REANALYSIS OF FARMER WILLINGNESS TO TOLERATE DEER DAMAGE IN WESTERN NEW YORK[1]

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INTRODUCTION

Crop depredation by white-tailed deer (*Odocoileus virginianus*) has been examined and discussed by wildlife managers since at least the early 1930's (Leopold 1933:283). As with most aspects of game management in those early years, managers' efforts focused on the biological parameters of depredation and control. In the 1960's a few researchers began examining the social implications of deer management and found farmers to be surprisingly tolerant of most deer damage (McDowell and Benson 1960, McNeil 1962:81, Flyger and Thoerig 1962:48). Because of changing agricultural, habitat, and deer population conditions, studies of farmer tolerance of deer damage were initiated in New York (Brown et al. 1977, 1978, 1979, 1980). This research helped to systematically quantify and apply the concept of farmer tolerance of deer damage as a determinant of deer range carrying capacity on agricultural lands in New York State.

The New York State Department of Environmental Conservation (DEC) has long considered socioeconomic as well as biological factors in determining Range Carrying Capacity Index (RCCI) objectives for deer in agricultural areas. The attitudes, perceptions and experiences of rural landowners, especially farmers, are particularly important. Integrating farmers' and rural landowners' interests into a deer management program requires detailed information on their perceptions and preferences about deer and deer damage. Using farmer tolerance levels to set the upper limit for deer populations in agricultural areas of the State (where habitat conditions permit) represents one approach to achieving overall satisfaction with deer management among the many publics that have vested interests in deer and agricultural resources.

PREVIOUS WORK

Studies to derive indices of farmer attitudes toward deer management levels were conducted in the Lake Plain (1976), West Central Plain (1978), and East Central Plain (1979) regions of New York(Figure 1) (Brown et al. 1977, 1978, 1979). These studies helped to define the relationships between farmer tolerance, attitudes about deer, and attitudes and perceptions of deer damage and deer population levels. It was determined from these earlier surveys (n = 9543) that deer populations in some areas were below levels at which crop damage became intolerable to farmers. Farmers generally held a custodial attitude toward deer and appreciated deer for aesthetic as well as hunting purposes. No striking differences in perceptions of crop damage between regions were found (Brown et al. 1980). Growers usually reported more damage to fruit than to other crops. Farmers in the Lake Plain region were generally less tolerant of damage than farmers in the 2 Central Plain regions, but in both areas there was a clear relationship between increasing economic loss and decreasing tolerance (as measured by preferences for future deer population trends) (Decker et al. 1981).

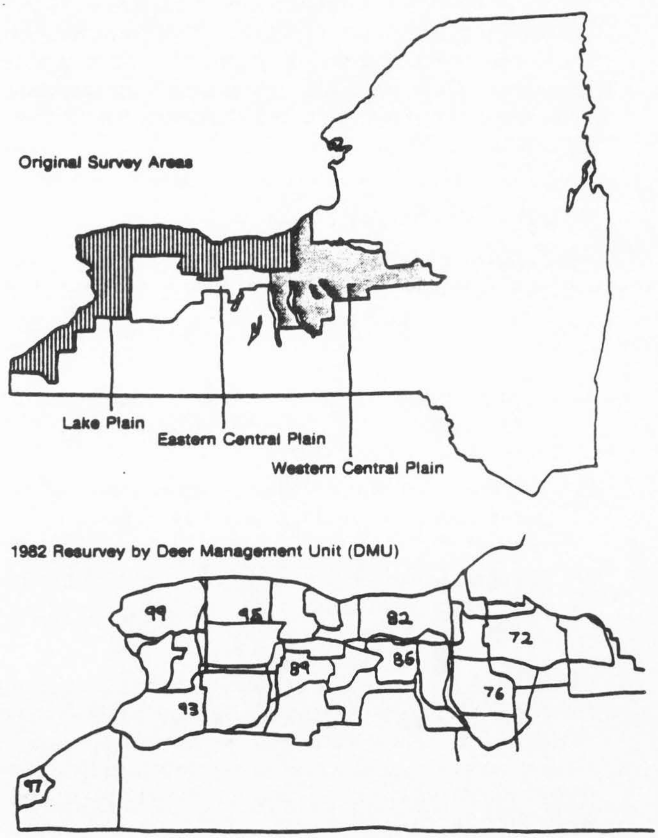

Figure 1. Study areas of the three original surveys and the 1982 resurvey.

[1] Research supported by New York Federal Aid in Wildlife Restoration Project W-146-R.

These studies also examined the relationship between farmers' preferences and the deer population index for each region. In the Lake Plain the deer population was generally below the RCCI of 1.01 to 1.50 BT/SM (legal bucks taken per square mile of deer habitat) prescribed for it, and most full-time farmers of that region desired higher deer population levels. In the Central Plain regions, the prescribed RCCI was 1.51 to 2.00 BT/SM, with two-thirds of the towns within or above this level, which was determined to be satisfactory to most full-time farmers. The higher RCCI prescribed for the Central Plain regions as compared to the Lake Plain is partially a reflection of the lower intensity of fruit and cash crop production occurring in them. Dairy farms are more common in these Central Plain regions and more land is wooded.

