DEER DAMAGE IN VIRGINIA: IMPLICATIONS FOR MANAGEMENT

Benjamin C. West

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James A. Parkhurst, Chair

Steve L. McMullin

Patrick F. Scanlon

Dean F. Stauffer

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(ABSTRACT)

A questionnaire was sent to 1,506 randomly selected agricultural producers and homeowners in Virginia during 1996 to determine perceptions about deer damage and management during 1995 (response rate 52%). Overall, 58% of respondents experienced damage by deer to their plantings during 1995. Producers (71%) were more likely to experience deer damage than homeowners (37%) Among farmers, producers of soybeans, tree fruits, and peanuts were most likely to experience damage and generally rated it as being more severe than that reported by others. Regardless of perceptions regarding damage, most (70%) individuals believed that Virginia's deer population should be reduced to some degree in the future. Respondents' perceptions regarding the level of damage influenced their opinion about the level to which deer populations should be reduced; those perceiving greater damage were increasingly likely to desire a dramatic decrease in Virginia's deer population. Similarly, perception about the level of damage affected a respondent's general opinion about deer; respondents who experienced severe damage also were more likely to believe that deer are a nuisance. Overall, a majority (84%) of respondents favored recreational hunting as a means to manage deer in Virginia. A respondent's gender and the situation in which they were raised (e.g., urban, rural, farm) were strongly related to preference for management options. Female respondents and those raised in more urban areas were more likely to favor "non-lethal" management options (i.e., contraception, trapping and relocating individuals, allowing nature to take its course, fencing, and repellents) than were male respondents and those raised in rural environments. Deer density in a respondent's county of residence was directly related to perception regarding deer damage and desire for future population management (e.g., reduction versus increase).

A pilot study was conducted to assess the impacts of refugia on traditional deer management efforts via recreational hunting during 1996. Two study areas in Virginia were selected and, using information supplied by the county tax office, questionnaires were sent to individuals who owned land in the respective areas to determine distribution of land-uses, extent and severity of deer damage, and role of recreational hunting within each site. Deer damage was strongly related to land-use; respondents who owned lands on which some agricultural activity occurred were more likely to experience damage than respondents who owned non-agricultural lands. Respondents in each study area harvested more deer from their land than the mean harvest rate for the county in which they resided. Thus, it appears that, in some situations, deer harvest did not reduce damage to an acceptable level. The presence of local refugia theoretically had the potential to contribute to this relationship, but more research is needed to make definitive conclusions.

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INTRODUCTION

Historic Deer Population Trends in Virginia

Historical changes in the abundance and distribution of white-tailed deer (*Odocoileus virginianus*) in Virginia parallel that observed in most other southeastern states (Knox 1997). The number of deer in Virginia at or before the time of European settlement is not known. However, deer populations in the southeastern United States were approximately 4 deer/km^2 at the time of settlement (Seton 1909). Using this estimate and the land area of Virginia, Knox (1997) estimated the statewide deer population at 400,000 animals during the precolonial period. Similarly, McCabe and McCabe (1984) used a model based on North America's historic Native American population to estimate a precolonial deer population density of 3.1 to 4.2 deer/km^2.

Between 1600 and 1900, the number of deer in Virginia declined. Though land-clearing and development of agriculture associated with settlement produced preferred deer habitat, year-round exploitation and over-harvest caused a dramatic population decline in deer. By the early 1900s, deer were nonexistent in Virginia's western mountain and piedmont regions (Reeves 1960). The decline was so dramatic that, by 1931, deer had been extirpated from many parts of the state. Robertson (1931) estimated the statewide deer population in 1931 was a mere 25,000 individuals.

The first state agency responsible for wildlife management in Virginia, the Virginia Department of Game and Inland Fisheries (VDGIF), was formed in 1916. One primary goal of the VDGIF was to develop a recovery program for the white-tailed deer population in Virginia. The first step in this program was the creation of seasons and bag limits. Additionally, in 1926, VDGIF initiated a deer restoration program. During the early stages of this program (1926 - 1950), approximately 1,300 deer were trapped in other states and relocated in Virginia (VDGIF, unpubl. data).

Because of the successful recovery program, the deer population in Virginia experienced tremendous growth. From a population low of 25,000 animals, Virginia's deer herd has now grown to approximately 1,000,000 individuals statewide (VDGIF, unpubl. data). As the deer population has grown, so too have the beneficial economic and social returns. In 1996, hunter expenditures in Virginia were approximately $518 million whereas non-consumptive wildlife activities contributed an additional $698 million to Virginia's economy (U.S. Department of the Interior 1996).

Deer Damage

Although a high deer population affords many benefits, including those discussed above, the number of negative deer-human interactions also increases as deer and human populations grow. Examples of negative interactions include crop depredation, damage to ornamental plants and gardens, and deer-vehicle collisions. All these factors can be listed under the generic term "deer damage."

Agriculture

Traditionally, the most prominent form of deer damage has been damage to agricultural crops. Moore and Folk (1979) stated that crop depredation by deer has been a serious and widespread problem in the Southeast since the mid-1970s. Earlier studies have shown that deer damage to agricultural crops historically has been viewed as a key issue among farmers. Flyger and Thoerig (1962) conducted an evaluation of deer depredation in Maryland and found that a majority (72%) of Maryland farmers wanted to reduce the deer population through the creation of a doe season. More recently, Tanner and Dimmick (1984) assessed deer damage in western Tennessee and found that about 70% of the occupational farmers there had incurred some degree of deer damage. Of those, only 12% believed the damage they incurred was unreasonable. In contrast, Sayre and Decker (1989) found that 83% of nursery producers in New York were intolerant of deer damage. This was much higher than the 2% of producers who expressed intolerance of deer in New York (Brown et al. 1978). More recently, Sayre et al. (1992) reported that 67% of nursery producers in southeastern New York and 61% of those in western New York experienced deer damage during 1989.

Little effort has been applied to evaluate agricultural damage caused by deer in Virginia. Lyon (Virginia Tech, unpubl. data) conducted a survey of Virginia soybean producers in 1985; 69% of respondents reported incurring damage by deer and estimated a mean annual yield loss of 3.7% attributable to deer damage. Although Lyon's study focused on soybean producers, damage to other crops also was assessed. Yield loss typically was estimated at $\leq$ 5% per crop, but reports of up to 90% yield loss were received from some producers of vegetable crops. Similar to other studies (e.g., Brown et al. 1978, Purdy 1987), the greatest percentage of producers (41%) wanted the deer population to remain at the current level despite the occurrence of damage.

