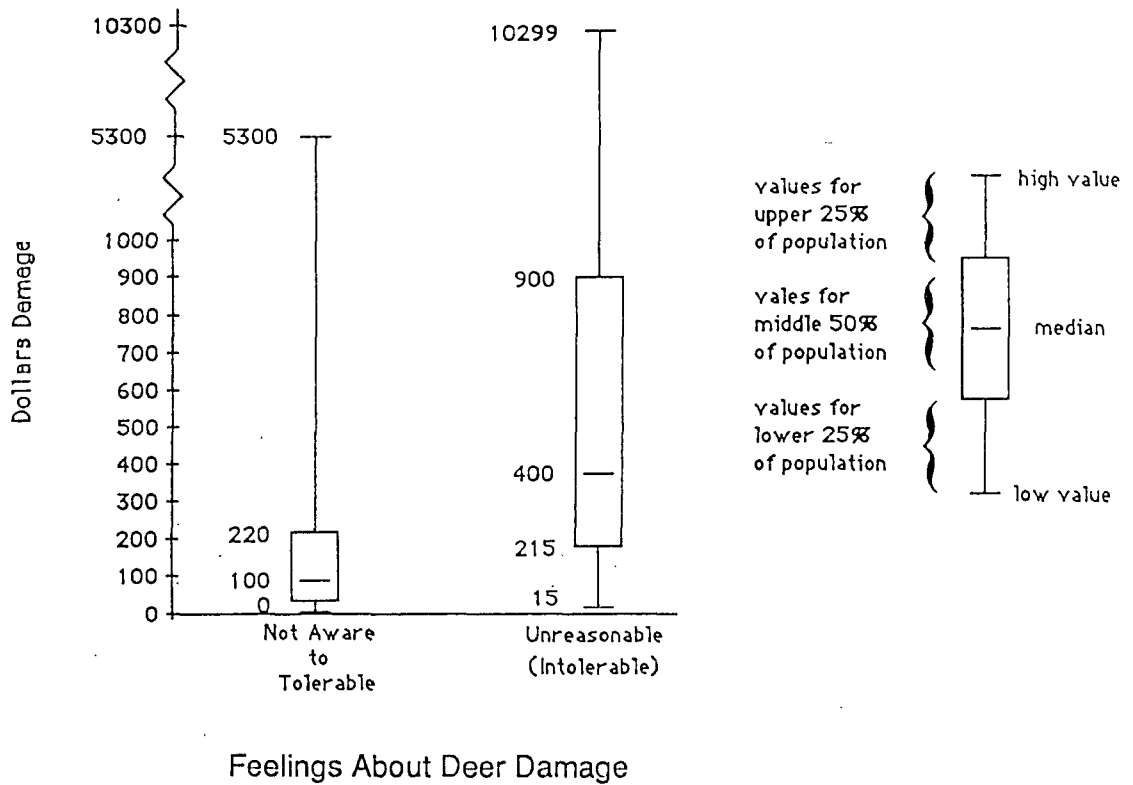


Figure 4. Estimates of total dollars of damage, by tolerance of damage.

Table 1. Deer-related concerns of Westchester County residents.

Concerns	Westchester County residents		Suburban/rural residents		Never saw deer on Property	Saw deer or sign on property	Reported deer damage
	Primary concern ^a	Primary concern	Urban residents Primary concern	Suburban/rural residents Primary concern	Primary concern	Primary concern	Primary concern
Percent							
Deer-vehicle collisions	71	38	30	41	42	53	29
Lyme disease transmission	63	39	42	38	35	35	44
Damage to garden and yard plantings	27	6	2	7	0	2	14
No concerns	15	17	26	14	23	10	14
		100%	100%	100%	100%	100%	100%

^aData under this category does not sum to 100% because respondents could give multiple concerns.

neighborhood. However, over 60% of those who enjoyed deer also worried about problems deer might cause. Nevertheless, only 8% did not enjoy having deer in their area and regarded them as a nuisance. Generally, those who had no concerns about deer enjoyed them and did not worry about potential problems (73%), whereas those with concerns about Lyme disease or damage to plantings tended to worry about problems or think deer were a nuisance (Table 2).

Respondents' preferences for future deer population trends in their area can be used as a general indication of their beliefs and attitudes about deer. Using this indicator, almost equal numbers of respondents wanted the population to remain at its current level (42%) or wanted a decrease (40%). Those who unconditionally enjoyed deer

wanted the population to increase or remain at its current level, while those who enjoyed deer but worried about problems wanted the population to decrease or remain at its current level (Table 3). Those who thought deer were a nuisance generally wanted a moderate decrease in the population.