Although farmer preferences and attitudes in the 3 contiguous western New York study areas were relatively similar, there is evidence that farmers who have different experiences (historical and recent) with deer population densities and growth rates will also have different thresholds of damage tolerance (Decker et al. 1981). A comparison of farmers' damage estimates to tolerance of deer population increases between western New York and southeastern New York illustrated that such differences exist between noncontiguous geographic areas (Decker and Brown 1982). Heretofore unknown is how farmers' perceptions, attitudes, and preferences would change if they experienced different "degrees" of deer population increases. Deer populations increased throughout the area studied during the period between the initial and follow-up surveys.

STUDY OBJECTIVES

This study evaluated if and how changes in the deer population have affected farmers' tolerance of deer and deer damage. The 3 basic objectives of the resurvey were:

1. To measure geographic differences for key attitudinal, perceptual, crop and damage variables and relationships.
2. To measure temporal change for key attitudinal, perceptual, crop and damage variables and relationships.
3 To combine discriminating variables and formal deer population indices into a management synthesis.

Objective 1 is covered in a brief status report using the 1982 resurvey data only; meeting objectives 2 and 3 required use of data from the 3 earlier studies and the 1982 resurvey. Data presentation relative to objectives 1 and 2 will be brief, used primarily to set the stage for a more detailed analysis to meet objective 3.

PROCEDURES

SURVEY METHODS

The questionnaire used in this study was essentially the same as that used in the 3 previous studies of western New York farmers, thereby facilitating temporal comparisons. The survey was implemented in January and February of 1982, following a procedure wherein up to 3 follow-up notices are sent to nonrespondents.

As in the previous studies, the sample was chosen from ASCS mailing lists. Farmers with holdings of less than 10 acres were excluded from sampling. Towns were then segregated to approximate the 9 Deer Management Units (DMUs) established by DEC in the region (Figure 1). For towns which were split by 1 or more DMUs, eligible names were chosen based on the location of the farm within the town. All absentee farmers in these split towns were excluded from sampling because we were not able to ascertain the location of their land.

A sample of approximately 300 farms was selected for each DMU, except DMU 97 where all 232 of the farms in the Unit were selected, thus permitting equal treatment of DMUs in comparisons of data between DMUs. This resulted in a sample of 2,650 farmers, 1,217 (45.9%) of whom had been surveyed in 1 of the earlier studies. DMU totals were appropriately weighted to ensure representativeness of all DMUs in regional and aggregate analyses. A response rate of 78% of deliverable questionnaires was achieved.

ANALYSIS METHODS

The 1982 resurvey included a farmer component that had been contacted in previous surveys, referred to as the "Repeater" group. "Nonrepeaters" are those who were contacted only during this resurvey. Much of the analysis in this paper is predicated on the assumption that the repeater and nonrepeater subsamples are each representative. Establishing this representativeness is important for an accurate analysis of temporal change which may have occurred between the original surveys (1976, 1978 and 1979) and the 1982 resurvey. A Kruskal-Wallis one-way ANOVA by ranks (Siegel 1956:181) was used to determine whether or not repeater and nonrepeater subsamples were similar for (1) the original surveys and (2) the resurvey. Comparisons of repeaters and nonrepeaters for key attitudinal and perceptual variables for all 4 surveys were found to be statistically similar, thereby enabling us to use the full complement of cases from each survey in the change analysis. In portions of the change analysis involving dollars of damage variables, DMUs 82, 97, and 99 had to be omitted because in the first survey of these DMUs damage costs were coded in categories rather than as continuous data.

RESULTS

1982 OVERVIEW

Overall about 30% of respondents reported deer damage to their crops, ranging from 25% (DMUs 95 and 99) incidence of crop damage to 50% (DMU 86). Damage varied widely among DMUs but was most common among fruit and grape growers. Damage was less frequent for field crops (green vegetables, wheat and hay) and averaged an almost consistent 20% for all 9 DMUs.

Nearly half of the farmers who reported damage estimated it to be in the $100-$499 range; nearly one-fourth estimated their damage to be ≥ $1,000. Although DMU 86 had the highest incidence of deer damage, DMU 97 had the most farmers reporting damage ≥$1,000. Four levels of damage (i.e., mean dollars of damage) were apparent from the data. Small fruit (berries) growers experienced the most severe damage (x = $2,656). A second level of damage ranging from $900 to $1500 was reported for tree fruits (apple, cherry, and peach) and green vegetable crops. Damage at a third level of severity ranging between $300 and $650 was reported for grapes, corn, wheat, hay, "other" farm crops, and forest plantations. The least severe damage (< $200 per grower) was reported for woodlands.