In 1993, at the request of the Virginia House of Delegates, the Department of Game and Inland Fisheries was charged to appoint a committee to evaluate deer damage to agricultural crops in Virginia. The Deer Damage Committee (1994) estimated that deer were responsible for $11.4 million in damage to Virginia's agricultural crops in 1992. However, this figure was not obtained through a systematic survey. Rather, it represented a synthesis of several informal surveys conducted by various stakeholder organizations (e.g., Virginia Apple Grower's Association) and assessments by Virginia Cooperative Extension Service professionals. Although somewhat subjective, these estimates heretofore were the best available indicators of the severity and occurrence of deer damage to agricultural crops in Virginia.

Ornamentals and Gardens

As discussed earlier, the deer population in Virginia has increased dramatically, from 575,000 deer statewide in 1987 to over 1,000,000 animals in 1995, despite liberalization of hunting regulations (VDGIF, unpubl. data). This population increase, in conjunction with increasing human urbanization, has resulted in more deer using urban habitats. Although residents often view urban deer as beneficial, damage associated with an urban deer population has made urban deer management one of the most "urgent and controversial wildlife management problems of the decade" (Decker and Richmond 1995:3). One of the primary conflicts between humans and an urban deer population is depredation of ornamental plants and gardens. Although this problem is not limited to urban or suburban areas, in residential areas with a high human

population density, one would expect more ornamental plantings and gardens and hence a greater opportunity for damage to occur.

Studies that evaluate damage to ornamentals and gardens are less abundant than those evaluating agricultural damage. Most of the work on urban deer damage was reported within the past 10 years. Decker and Gavin (1987) conducted a survey of residents in Islip, New York, to determine the amount of damage attributable to deer and to assess residents' perceptions concerning deer damage and the deer population. In their sample population, 29% indicated an enjoyment of deer, but were worried about damage caused by deer whereas 9% of respondents considered deer a nuisance and desired a severe reduction of the deer population. In this and other similar situations, where no population control methods are applied to the deer population, it is reasonable to expect the deer population, deer damage, and intolerance among residents to increase.

Few formal studies have been conducted to evaluate deer damage to ornamental plantings and gardens in Virginia. The Virginia Nurserymen's Association surveyed its members in 1992 and estimated $500,000 in damage attributable to deer (Deer Damage Committee 1994). Although these results provide some indication of the losses incurred by commercial nurseries, there are no data that describe damage incurred by Virginia homeowners. However, sufficient subjective information currently exists to verify that damage to ornamental plantings and gardens by deer is a major issue among homeowners in some areas of Virginia. In fact, damage to ornamental plantings and gardens in Fairfax County has been labeled the most important issue in the community by some residents (W.W. Cole, Pres., Occoquan Watershed Coalition, pers. commun.).

Vehicle-Deer Collisions

In addition to damage to vegetation, deer also may jeopardize the safety of Virginia's motorists and can cause substantial damage to vehicles during vehicle-deer collisions. Although often referred to as an "urban" issue, vehicle-deer collisions can occur on any road or highway. However, Stout et al. (1993) found vehicle-deer collisions occur most often in areas with a high deer population and a high traffic density. The Deer Damage Committee (1994) estimated that approximately $4.2 million in damage occurred to vehicles in Virginia annually for the period 1987 through 1991. This figure does not include the cost of medical treatment needed for drivers or passengers because of the collisions. Also, no indication was made concerning the number of deaths and injuries caused by vehicle-deer collisions. Scanlon et al. (1995) noted an increase from 105 vehicle/deer collisions in 1987 to 134 collisions in 1991 in the City of Lynchburg, Virginia. On a national level, Conover (1995) reported that vehicle-deer collisions caused $1.4 billion in damage to vehicles, a $1.4 billion loss in the value of deer, 15,000 human injuries, and 195 deaths annually.

Attitudes about Deer

In addition to characterizing perceptions regarding the extent and severity of deer damage, much work previously has been accomplished to evaluate stakeholders' overall attitudes about deer. In many studies, stakeholder attitudes have been embodied within stated desires for future deer management (e.g., increase in deer population versus decrease in deer population) (Brown et al. 1978, Decker and Brown 1982, Tanner and Dimmick 1984, Decker and Gavin 1985, Decker and

Gavin 1987, Sayre and Decker 1989). Decker and Gavin (1987) found that 72% of homeowners residing in Islip, New York, desired a stabilization or increase in the local deer population. In contrast, Decker and Brown (1982) found that 59% of fruit producers in New York wanted fewer deer. Clearly, desires for future deer management can vary widely among different stakeholder groups, among those living in different areas, and over time.

More important than simply characterizing stakeholder desires, the ability to predict public attitudes regarding deer in light of increasing deer populations is of paramount importance to deer managers. In effect, the concept of cultural carrying capacity (CCC) has become increasingly important in deer management (Ellingwood and Spignesi 1986). Though previous attempts to define CCC have focused on the maximum wildlife population level acceptable to stakeholder groups (Decker and Purdy 1988), Minnis and Peyton (1995:20) defined CCC as "the wildlife population level in a defined area that produces the most manageable amount of issue activity at a specific time" and further suggested that just as managers should consider the maximum CCC when formulating management actions, they also should consider the minimum desired population level. However, to use the concept of CCC in formulating management decisions, managers must assume some relationship between wildlife population size and stakeholder attitudes. Previous research has presented confounding evidence of such relationships (Decker et al. 1983).

Role of Recreational Hunting

Although deer damage only recently has begun to command attention from managers in Virginia, damage caused by an overabundance of deer is not a new concept. Leopold (1966) mentions deer damage several times in *A Sand County Almanac*. Traditionally, recreational hunting has been the method most often used to reduce deer populations and to manage deer damage (Ellingwood and Caturano 1988). This remains the situation today. In Virginia and other states, deer hunting regulations have been liberalized in an attempt to stabilize or reduce the deer herd. During the 1994 hunting season, Virginia deer hunters legally harvested 209,373 deer statewide (VDGIF, unpubl. data). Assuming a statewide population of 1,000,000 animals, legal hunters harvested nearly 21% of the Virginia deer population in 1994. This figure does not account for deer harvested illegally or other mortality factors (e.g., vehicle-deer collisions). Yet, in some regions of the state, the deer population still appears to be increasing and in good health (VDGIF, unpubl. data). Given the large number of deer harvested annually in Virginia, recreational hunting is a prominent activity in Virginia and is of utmost importance when discussing deer management in the Commonwealth.