Similarly, respondents' future population preferences differed according to their primary deer-related concern (Table 4). Those whose primary concern was damage to plantings wanted a decrease in the population (82%). Fewer giving Lyme disease transmission as a primary concern wanted a decrease (45%), and even fewer giving deer-vehicle collisions as a primary concern wanted a decrease (34%). Among those having no concerns, nearly 50% wanted the population to stay the same while 39% wanted an increase.

Table 2. Westchester County residents' attitudes about the presence of deer by primary concern.

Primary deer-related concern	Attitude about deer				n
	Enjoy deer, do not worry	Enjoy deer, but worry	Do not enjoy, nuisance	No particular feelings	
	Percent				
Deer-vehicle collisions	43.5	44.2	6.0	6.3	208
Lyme disease transmission	13.6	72.4	8.1	5.9	213
Damage to plantings	12.5	61.2	24.9	1.4	34
No concerns	72.9	9.0	1.1	17.0	92

Table 3. Westchester County residents' preferences for the future deer population trend by their attitude about deer.

Attitude about deer	Preferred deer population trend					n
	Moderate increase	Slight increase	No change	Slight decrease	Moderate decrease	
	Percent					
Enjoy deer, do not worry	27.9	14.7	46.2	8.3	2.9	213
Enjoy deer, but worry	3.1	3.9	42.3	25.1	25.6	332
Do not enjoy, nuisance	0.0	2.9	0.0	10.7	86.4	50
No particular feelings	1.2	3.5	64.3	15.4	15.5	41

Table 4. Westchester County residents' preferences for the future deer population trend by primary concern.

Primary deer-related concern	Preferred deer population trend					n
	Moderate increase	Slight increase	No change	Slight decrease	Moderate decrease	
Deer-vehicle collisions	12.3	7.1	46.4	18.8	15.4	202
Lyme disease transmission	7.5	6.1	41.1	18.0	27.4	207
Damage to plantings	0.0	4.2	13.9	31.9	50.0	34
No concerns	23.1	15.7	49.5	7.9	3.9	86

In summary, people who enjoyed deer and did not worry about problems generally wanted deer numbers to remain at their current levels or increase. People who enjoyed deer but worried about the disease or damage potential, or who considered deer a nuisance, generally wanted fewer deer.

Value of Westchester County Deer Herd

To estimate the economic value of the local deer herd to Westchester County residents, with regard to deer damage to plantings only, we can derive dollar estimates to correspond to the attitudinal data. (This does not include societal benefits such as ecological value, scientific value, educational value.) This can be useful for decision-making; the relative benefits of one type of management or educational program over another can be assessed by impacts on value (i.e., dollars) added or diminished.

The first step in this procedure is assigning a reasonable dollar value of the deer resource to an individual household. For our purposes, we regarded each respondent as representing a household, because the sample was selected based on property-tax records. The positive value of deer to be assigned for each household that reported "I enjoy having deer in my area and I do not worry about problems deer may cause" was determined from our only dollar estimates of deer-plant damage sustained from deer that was considered "tolerable in exchange for having deer around". This measure

then was a surrogate for the sum of all the positive values associated with deer. Because the ranges of dollars of damage overlapped for those who considered their damage tolerable and those who considered their damage intolerable, we looked for a damage threshold value. Above the threshold were the majority of people with intolerable damage and below the threshold were the majority of people with tolerable damage. We chose \$220, below which were 75% of those with tolerable damage and above which were 75% of those with intolerable damage (refer back to Fig. 4). We assumed that this value represented the amount of damage people (i.e., an average household) were willing to tolerate in return for having deer in their neighborhood and used it as a base in the remainder of these calculations.

To determine the total positive value of the deer herd to northern Westchester County residents, we multiplied \$220 by the number of households where respondents unconditionally enjoyed deer in their area. To be conservative, we did not include those who enjoyed deer but worried about problems such as Lyme disease or deer-vehicle collisions. Because we did not receive responses from every household in the sample, 2 scenarios were possible. One was that those who did not respond were disinterested in deer (i.e., assigning them a value of 0) and the other (based on no differences between the respondents to the mail survey and

respondents to the telephone follow-up) was that those who did not respond were equally as interested in deer. We also calculated the total value of deer once for respondents who had seen deer on their property (n=120) and a second time by also including those who had not seen deer on their property (n=218 [98 + 120 = 218]). The value of deer to households expanded to a northern Westchester County total is shown in Table 5 for the possible combinations of assumptions.