A majority of farmers (56%) wanted deer populations to remain the same ; 24% wanted an increase and 19% wanted a decrease. The percentage of farmers in each DMU who wanted deer populations to remain the same ranged from 49% to 63%. For those farmers who reported damage, 49% wanted the deer population to remain the same, but 37% wanted the deer population level to decrease. This indication of intolerance, wanting a "decrease in future deer populations", becomes the major preference for the resurvey population at and above the $500-$999 level, suggesting the existence of an upper threshold of tolerable monetary loss (Table 1).

CHANGE ANALYSIS

Although only in DMU 72 did a majority of farmers correctly perceive increasing deer population trends, in all DMUs more farmers in the recent survey than before reported a deer population increase. Consistent with this shift in responses, a greater percentage of farmers in 1982 than before indicated they "worried" about crop damage. The percent of farmers reporting crop damage has remained essentially unchanged between studies. However, the mean dollars of damage reported by farmers has increased between 10% and 328%, implying that farmers who experience crop damage now suffer monetary losses much greater than the earlier estimations. These perceptual, attitudinal and experimental changes were manifest in diminished tolerance for increasing the deer population and greater acceptance of the existing deer population level than was evident in the earlier surveys.

MANAGEMENT SYNTHESIS

In general, the trends of change in farmers' attitudes, perceptions, experiences and preferences and in the deer population suggest that functional relationships between 2 or more of these variables may exist. This section examines those relationships and synthesizes the findings as management implications.

The basic paradigm outlined at the initiation of the study was that a change in deer population levels would result in a change in crop depredation; these 2 phenomena would then effect a change in farmers' attitudes about deer and deer damage and ultimately change farmers' tolerance of deer damage, manifest in this study as perferences for future deer population trends.

Changes observed in farmers' perceptions of deer populations, indicating that more now than before (though not a majority) feel that deer populations have been increasing, are in agreement with DEC's estimates of deer population trends (BT/SM) which show increases in DMUs ranging from about 50% to

Table 1. Relationship between damage amount and preferences for future deer population trends

Dollars of Crop Damage	Want an Increase	Want No Change	Subtotal (No Decrease)	Want a Decrease	Total
			Percent		
0:	22.2	44.1	66.3	5.8	72.1
1-99:	1.4	3.1	4.5	0.7	5.2
100-499:	1.8	7.1	8.9	3.6	12.5
500-999:	0.2	1.3	1.5	2.2	3.7
1000-2999:	0.2	1.4	1.6	2.6	4.2
3000-4999:	0.0	0.2	0.2	0.8	1.0
5000+:	0.1	0.2	0.3	1.1	1.3
Totals:	25.9	57.4	83.3	16.8	100.0
With Damage:	22.2	44.1	66.3	5.8	72.1
Without Damage:	3.7	13.3	17.0	11.0	27.9

180% between 1975 and 1982 (Figure 2). DMUs with lower initial BT/SM tend to have the lower resurvey BT/SM but display the greatest relative increase as measured by "percent change." [2] This is important because it is conceivable that preference change may be triggered by either the absolute number of deer and/or the relative magnitude of change in populations from initial survey to resurvey. This change in deer population levels has affected farmer experiences, attitudes, and perceptions in different ways which are important for managers to recognize. The percent of farmers reporting crop damage has remained essentially unchanged while estimates of mean dollars of damage has increased markedly in most DMUs, implying that the few farmers who experience crop damage now suffer monetary losses much greater than they reported in previous studies. In general, these perceptions of greater damage are accompanied by less accepting attitudes about damage and less custodial attitudes about deer, resulting in management preferences less supportive of increases in future deer population levels.

Figures 3 and 4 illustrate the relationship between 2 key parameters: change in deer population and change in mean dollars of damage. Most notable is that on a DMU basis increases in monetary losses appear to be independent of changes in deer population level. Moreover, an examination of actual change in these 2 variables (Figure 5) shows that while 4 DMUs exhibit approximately similar patterns, DMUs 72 and 86 experienced considerably lower increases in monetary losses while experiencing growth in their deer populations similar to other DMUs. This raises the possibility that any changes in tolerance in these 2 units might be linked more strongly to deer population levels (perceived threat to crops) than to actual monetary losses experienced or that farmers in these units are sensitive to small increases in monetary loss.

Additional evidence that major differential responses to damage may exist can be found. For example, all DMUs reporting an increase in the mean dollars of deer damage were accompanied by an increase in the percent of farmers wanting the deer population reduced (Figures 6 and 7). However, DMUs 72 and 86 showed particularly strong rises in intolerance associated with relatively minor changes in damage, while DMUs 89 and 95 demonstrated considerable tolerance to a high absolute and relative increase in monetary loss. DMUs 76 and 93 occupy intermediate positions. These indications of the existence of different levels of tolerance are further supported in Figure 8 by the relationship between changes in attitudes toward deer and increasing fiscal loss; the smallest increments to unfavorable attitudes occur at the greatest increases in monetary loss (i.e., > 250% increase in losses) associated with DMUs 89 and 95.