Objectives

My specific objectives for this study were to:

1. Characterize perceptions about deer damage among different stakeholder groups (e.g., producers of agricultural commodities, homeowners, full- versus part-time producers) in Virginia during 1995;

2. Evaluate the use and perceived effectiveness of measures to deter deer damage among stakeholder groups;

3. Assess the occurrence of and perceptions about vehicle/deer collisions;

4. Evaluate perceptions regarding options that may be used to manage deer populations and identify factors that may influence such perceptions;

5. Determine the level of intolerance for deer among stakeholder groups and identify factors that may contribute to intolerance for deer; and

6. Evaluate the role of recreational hunting on stakeholders' lands in Virginia during 1995.

METHODS

Questionnaire Development and Implementation

To evaluate agricultural producers' (referred to as "producers" hereafter) and homeowners' or hobbyists' (referred to as "homeowners" hereafter) perceptions and attitudes toward deer and deer damage in Virginia during 1995, I developed a mail questionnaire (Appendix A) and administered it during the fall of 1996 using a modified version of Dillman's (1978) total design method (see below for specific modifications). The survey instrument consisted of 61 questions concerning participant demographics, the plantings or crops they produced, perceived severity of deer damage and its economic costs, occurrence and intensity of hunting on the subject's land, and attitudes toward deer damage and management in Virginia.

After the prototype survey instrument was reviewed for content and organization by 3 faculty members in the Department of Fisheries and Wildlife at Virginia Tech, the questionnaire was pre-tested on 7 agricultural extension specialists with Virginia Cooperative Extension and 16 randomly selected agricultural producers in the Commonwealth of Virginia. Pre-test participants were informed that their responses would be used only to evaluate the effectiveness of the instrument and would not be included in data used in the final analysis. Additionally, I encouraged pre-test participants to suggest ways the survey instrument could be improved so that respondents' concerns were most clearly measured and to facilitate ease of completion. After reviewing the responses given by pre-test participants and their anecdotal comments, I revised the instrument based on their comments and subjective evaluations regarding the ease with which they completed the questionnaire. The final survey instrument was printed in an 8.5" by 11" booklet format.

Survey subjects were asked to characterize themselves as either a "producer of agricultural commodities" or a "homeowner/hobbyist." To ensure consistent responses and interpretation, participants were instructed to consider themselves producers if they had received $\geq$ \$1,000 in income from their agricultural operation during 1995. Homeowners or hobbyists were defined as those who either did not produce plantings for sale or generated < \$1,000 in sales during 1995. Producers were then asked to indicate if they were full- or part-time producers during 1995. A full-time producer was defined as an operator of a facility having at least 1 full-time employee, which could include the survey subject. Depending on reported activity (producer versus homeowner), respondents were asked to select 2 plantings from an extensive list (see question 2 in Appendix A for complete list) and designate one as their most important planting and one as their second most important planting during 1995.

To obtain information about the beliefs and opinions of stakeholders within groups suspected of having deer damage, I selected a sample population from membership lists maintained by the Virginia Christmas Tree Growers Association, the Virginia Forage and Grassland Council, the Virginia Peanut Board, the Virginia Small Grains Association, the Virginia Soybean Board, the Virginia State Apple Board, the Virginia Master Gardeners Association, the Virginia Department of Agriculture and Consumer Services, and the Virginia Cooperative Extension Service. A 45% systematic random sample was taken from each list and identified 1,506 individuals to participate in the survey. Each survey subject initially was sent a packet containing a questionnaire, a postage-paid return envelope, and a cover letter that explained the purpose of the

survey and the need for participation. Three weeks later, all nonrespondents were sent a postcard stating that their questionnaire had not yet been received and that again asked for their participation. After another three weeks, all nonrespondents were sent a packet containing another copy of the questionnaire, a postage-paid return envelope, and a new cover letter. Finally, four weeks after the third mailing, a postcard was sent to all remaining nonrespondents announcing the pending closure of the survey and appealing for their participation. I placed a unique coding number on the back of each questionnaire and on the return envelope that allowed me to track participation.

After the survey closed, I randomly selected 10 non-respondents from each stakeholder group that failed to achieve a 65% response rate (Dolsen and Machilis 1991) to interview by telephone and evaluate non-response bias. I revised the original survey instrument to facilitate telephone interviews (i.e., it included only key attitudinal questions [Q-1, 2, 3, 4, 6, 11, 16, 20, 22, 30 – 40, 51, and 52 – 54]). I attempted to contact and interview all of these individuals between 5:00 p.m. and 9:00 p.m. over a 1-month period.

To assess the potential effects of nonresponse bias, I used χ^2 goodness-of-fit tests to compare the responses to similar questions given by individuals who participated in the telephone interviews with answers received from those who responded to the mail questionnaire (Ott 1988). Also, given the assumption that participants who respond later in a survey process are more likely to respond similar to nonrespondents than those who responded early in a survey process, I evaluated nonresponse bias by using a G-test of independence to compare responses received after each of the 4 respective mailings to determine whether attitudes differed among participants who responded at different times (Drane 1993, A. Bayer, Virginia Tech Center for Survey Research, pers. commun.).

Data Analysis

I assigned numbers (e.g., 0, 1, 2) to specific categorical responses and entered the data into a Statistical Package for Social Sciences (SPSS 7.0) database. I calculated simple descriptive statistics such as frequencies, means, and measures of variability and performed inferential tests using SPSS protocol (SPSS, Inc. 1996a). For all inferential tests, I considered a probability value of 0.05 to be statistically significant. Comparisons of categorical responses between groups were made using the SPSS Crosstabs procedure (SPSS, Inc. 1996a). In contingency tables where > 20% of cells had expected values < 5, similar categories were collapsed (e.g., "strongly agree" and "agree" collapsed to "agree") to increase the expected values in cells and the validity of the log-likelihood ratio (G-test). After collapsing, if > 20% of cells still had expected values < 5, I used standardized residuals to subjectively evaluate questionable cells' contribution to the significance of the G-test. If questionable cells' contribution to the significance of the test was negligible (i.e., if significance would be found even without those cells' contributions), I drew statistical conclusions; if those cells contributed substantially to the G-test statistic (i.e., if significance would not be found without those cells' contributions), I made no statistical conclusions (SPSS, Inc. 1996b). After the identification of significant bivariate relationships, I used multivariate contingency analysis to identify variables that may partially explain the bivariate association (Bohrnstedt and Knoke 1994). Comparisons between groups involving continuous data (e.g., reported economic or yield loss) were made using either

ANOVA or Kruskal-Wallis analyses. Tests for linear trends in continuous data typically were accomplished using linear contrasts (Ott 1988, Bohrnstedt and Knoke 1994).