The costs of the deer herd can be thought of as the total damage incurred by those who considered their damage intolerable minus the tolerable portion of that damage (\$220/household) plus the cost of damage control. This amount expanded to the total population of people in the northern portion of Westchester County was \$4.0 million (assuming nonrespondents had no deer damage) or \$5.9 million (assuming

nonrespondents had a similar amount of damage as respondents).

This amount was then subtracted from the positive value to arrive at a net value under each of the 4 assumptions presented earlier. It can be seen from Table 6 that by using any of the assumption combinations, at this point in time, the damage caused by deer outweighs the benefits of those deer.

Obviously, the assumptions made and the procedure used to arrive at the value estimates should be reviewed critically. Nevertheless, we offer this for consideration primarily to raise awareness of a broad concept of costs and benefits associated with the Westchester County deer herd.

IMPLICATIONS

These findings can be used in deer-related management decisions. For example, if the perceived Lyme disease

Table 5. The total value of the deer herd to northern Westchester County residents under 4 different assumptions.

	Nonrespondents Disinterested in Deer (expansion factor = 63.3)	Nonrespondents Interested in Deer (expansion factor = 94.4)
Seen deer on property (n=120)	\$1.7 million	\$2.5 million
Seen + had not seen deer on property (n=218)	\$3.0 million	\$4.5 million

Table 6. The net value of the deer herd to northern Westchester County residents under 4 different assumptions.

	Nonrespondents Disinterested in Deer and No Deer Damage	Nonrespondents Interested in Deer and Had Deer Damage
Seen deer on property	-\$2.3 (\$1.7-\$4.0)	-\$3.4 (\$2.5-\$5.9)
Seen + had not seen deer on property	-\$1.0 (\$3.0-\$4.0)	-\$1.4 (\$4.5-5.9)

hazard could be overcome, and people realized (e.g., via an educational-communications program) that by driving carefully deer-vehicle collisions could be reduced to being a negligible concern, the proportion of those who unconditionally enjoy deer would increase, and thus the value of the deer herd would increase from -\$1.4 million to \$5.7 million. Another use of these dollar estimates would be in establishing the level of resources to allocate to a deer damage control program. The cost of the deer herd in terms of intolerable damage (minus the tolerable portion) was \$2.8 million or \$4.1 million (depending on the type of assumptions made). Therefore, an expenditure for deer damage control that results in a reduction of up to \$2.8 million or \$4.1 million of damage annually would be warranted, as long as the associated costs did not exceed this amount.

Another way of considering the value of the deer herd is by looking at cost per deer. Precise deer population estimates for Westchester County do not exist, but a number often quoted is 4,000 to 6,000 deer (Merrill 1987). By dividing the intolerable portion of damage (\$2.8 or \$4.1 million) by the number of deer (4,000 to 6,000), we arrive at a cost range of \$467 to \$700/deer (for \$2.8 million) or \$683 to \$1,025 (for \$4.1 million). Recent estimates for various deer removal techniques used elsewhere in urban areas suggest a much lower cost to remove deer; e.g., shooting over bait \approx \$75/deer and live removal by dart gun and transfer \approx \$180/deer (Ishmael and Rongstad 1984). The most cost-effective method of managing deer would be through regulated recreational hunting where firearms are used. This approach has virtually no cost above that incurred by the individual hunter for licenses, equipment, transportation, etc. Thus, a deer herd properly managed through recreational hunting with firearms, the approach used for deer population management throughout most of New York south of the Adirondack Region, would have a significant net economic benefit in

Westchester County. However, the political feasibility of initiating recreational hunting with firearms in this particular suburban situation is uncertain.

CONCLUSIONS

The various dimensions of managing the deer herd in northern Westchester County are challenging and complex for both the wildlife biologist and the Extension educator. Based on the findings from this study, it is apparent that deer cause significant problems for some Westchester County residents. The estimated cost of damage to plantings was high, possibly between \$6.4 and \$9.5 million. Most respondents used some form of deer damage control, but few reported their problems to officials.

Despite these costs, our findings show that health and safety risks were more of a concern to county residents than damage to plantings. Deer have many positive values, but rough economic cost/benefit analysis showed that currently the costs (perceived risk of disease or accident, cost of damage) outweigh the benefits. Educational-communications programs that could address concerns such as deer-vehicle collisions (e.g., safe driving techniques along County parkways, time of year or day when deer are most mobile) or Lyme disease (e.g., the real role of deer in Lyme disease transmission, symptoms of the disease, tick identification) might be most beneficial in affecting more positive attitudes toward deer.

As suburban deer populations continue to grow, situations like that found in Westchester County, New York will become more common. We need to understand our constituencies well if we hope to develop effective educational programs and acceptable management approaches to address the management of deer in suburban environments.

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