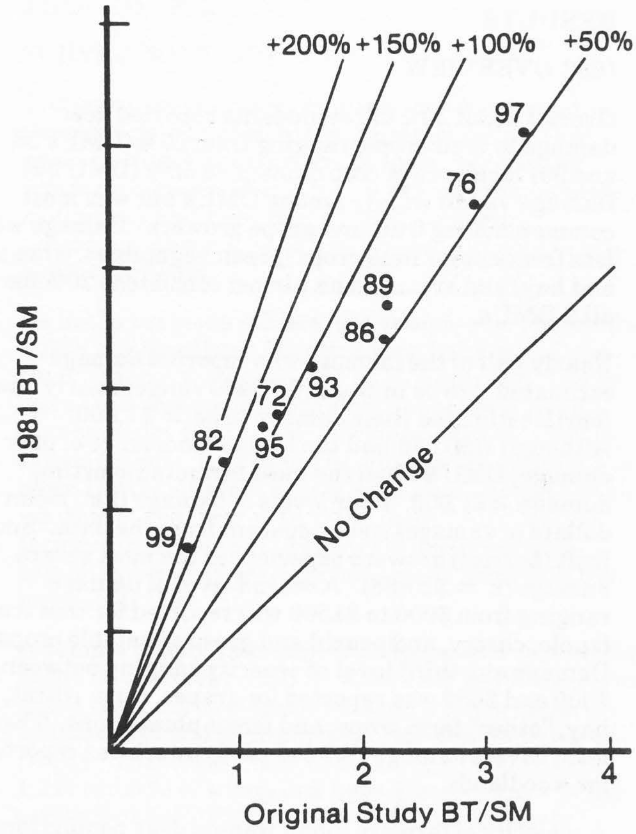

Figure 2. Actual and relative changes in BT / SM, by DMU

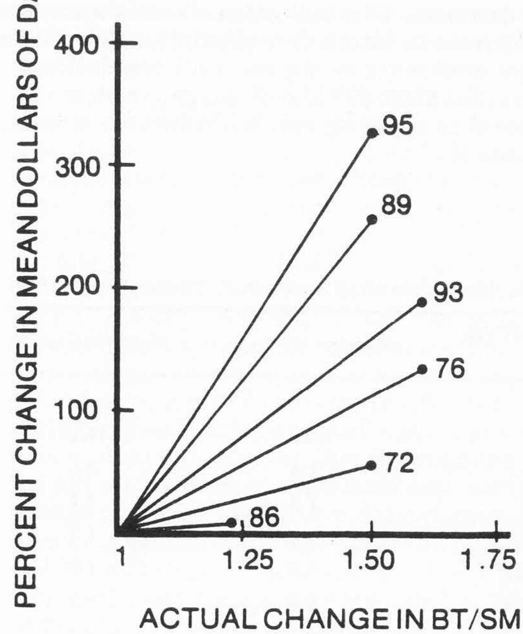

Figure 3. Relationship between the percent change in mean dollars of damage and the actual change in deer populations (BT / SM), by DMU.

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[2] Percent Change = $\frac{\text{(New BT/SM - Old BT/SM)}}{\text{(Old BT/SM)}} \times 100$

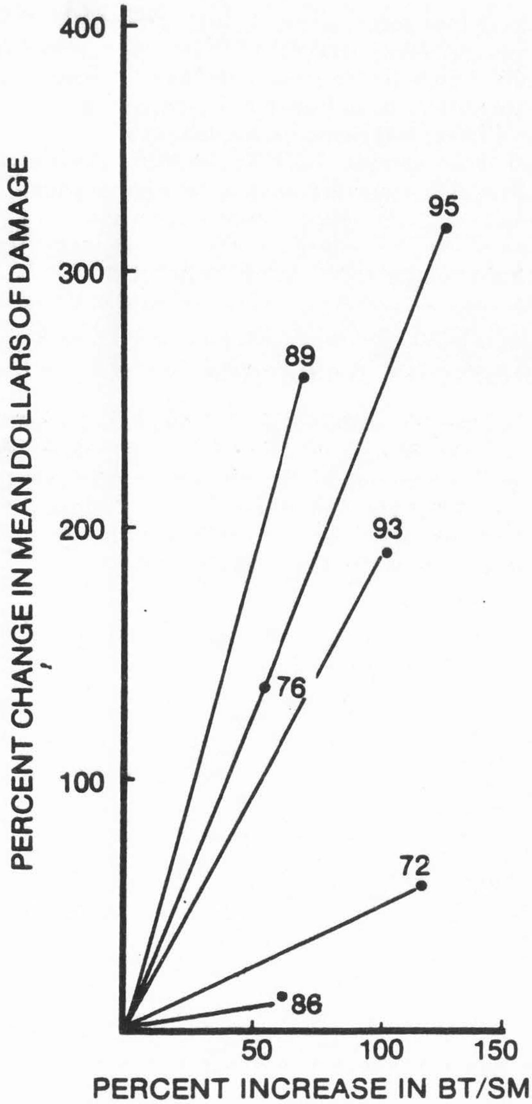

Figure 4. R elationship between percent change in mean dollars of damage and percent increase in BT/SM, by DMU.