If a contingency table analysis yielded a significant G-test statistic, proportional reduction in error (PRE) measures of association (for ordinal data) and adjusted residuals (for nominal data) were used to measure the relative strength of the relationship (Bohrnstedt and Knoke 1994, SPSS, Inc. 1996b). Although use of measures of association to evaluate the relative strength of observed relationships has long been used by social scientists, those involved with wildlife research have yet to recognize and make use of these measures to more completely describe relationships. PRE measures of association compare the error made in predicting one variable (variable A) with knowledge of another variable (variable B) to the error made in predicting variable A without any knowledge of variable B. Thus, these measures of association allow one to objectively determine whether an observed significant relationship is substantially important, rather than simply declaring statistical significance. Because Goodman and Kruskal's gamma (γ) is the PRE measure of association used most often for ordinal data and to allow meaningful comparisons between different relationships, I used this measure exclusively. As with most measures of association, gamma ranges from –1.00 to +1.00, with +/-1.00 indicating a "perfect" relationship and 0.00 indicating no relationship. The sign (+/-) simply indicates the direction of the relationship and easily can be manipulated by altering the order of the row and column categories. Thus, all scores will be reported as the absolute value of γ and the direction of the relationship will be explained grammatically.

Kviz (1981) suggested that PRE measures should be interpreted as the proportion of error explained in one value by knowledge of another. Although PRE measures certainly allow this interpretation, this method has yet to gain wide acceptance in the social sciences. Instead, many have suggested a predetermined scale when interpreting PRE measures of association to evaluate the relative strength of the observed significant relationship. Bohrnstedt and Knoke (1994:167) suggested the following scale to evaluate PRE measures: 0.00 – 0.24 = "virtually no relationship"; 0.25 – 0.49 = "weak relationship"; 0.50 – 0.74 = "moderate relationship"; 0.75 – 1.00 = "strong relationship."

Finally, I used adjusted residuals to identify specific cells that differed markedly from the model of independence, particularly when evaluating nominal data (SPSS, Inc. 1996b). Adjusted residuals are standardized estimates of the difference between an observed count and that cell's expected value. Typically, values above 2.0 or below –2.0 suggest statistical importance (SPSS, Inc. 1996b).

Comparisons among groups were made based on a respondent's stated primary planting. For certain crops among the initial list offered to participants, a very small number of producers actually reported growing some of these during 1995. Therefore, I grouped producers' reported primary and secondary crops into 14 condensed groups to allow more meaningful comparisons among commodity groups (Appendix B). These general commodity groups were: grains, tree fruits, shrub fruits, nursery plants, truck crops, forages, Christmas trees, soybeans, peanuts, strawberries, tobacco, pumpkins and melons, miscellaneous, and undefined. I also grouped homeowners' reported primary and secondary plantings into 9 general planting groups, including: tree fruits, shrub fruit, bedding fruits, woody ornamentals, vegetable gardens, flowers, general ornamentals, miscellaneous, and undefined (Appendix C). In many instances, small

sample sizes within commodity and planting groups resulted in many small expected values (i.e., < 5) when performing a crosstabulation. Thus, to reduce the number of cells with expected values < 5 and allow statistical comparisons, I typically omitted responses given by producers of shrub fruits, miscellaneous crops, undefined crops, strawberries, tobacco, and pumpkins/melons (referred to as 'small commodity groups' hereafter) and responses given by homeowners who reported growing shrub fruits, bedding fruits, miscellaneous plantings, and undefined plantings (referred to as 'small planting groups' hereafter) prior to performing a G-test.

Indices of deer density (i.e., number of antlered bucks harvested per square kilometer of habitat [agricultural and forest land], referred to as "BH/km^2" hereafter) for each county in Virginia were obtained from the VDGIF and were used to evaluate the effects of deer density on a participant's perception about the severity of damage and attitudes toward deer (VDGIF, unpubl. data). I used ANOVA analyses and linear contrasts to evaluate the effect of deer density on participants' responses to questions on the occurrence and severity of damage and their desires for future deer population trends.

RESULTS

Response Rates

Of the 1,506 original questionnaires, 732 were properly completed and returned, 44 were returned and marked "not applicable" by the recipient, 2 were received after the closing date of the survey, and 49 were returned as undeliverable by the U.S. Postal Service. Using these figures, I calculated the overall adjusted response rate as 51.8%. Adjusted response rates varied among stakeholder groups (Table 1). Greatest response (71.6%) was received from members of the Virginia Christmas Tree Growers Association whereas weakest response (37.9%) was from individuals on the list maintained by the Virginia Department of Agriculture and Consumer Services (primarily included producers of vegetables and strawberries).

Nonresponse Bias

I obtained data from 33 nonrespondents by administering a modified version of the questionnaire via telephone interviews. I was able to contact few individuals who identified themselves as homeowners in the telephone interviews ($n = 8$); thus, low sample sizes precluded statistical comparisons between respondents and nonrespondents who were homeowners, but a subjective evaluation of respondents and nonrespondents yielded no notable differences. I found few differences between respondents and nonrespondents identified as producers. A greater proportion of nonrespondents were full-time producers than would be expected based upon information supplied by respondents ($\chi^2 = 6.7$, df = 1, $P = 0.009$). Also, nonrespondents differed from respondents with respect to their opinion of hunters paying a fee to compensate those that experience damage (See Appendix A, Q-30); nonrespondents were more likely to disagree with this concept ($\chi^2 = 7.3$, df = 2, $P = 0.026$). Finally, nonrespondents were more likely than respondents to disagree with the option of using birth control as a means of managing the deer population in Virginia (Q-35 in Appendix A) ($\chi^2 = 9.6$, df = 2, $P = 0.008$). I found no other differences between nonrespondents and respondents.