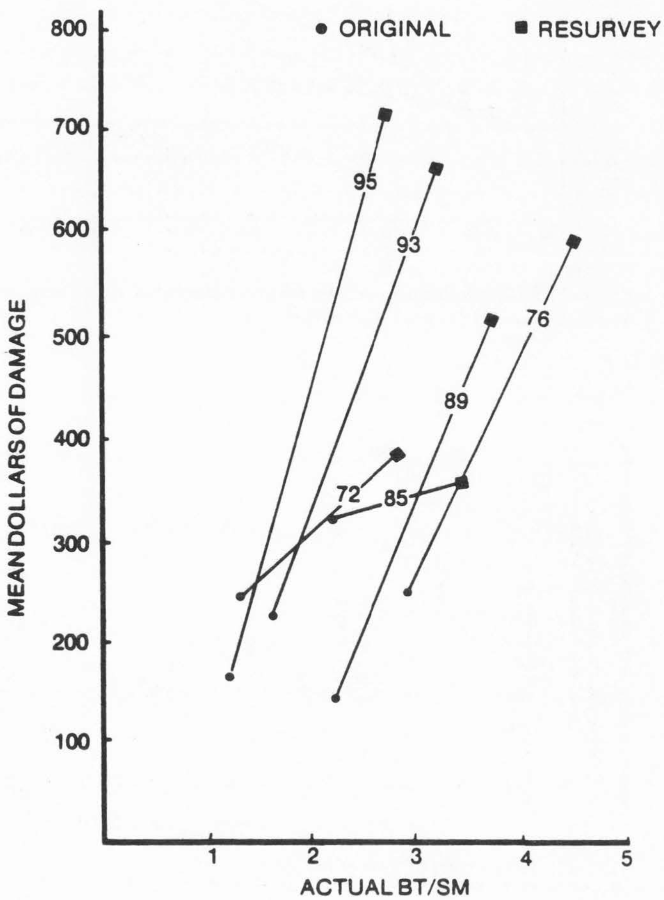

Figure 5. Changes in the relationships between mean dollars of damage and actual BT/SM, by DMU.

Further analysis of the relationship of tolerance change to monetary loss indicates that for the resurvey only about 65% of the farmers wanting a decrease in the future deer population had damage; for the original survey this figure was 77%. This suggests that increases in the deer population are becoming more important in determining attitudes/tolerance. Furthermore, farmers without monetary loss account for about 43% of the change in the "decrease the future deer population" preference segment, suggesting that increases in losses alone do not explain the shift in tolerance. Possibly an increased "threat" of potential losses is operating here. The relative importance of monetary loss in affecting tolerance change can be assessed from the ratio between the percent of respondents who experienced no damage yet desired a decreased future deer population and those with monetary loss who desired decreased future deer populations (Table 2). These ratios were used to help identify and explain the probable causative factors of tolerance change.

Figure 9 illustrates the actual changes that occurred in BT/SM and the actual percent of farmers wanting a decrease in future deer populations, by DMU. The general direction of change is similar for 7 DMUs, with units 89 and 95 displaying characteristics suggesting that tolerance for their constituent farmers is less strongly linked to deer populations than in the other units. Coincidentally, units 89 and 95 also exhibit the greatest increases in dollars of crop damage. In general, the direction of change among DMUs is from "low" BT/SM-"low" intolerance to "moderate" BT/SM-"moderate" intolerance. The extreme position of DMU 97 is consistent with the atypically high deer population that has been characteristic of that unit during these studies.

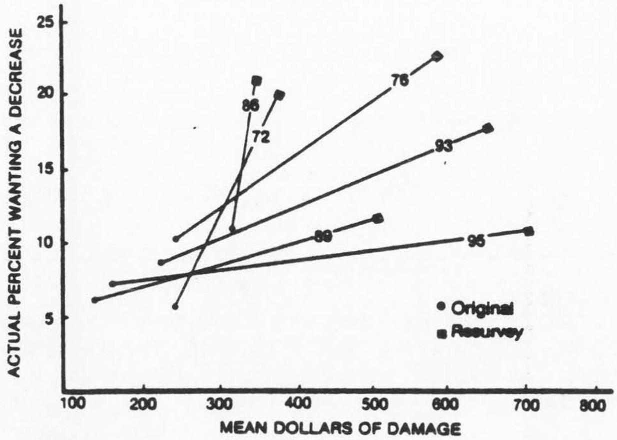

Figure 6. Relationship between actual percent wanting a decrease and mean dollars of damage, by DMU.

On a relative (percent change) scale (Figure 10), comparing increases in BT/SM of DMUs to increases in the percent of farmers wanting a decrease in deer yields little indication of linearity in responses. However, differential response consistency is reinforced. For example, DMU 72, identified earlier as one that probably responds more to deer population levels than to economic loss, exhibits the least tolerance and unit 95, where responses were identified as being economic related, shows the greatest tolerance.