With the exception of Questions 6 and 51, I found no differences among individuals who responded after each of the respective mailings regarding their responses to attitudinal questions. Respondents' time of response to the survey and their likelihood of having experienced damage (Q-6) were dependent, but the relationship was non-directional in nature and was extremely weak ($G = 8.51$, df = 3, $P = 0.037$, $\gamma = 0.033$). I collapsed Q-51 (desire for future population trends) into 3 categories (decrease, no change, and increase) to increase expected values in cells. Respondents' time of response and their desires for future deer population levels also were dependent, but again, the relationship was very weak and non-directional in nature ($G = 14.9$, df = 3, $P = 0.021$, $\gamma = 0.158$). Given these observations and those from the telephone interviews, I believe the impact of nonresponse bias on data analysis was negligible (Drane et al. 1993, Bernick and Pratto 1994).

General Demographics

Most (64.3%, $n = 471$) respondents reported being a producer of agricultural commodities during 1995 whereas the remaining individuals (35.7%, $n = 261$) classified themselves as homeowners

during the same period. Respondents typically were middle-aged ($\bar{x}$ = 53.5, n = 579, SE = 0.52) and were male (81.1%, n = 579). Producers were slightly younger than homeowners ($\bar{x}_d$ = 2.40, t = -2.2, df = 577, P = 0.029) and were more likely than homeowners to be male (92.6% vs. 60.7%, respectively; G = 105.9, df = 1, P < 0.001, γ = 0.779). Respondents most frequently (40.3%, n = 287) reported having a high school diploma, but homeowners had achieved a higher level of education than producers (G = 23.2, df = 3, P < 0.001, γ = 0.287; Figure 1). The greatest percentage of respondents (42.0%, n = 267) reported an annual net household income of $30,000-$59,999. Annual net household income differed between producers and homeowners; homeowners were more likely to report income in excess of $60,000/year ($G$ = 24.1, df = 4, P < 0.001, γ = 0.290; Figure 2).

Among producers, 66.7% (n = 307) indicated they were full-time producers during 1995 whereas the remaining individuals (n = 153) indicated they were part-time producers during the same period. No differences in gender (94.5% vs. 89.4% male) or education (32.0% vs. 34.9% with bachelor's degree) were found between full- and part-time producers (G = 3.3, df = 1, P = 0.069; G = 6.5, df = 3, P = 0.089, respectively). Part-time producers reported slightly higher income levels than those of full-time producers (33.3% vs. 24.2% with income $\geq$ $60,000/year annually), but this relationship was very weak (G = 13.2, df = 4, P = 0.010, γ = 0.192). Part- ($\bar{x}$ = 53.4) and full-time producers ($\bar{x}$ = 52.2) were similarly aged (t = 0.827, df = 376, P = 0.409).

Among all respondents, a majority (52.0%, n = 377) reported living on a farm since 1990 whereas the smallest percentage (8.4%, n = 61) reported living in a small city during the same period (see Appendix A, Q-60) (Figure 3). Similarly, 49.4% (n = 357) reported being raised on a farm and only 13.7% (n = 99) reported being raised in a small city (see Appendix A, Q-59) (Figure 3). As expected, there was a strong relationship between a respondent's living situation since 1990 and present activity; producers reported living on a farm more often than did homeowners during that period (G = 264.3, df = 3, P < 0.001, γ = 0.792; Figure 4). I also found a strong relationship between activity and upbringing; producers again were much more likely to report being raised on a farm whereas homeowners were more likely to report being raised in another non-farm situation (G = 180.5, df = 3, P < 0.001, γ = 0.688). Regarding the relationship between level of production involvement and living situation since 1990, full-time producers were more likely than part-timers to report living on a farm during that period (G = 18.4, df = 3, P < 0.001, γ = 0.382). Full-time producers also were more likely to report having grown up on a farm whereas part-time producers were more likely to report an upbringing in one of the other living situations (G = 14.4, df = 3, P = 0.002, γ = 0.319).

The reported acreage used to grow a respondent's primary planting was higher for producers ($\bar{x}$ = 103.6 ha, n = 436, SE = 12.8) than for homeowners ($\bar{x}$ = 0.3 ha, n = 171, SE = 0.06). Similarly, the acreage that producers reported ($\bar{x}$ = 60.1 ha, n = 278, SE = 7.5) using to produce their secondary planting was greater than that reported by homeowners ($\bar{x}$ = 0.2 ha, n = 97, SE = 0.1). Homeowners were given the option to report the number of plants grown for their primary and secondary plantings during 1995 rather than the acreage used to grow them. The average number of plants for homeowners' primary planting was 199.4 (n = 54, SE = 62.3) and 59.8 (n = 43, SE = 11.3) for their secondary planting. Full-time producers reported greater acreage in

production than part-time producers for both their primary and secondary plantings ($\bar{x}_d$ = 114.8, t = 4.2, df = 429, $P < 0.001$; $\bar{x}_d$ = 67.1, t = 4.057, df = 274, $P < 0.001$, respectively). Finally, I noted differences in the amount of acreage in production among producers who reported growing different primary and secondary commodities during 1995 (F = 5.4, df = 14, 421, $P < 0.001$; F = 6.1, df = 14, 263, $P < 0.001$, respectively; Table 2). Generally, producers of field crops (e.g., soybeans, grains, peanuts) reported growing their commodities on larger acreages than did other producers.

Among producers, nursery plants (17.4%, n = 82), tree fruits (13.6%, n = 64), soybeans (12.3%, n = 58), and grains (11.1%, n = 52) most often were reported as primary plantings during 1995 (Figure 5). Crops least frequently reported as being a primary planting included strawberries (2.3%, n = 7), pumpkins and melons (1.3%, n = 6), and shrub fruits (1.1%, n = 5). Two hundred and ninety-nine (63.6%) producers reported growing a secondary planting in addition to their primary planting during 1995 (Figure 5). Grains (20.7%, n = 62), forages (12.4%, n = 26), and soybeans (10.4%, n = 31) were most likely to be named as secondary plantings. Crops least likely to be named as a secondary planting included tobacco (1.0%, n = 3), strawberries (1.3%, n = 5), and shrub fruits (1.7%, n = 5). I was unable to statistically test for independence between producers' primary and secondary plantings due to a high number of empty cells, but subjective evaluation identified some possible relationships. Producers who listed soybeans as their primary planting also were very likely to report a grain (83.0%, n = 39) as their secondary crop during 1995. Producers who listed a grain as their primary crop also listed soybeans (37.5%, n = 8) as their secondary planting more so than any other crop. Producers who listed a particular tree fruit as their primary planting were most likely to grow a different type of tree fruit as their secondary planting (40.0%, n = 16). Similarly, producers who raised nursery plants as their primary planting also were most likely to grow a different type of nursery plant as their secondary planting (66.7%, n = 26). Producers of primarily Christmas trees were most likely to grow a nursery plant (55.6%, n = 10) as their secondary crop. Finally, a respondent's likelihood of growing alfalfa and other forages (i.e., other hay, silage) were strongly related; 81.8% (n = 9) of those who grew alfalfa raised another type of forage as a secondary crop.

Homeowners most often reported vegetable gardens (29.1%, n = 76), woody ornamentals (21.1%, n = 55), and flowers (16.5%, n = 43) as their primary planting during 1995 (Figure 6). Most homeowners (64.4%, n = 168) grew a secondary planting in addition to their primary planting. Flowers (41.7%, n = 70), woody ornamentals (22.6%, n = 38), and vegetable gardens (19.0%, n = 32) most often were cited as a secondary crop (Figure 6).

I placed each respondent into a VDGIF wildlife administrative district based upon the county in which a respondent claimed to have resided during 1995 (see Appendix D). Using these groupings, I found a wide distribution of respondents across the state, ranging from a low of 2.1% (n = 15) of the total responses in Region 3, District 2 to a high of 18.1% (n = 132) of the total responses in Region 5, District 1. I found differences in the district of residence between producers and homeowners (G = 55.7, df = 9, $P < 0.001$; Figure 7). The greatest percentage of producers resided in Region 1, District 2 (17.5%, n = 82) whereas the fewest producers lived in Region 3, District 2 (2.6%, n = 12). In contrast, homeowners most frequently reported living in Region 5, District 1 (28.5%, n = 74) whereas the lowest percentage resided in Region 3, District 2 (1.2%, n = 3).

I assumed homeowners grew their plantings at their place of residence during 1995. Thus, homeowners were not asked to differentiate between the county in which they lived and the county in which they grew their plantings. However, producers were asked to identify both the county in which they resided and that in which they grew their crops so that I could examine whether producers commonly grew commodities in counties other than that of their residence. During 1995, only 4.1% (n = 19) of producers grew crops in a district other than that of their residence. Producers of some commodities were concentrated in certain regions of the state (Table 3). Producers of traditional field crops (e.g., soybeans, peanuts, grains) typically lived in the piedmont area of Virginia (e.g., Region 1, Districts 1 and 2). In contrast, most producers of tree fruits, forages, alfalfa, and Christmas trees lived in the mountainous western region of the state. Producers of nursery plants were distributed somewhat evenly across the Commonwealth.

Damage Occurrence and Severity

Overall, 58.3% (n = 427) of all respondents reported that they had experienced deer damage to at least one of their plantings during 1995. More specifically, 409 (55.8%) individuals reported damage to what they had described as their primary planting. Overall, 24% (n = 176) of respondents described damage to their primary plantings as moderate (Figure 8). The remaining respondents were divided equally between low (15.8%, n = 116) and severe (16.0%, n = 117).

Overall, producers (70.9%, n = 334) were more likely to report having incurred deer damage than were homeowners (35.6%, n = 93) during 1995 (G = 86.4, df = 1, P < .001, γ = 0.630). Among all respondents, producers were more likely to incur damage and describe it as being severe (G = 89.0, df = 3, P < 0.001, γ = 0.521; Figure 9). However, among only those who reported damage, both homeowners and producers reported similar damage severity for their primary planting (G = 1.51, df = 2, P = 0.471).

The average economic loss attributed to deer and reported for primary plantings among all respondents was \$7,396 (n=145, SE = \$1,542) and \$3,370 (n = 75, SE = \$19) for secondary plantings. I calculated mean economic loss/hectare of production by using respondents' reported economic loss and number of hectares in production for primary and secondary plantings ($\bar{x}$ = \$999/ha, n = 131, SE = \$240; $\bar{x}$ = \$8,015/ha, n = 74, SE = \$7,260, respectively). The unusually high estimate for loss/hectare for secondary plantings was due primarily to one outlier (\$537,777 loss/ha). Omitting this outlier, mean economic loss/hectare for secondary plantings fell to \$758/ha (n = 73, SE = \$222). Mean percent yield loss reported by producers for primary and secondary plantings was 16.7% (n = 104, SE = 2.0) and 13.9% (n = 75, SE = 2.1), respectively (only producers were given the option of reporting yield loss, see Q-13 in Appendix A). Mean percentage of primary and secondary plantings damaged by deer was 25.7% (n = 94, SE = 3.04) and 26.5% (n = 58, SE = 3.8), respectively.

Producers reported much greater economic loss ($\bar{x}$ = \$8, 277.12, n = 129, SE = \$1,718.24) because of deer damage to their primary planting than did homeowners ($\bar{x}$ = \$287.81, n = 16, SE = \$76.24) (M-W U = 148.0, df = 144, P < 0.001). However, homeowners ($\bar{x}$ = \$6,185.75, n = 8, SE = \$2,261.94) reported significantly higher estimates of economic loss/hectare than producers ($\bar{x}$ = \$662.02, n = 123, SE = \$175.56) (M-W U = 92.0, df = 130, P < 0.001). Homeowners ($\bar{x}$ =

31.9, n = 41, SE = 5.1) also reported a greater percentage of plants lost or affected because of damage by deer than did producers ($\bar{x}$ = 20.8, n = 53, SE = 3.5), but this relationship was not significant (M-W U = 886.5, df = 93, P = 0.126).

Full-time producers (76.5%, n = 235) were more likely than part-time producers (60.8%, n = 93) to report experiencing damage by deer during 1995 (G = 12.1, df = 1, P = 0.001, γ = 0.356). One's production involvement and perception of the severity of damage also were dependent; full-time producers were more likely to perceive damage as being severe than were part-timers (G = 23.1, df = 3, P < 0.001, γ = 0.382; Figure 10). Full-time producers reported greater economic loss ($\bar{x}$ = \$10,482.76, n = 97, SE = \$2,240.05), greater economic loss/hectare ($\bar{x}$ = \$679.30, n = 93, SE = \$89.5), and a greater percentage of plants damaged by deer ($\bar{x}$ = 24.8, n = 36, SE = 4.4) than did part-time producers ($\bar{x}$ = \$1,591.25, n = 32, SE = \$349.70, $\bar{x}$ = \$608.46, n = 30, SE = \$227.33, and $\bar{x}$ = 12.9, n = 16, SE = 6.1, respectively) (M-W U = 625.0, df = 128, P < 0.001, M-W U = 1097.0, df = 122, P = 0.079, and M-W U = 174.0, df = 51, P = 0.023, respectively). Estimates of percent yield loss caused by deer did not differ between full- and part-time producers (M-W U = 904.0, df = 103, P = 0.828).