ANTECEDENTS OF TOLERANCE

Because the relationships between tolerance change and changes in deer population and damage estimates are neither constant nor linear, attempts to identify the prime antecedents of tolerance change yielded an outcome that had less predictive ability than was hoped, but reemphasized the need for using

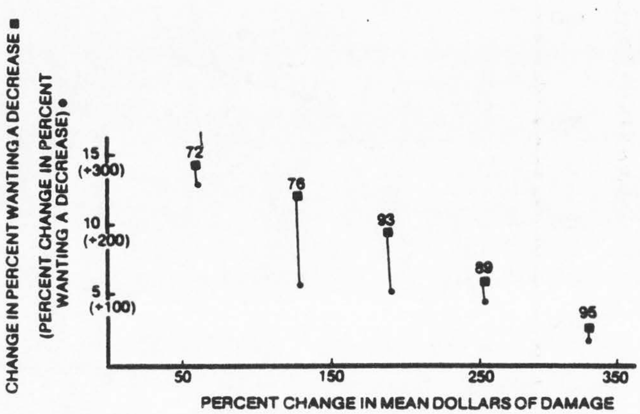

Figure 7. Parameters of change in tolerance related to percent change in the mean dollars of damage, by DMU.

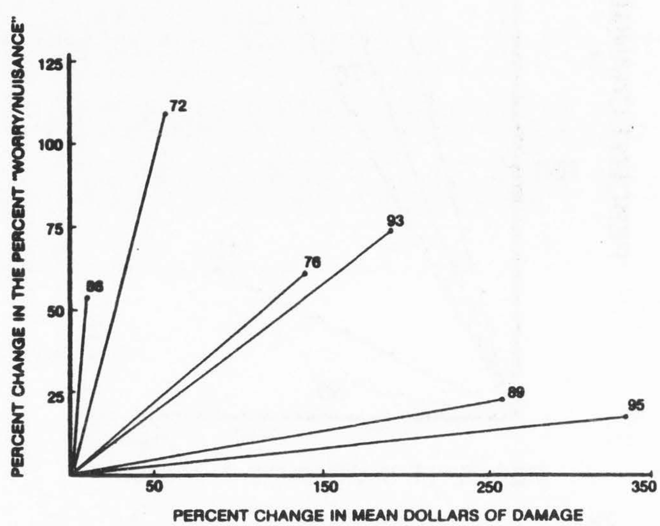

Figure 8. Relationship between attitude toward deer and percent change in mean dollars of damage, by DMU.

Table 2. Change in relative importance of monetary loss as a component of tolerance change

DMU	Percent of Respondents Wanting a Decrease: Without Damage		Percent of Respondents Wanting a Decrease: With Damage		Ratio (1:)		Rank (based on importance of damage)	
	Initial Survey	Resurvey	Initial Survey	Resurvey	Initial Survey	Resurvey	Initial Survey	Resurvey
72	1.1	7.4	4.1	9.4	3.73	1.27	6	9
76	1.3	6.3	9.1	15.1	7.00	2.40	2	5
82	1.1	3.6	4.4	12.1	4.00	3.36	5	2
86	0.8	6.1	9.4	14.2	11.19	2.78	1	3
89	1.5	3.6	4.2	8.9	2.82	2.47	8	4
93	1.5	6.7	6.7	11.7	4.47	1.75	4	7
95	1.7	2.0	5.9	6.8	3.47	3.40	7	1
97	3.7	12.1	18.5	26.1	5.00	2.16	3	6
99	2.0	5.2	2.7	8.4	1.35	1.61	9	8

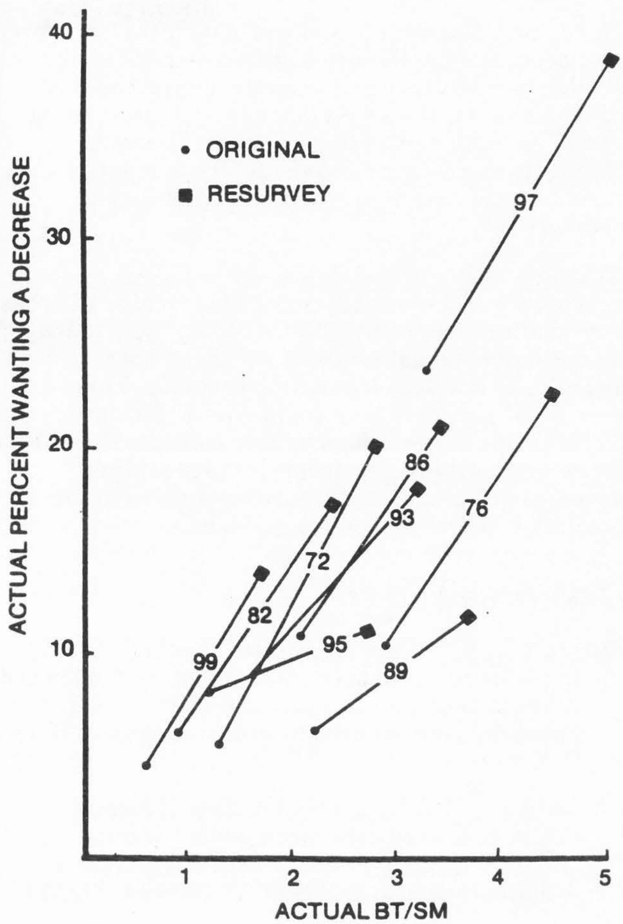

Figure 9. Changes in the relationship between percent wanting a decrease in future deer populations and actual BT / SM, bu DMU.