The likelihood of incurring damage by deer varied greatly among respondents who grew different commodities (Table 4). To reduce the number of cells with expected values < 5 and thus allow me to make statistical comparisons, I omitted responses given by producers of shrub fruits, miscellaneous crops, undefined crops, strawberries, tobacco, and pumpkins/melons (referred to as 'small commodity groups' hereafter) in latter analyses. With these groups omitted, I found a dependent relationship between the crop grown and the likelihood of experiencing damage from deer (G = 52.6, df = 8, P < 0.001). Producers of tree fruits and soybeans were most likely to incur deer damage (Res_{adj} = 3.6 and 2.3, respectively) whereas producers of forages and nursery plants were least likely to experience damage (Res_{adj} = -5.1 and -2.8, respectively). Perceptions about damage severity also varied greatly among respondents in different commodity groups (Table 4). With small commodity groups omitted, I found respondents who grew differing commodities and their reported severity of damage were dependent (G = 121.1, df = 24, P < 0.001). Producers of tree fruits (Res_{adj} = 4.9) were most likely to view damage as being severe whereas producers of forages (Res_{adj} = -3.5) were least likely to perceive the same.

Before attempting to test for differences in estimated economic loss and economic loss/hectare among producers in different commodity groups, I omitted any commodity group where < 5 respondents reported an economic loss estimate (shrub fruits, truck crops, forages, miscellaneous, undefined, strawberries, tobacco, pumpkins/melons, and alfalfa were omitted). Differences existed in the mean total economic loss and economic loss/hectare estimates provided by producers of Christmas trees, grains, nursery plants, peanuts, soybeans, and tree fruits (K-W χ^2 = 21.4, df = 5, P = 0.001, K-W χ^2 = 27.6, df = 5, P < 0.001; Table 5). Generally, producers of field crops (e.g., soybeans, peanuts, grains) reported relatively low economic loss/hectare, but, because of the large amount of land on which these commodities were grown, reported high total economic loss. To compare differences in estimates of the percentage of plants damaged by deer, I omitted all responses given by producers who grew crops other than tree fruits, nursery plants, and Christmas trees. I found no significant difference in the reported

percentage of plants damaged by deer among these producers (K-W χ^2 = 1.3, df = 2, P = 0.523, Table 5). I also compared estimates for loss of yield among commodity groups where $\geq$ 5 responses were received (alfalfa, miscellaneous crops, pumpkins/melons, shrub fruits, strawberries, tobacco, and undefined crops were omitted). With these groups removed, mean yield loss estimates differed among commodity groups (K-W χ^2 = 18.6, df = 7, P < 0.01; Table 5). Producers of tree fruits ($\bar{x}$ = 31.4, SE = 9.0, n = 11) and truck crops ($\bar{x}$ = 26.4, SE = 11.1, n = 5) reported the greatest yield loss whereas producers of forages ($\bar{x}$ 4.0, SE = 1.6, n = 5) and Christmas trees reported the lowest yield loss estimates.

I also compared perceptions about damage severity among homeowners who grew different plantings. Again, to reduce the number of cells with expected values < 5 and allow statistical comparisons, I omitted responses given by homeowners who reported growing shrub fruits, bedding fruits, miscellaneous plantings, and undefined plantings (referred to as 'small planting groups' hereafter) during 1995. With these groups omitted, I found no relationship between homeowners associated with different planting groups and their likelihood of experiencing deer damage (G = 4.3, df = 4, P = 0.362). Also, homeowners across the different planting groups displayed similar opinions concerning the severity of the deer damage they experienced (G = 12.4, df = 12, P = 0.416).

Among all respondents, there was a relationship between reported economic loss and one's perceptions about the severity of damage experienced (K-W χ^2 = 37.7, df = 2, P < 0.001). However, upon further examination, I found that this relationship existed only among producers (K-W χ^2 = 40.6, df = 2, P < 0.001; Figure 11) and not among homeowners (K-W χ^2 = 2.6, df = 2, P = 0.279). Similarly, reported economic loss/hectare and perceptions about damage severity were related (K-W χ^2 = 6.7, df = 2, P = 0.035). Again, this relationship existed only among producers (with two outliers omitted from the analysis) (K-W χ^2 = 8.3, df = 2, P = 0.016; Figure 12), but not among homeowners (K-W χ^2 = 1.1, df = 2, P = 0.574). Further, I detected a relationship between the estimate for the percentage of plants damaged and perception of damage severity among respondents (K-W χ^2 = 53.4, df = 2, P < 0.001). This relationship held among both producers and homeowners (K-W χ^2 = 26.9, df = 2, P < 0.001, K-W χ^2 = 27.6, df = 2, P < 0.001, P < 0.001; Figure 13). Finally, a producer's estimate of yield loss was related to the perception about damage severity (K-W χ^2 = 40.4, df = 2, P < 0.001; Figure 14), as those reporting higher yield loss also were more likely to believe damage was most severe.

Among all respondents, most (41.5%, n = 301) indicated that the type of damage they experienced in 1995 was similar to that incurred during the preceding 5-year period. However, 28.4% (n = 206) of individuals also indicated that they experienced more severe damage during 1995 than during the previous 5 years; 8.8% (n = 64) reported less damage by deer since 1990 and 21.2% (n = 154) expressed no opinion. Producers (38.8%) more often believed that damage had increased since 1990 than did homeowners (29.2%) (G = 6.15, df = 2, P < 0.046, γ = 0.129).

As would be expected, a respondent's experience with damage during 1995 and the perception of previous damage were highly dependent; those who incurred damage during 1995 were more likely to perceive an increase in damage compared with the previous 5 years (G = 312.1, df = 3, P < 0.001, γ = 0.780). Further, respondents' perceptions about damage severity and opinions of damage during 1995 compared with the previous 5 years also were dependent (G = 62.3, df = 6,

$P < 0.001$, $\gamma = 0.468$, Figure 15). This relationship held for producers ($G = 144.5$, df = 6, $P < 0.001$, $\gamma = 0.576$) and for homeowners ($G = 96.3$, df = 6, $P < 0.001$, $\gamma = 0.750$).