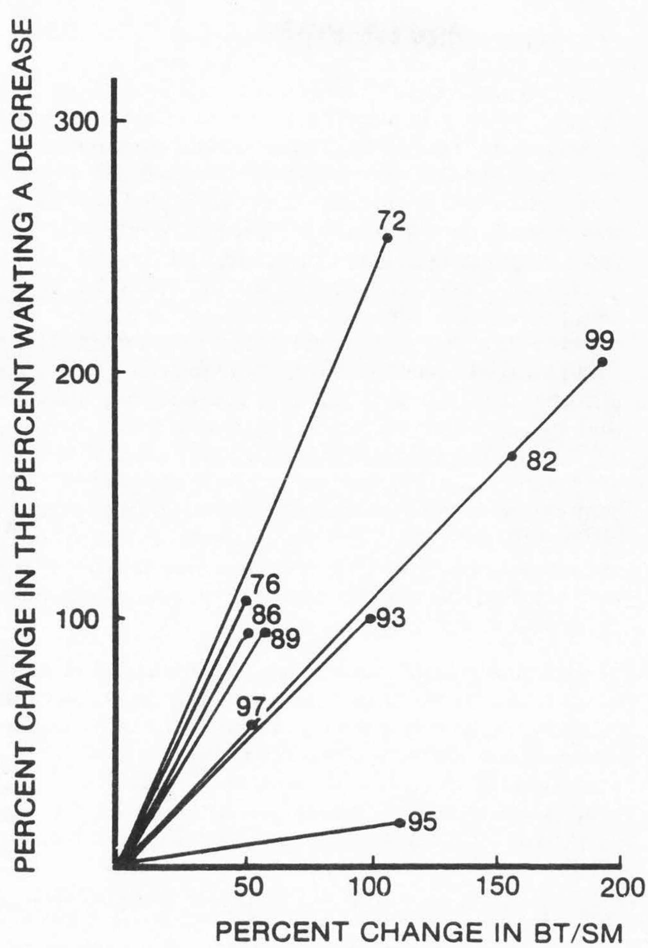

Figure 10. Relationship between percent change in the percent of farmers wanting a decrease in future deer populations and the percent change in BT / SM, by DMU.

homogeneous management units. To best synthesize data, the profiles of the major antecedents of tolerance and tolerance change were developed for each DMU. Summaries of these are presented in order of increasing relative tolerance (as assessed by percent change in farmers wanting a decrease).

DMU 72. A growing deer population and a low tolerance to monetary loss, heightened by the high levels of original losses.

DMU 99. A low tolerance to increases in the deer population.

DMU 82. A low tolerance to increases in the deer population.

DMU 76. Actual fiscal losses experienced appear to be less important than perceptions of deer population levels in determining tolerance.

DMU 93. The large deer population and the relatively rapid growth of the population are the major factors influencing tolerance in this unit.

DMU 86. Very intolerant of increases in the deer population.

DMU 97. This unit has experienced very high deer populations for at least 6 years. Data suggest that the thresholds of tolerance may have been exceeded.

DMU 95. While most of the change in tolerance appears to be damage dependent, monetary losses were high and deer population levels and growth low, suggesting a low tolerance to deer numbers or a high sensitivity to small increases in monetary loss.

DMU 89. Deer populations were high during both the original study and the resurvey while monetary losses were low. Increased intolerance is probably induced by fiscal concerns.

MANAGEMENT IMPLICATIONS

That increasing deer populations would result in increasing crop damage from deer and that increasing damage would result in greater farmer intolerance of deer were not startling findings. Unexpected, however, were the findings that despite substantial increases in deer numbers the percent of farmers reporting damage did not increase, and that no consistent linear relationship seems to exist between deer population increases and damage levels or between damage levels and intolerance to deer. These findings are important and to some degree disappointing to deer managers because they indicate that straightforward generalizations of relationships, and therefore generalized predictions of responses to deer population changes, cannot be made with confidence. Rather, farmers in different areas react differently to various levels of damage or perceptions of population levels. This revelation leads to several distinct implications for refining deer management programs in agricultural areas.

First, management areas, such as DMUs in New York, need to be viewed individually from a farmer tolerance standpoint. Levels of deer populations or crop damage acceptable to farmers of one area may not be acceptable to those of another area. The earlier practice of determining deer population level objectives for a region by crossectional studies where farmers' preferences were plotted for various townships having different deer population levels, then applying some criteria for selecting the optimal level based on trends demonstrated across the region (Brown and Decker 1979), though intuitively straightforward and attractive, is now seen to be imprecise and may lead to "mismanagement" of some units within the broader region. Thus, the same reasoning that leads to deriving ecological units for deer management should be applied to derive "sociological" units, or at least used to help form the boundaries of management units.

Second, if deer management programs already have management units in place, 5 factors relative to farmers' perceptions need to be considered when assessing deer population management objectives for the individual units: (1) the relative tolerance or (2) intolerance to deer numbers, the relative (3) tolerance or (4) intolerance to monetary loss, and the (5) percent of tolerance change attributable to damage. All else being equal, the greater the contribution of nondamage factors (i.e., deer numbers) to overall tolerance change the greater the need for deer population reduction. In units that show tolerance to deer and intolerance to monetary loss, population reductions will have less value than will provisions for excluding deer from crops or other mitigation measures. Cost effectiveness of such measures will have to be determined since the relationship between farmers' perception of dollars damage and actual dollars damage is unknown at this time. Further research is needed to determine this relationship.

Third, the differential responses of farmers for future deer population preferences in units experiencing similar population increases or damage estimates indicates that some as yet unmeasured intervening variables exist which are influencing farmers. Managers and researchers should try to identify such variables and determine their susceptability to management.

Refinements in understanding the sociological dimensions of deer management in agricultural areas, such as those represented by this study, help managers set optimum population goals which are both biologically and sociologically acceptable. This melding of considerations for biological feasibility and social acceptability enhances deer managers' ability to serve their various constituencies to providing management programs that are responsive to the needs and desires of those constituencies.

LITERATURE CITED

Brown, T.L., C.P. Dawson, and D.J. Decker. 1977. Deriving social indices of farmer attitudes toward deer management levels (Lake Plains). N.Y. Federal Aid in Wildlife Restoration Project W-146-R-2, Study I.

———. 1977. Deriving social indices of farmer attitudes toward deer management levels (Western Central Plain). N.Y. Federal Aid in Wildlife Restoration Project W-146-R-4, Study I.

Brown, T.L., D.J. Decker, and D.L. Hustin. 1979. Deriving social indices of farmer attitudes toward deer management levels (Eastern Central Plain). N.Y. Federal Aid in Wildlife Restoration Project W-146-R-5, Study I.

Brown, T.L. and D.J. Decker. 1979. Incorporating farmers' attitudes into management of white-tailed deer in New York. J. Wildl. Manage. 43(1):236-239.

Brown, T.L., D.J. Decker, and D.L. Hustin. 1980. Farmers' tolerance to white-tailed deer in central and western New York. Search: Agriculture No. 7, N.Y.S. Col. of Agr. and Life Sci., Cornell Univ., Ithaca, N.Y. 16 pp.

Decker, D.J. and T.L. Brown. 1982. Fruit growers' vs. other farmers' attitudes toward deer in New York. Wildl. Soc. Bul. 10(2):150-155.

Decker, D.J., T.L. Brown, and D.L. Hustin. 1981. Comparison of farmers' attitudes toward deer abundance in two regions of New York having different agricultural and deer population characteristics. New York Fish and Game J. 28(2):202-207. Flyger, V. and T. Thoerig. 1962. Crop damage caused by Maryland deer. Proc. Southeast Assoc. Game Fish Comm. 16:45-52.

Flyger, V. and T. Thoerig. 1962. Crop damage caused by Maryland deer. Proc. Southeast Assoc. Game Fish Comm. 16:45-52.

Leopold, A. 1933. Game Management. Charles Scribner's and Sons, New York, N.Y. 481 pp.

McDowell, R.D. and F.C. Benson. 1960. The deer herd and landowner in Connecticut. Bul. 348, Experiment Sta., Col. of Agr., Univ. of Conn., Storrs. 16 pp.

McNeil, R.J. 1962. Population dynamics and economic impact of deer in southern Michigan. Mich. Dept. Conserv., Game Div. Rep. 2395. 143 pp.

New York Crop Reporting Service. 1976. New York Agricultural Statistics 1975. Albany, N.Y. 70 pp.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Co., New York, N.Y. 312 pp.

Stanton, B.F. and W.A. Knoblauch. 1981. New York Agriculture Census Data, 1978. A.E. Ext.: 81-27. Dept. Agr. Econ., N.Y.S. Col. of Agr. and Life Sci., Cornell Univ., Ithaca, N.Y. 51 pp.

U.S. Department of Agriculture and U.S. Bureau of the Census. 1977. 1974 Census of Agriculture. Vol. I. State and County Data, Part 32, New York. Washington, D.C.

U.S. Department of Agriculture and U.S. Bureau of the Census. 1981. 1978 Census of Agriculture. Vol. I. State and County Data, Part 32, New York. Washington, D.C.