Among all respondents, individuals who incurred damage lived in counties with higher BH/km^2 estimates than did those who did not report damage ($\bar{x}_d = -0.32$, $t = -3.0$, df = 675, $P = 0.003$). This relationship held for both producers ($\bar{x}_d = -0.28$, $t = -2.0$, df = 449, $P = 0.049$) and homeowners ($\bar{x}_d = -0.42$, $t = -2.3$, df = 224, $P = 0.023$). A respondent's perception about damage severity was related to deer density (BH/km^2), as those living in counties with higher deer densities also were more likely to perceive damage as being severe ($F = 4.0$, df = 3, 673, $P = 0.007$). However, upon further inspection, I detected this relationship only among producers ($F = 4.4$, df = 3, 447, $P = 0.005$) and not within homeowners ($F = 2.1$, df = 3, 222, $P = 0.107$) (Figure 16).

Time of Damage

Respondents were asked to indicate when they observed damage to their plantings caused by deer by identifying all months during which damage occurred (i.e., respondents could select multiple months; see Q-8 in Appendix A). To increase sample sizes and statistical power, I pooled responses for individuals who grew the same primary and secondary plantings. Among all respondents, late summer and early fall were the periods during which damage most frequently occurred. Damage reported by producers followed the overall trend whereas homeowners observed damage more during late spring and early summer (Figure 17). The time of year when damage by deer was observed varied according to the planting produced for both producers and homeowners (Tables 6 and 7, respectively).

Respondents also were asked to identify the 1 month of the year during which damage from deer to their crops or plantings was most severe and then indicate whether that damage was a result of direct feeding activities or antler rubbing. Overall, 81.5% ($n = 317$) of respondents reported that the most severe damage was due to feeding activities of deer. Overall, this was consistent for both producers and homeowners ($G = 2.8$, df = 1, $P = 0.096$). However, producers of Christmas trees (49.3%, n = 16), nursery plants (47.7%, n = 21), and tree fruits (40.8%, n = 21) often reported severe damage to their plantings as a result of antler rubbing.

Overall, severe damage most often was observed during late spring and late summer. I found this same trend for both homeowners and producers, but a greater percentage of producers reported peak damage during late summer than did homeowners; homeowners reported peak damage during late spring (Figure 18). The time of year when the onset of damage was most severe varied by commodity group. Damage to crops susceptible to antler rubbing (e.g., fruit trees, nursery plants, Christmas trees) became increasingly severe beginning in August, peaked in October, and waned until December, when rubbing damage typically ceased (Figure 19). Peak damage because of direct feeding activities by deer was observed by producers most often in mid-to late summer (Figure 20).

Compensation Programs

Respondents were asked to provide their opinion about 3 different hypothetical scenarios as a means to assess their attitudes about monetary compensation for deer damage (see Appendix A, Q-30, 31, 32). Among all respondents, the greatest percentage (35.4%, $n = 259$) agreed with the statement "those affected by deer damage should not be compensated at all" (referred to hereafter as "no payment"). Respondents agreed to a lesser extent (30.9%, $n = 226$) with the statement "those affected by deer damage should be compensated with general state funds" (referred to hereafter as "state payment") and even less so with "hunters should pay a fee to compensate those affected by deer damage" (25.4%, $n = 186$) (referred to hereafter as "hunter payment").

Producers and homeowners differed in their opinions of "no payment" and "state payment" ($G = 30.0$, df = 2, $P < 0.001$, $\gamma = 0.329$; $G = 40.6$, df = 2, $P < 0.001$, $\gamma = 0.374$, respectively); 38.6% ($n = 182$) of producers, but only 16.9% ($n = 44$) of homeowners, agreed with the "state payment" option. In contrast, 45.4% ($n = 118$) of homeowners, but only 29.9% ($n = 141$) of producers, agreed with the "no payment" scenario. I found only a marginal difference between producers and homeowners with respect to their opinion on "hunter payment"; only 28.0% ($n = 132$) of producers and 20.8% ($n = 54$) of homeowners favored this option ($G = 5.8$, df = 2, $P = 0.054$, $\gamma = 0.079$).

Respondents' perceptions of their level of damage influenced their opinions on compensation programs. The likelihood of agreeing with "state payment" increased as the respondent's stated perception of damage severity increased ($G = 35.4$, df = 6, $P < 0.001$, $\gamma = 0.257$). In contrast, respondents were less likely to agree with "no payment" as severity of damage increased ($G = 26.0$, df = 6, $P < 0.001$, $\gamma = 0.209$; Figure 21). I found no relationship between perceived level of damage and a respondent's agreement with the "hunter payment" scenario ($G = 2.8$, df = 6, $P = 0.833$). The relationship between perceived level of damage and a respondent's opinion on "no payment" and "state payment" was stronger among producers ($G = 18.5$, df = 6, $P = 0.005$, $\gamma = 0.218$; $G = 17.1$, df = 6, $P = 0.009$, $\gamma = 0.140$, respectively) than among homeowners ($G = 5.2$, df = 6, $P = 0.525$, $\gamma = 0.092$; $G = 2.8$, df = 6, $P = 0.839$, $\gamma = 0.121$, respectively).

I found no differences of opinion regarding the "hunter," "state," and "no payment" options between full- and part-time producers ($G = 5.0$, df = 2, $P = 0.082$; $G = 5.9$, df = 2, $P = 0.052$; $G = 3.6$, df = 2, $P = 0.163$, respectively). Following the omission of small commodity groups, I found differences in respondents' opinion of "hunter," "state," and "no payment" options among those representing different commodity groups ($G = 33.5$, df = 16, $P = 0.006$; $G = 34.9$, df = 16, $P = 0.004$; $G = 31.7$, df = 16, $P = 0.011$, respectively, Table 8). Producers of alfalfa and other forages were most likely to agree with "hunter payment" ($Res_{adj} = 2.3$ and 2.6, respectively) whereas producers of soybeans were least likely to agree ($Res_{adj} = -3.0$). When considering a respondent's opinion of "state payment," producers of tree fruits were most likely to agree ($Res_{adj} = 1.9$) whereas producers of nursery plants were least likely to agree ($Res_{adj} = -2.3$). Finally, I found producers of nursery plants most likely to agree with the "no payment" option ($Res_{adj} = 3.7$) and grain producers were least likely to agree ($Res_{adj} = -1.8$). Due to a high number of cells with expected values < 5, I was unable to further evaluate these comparisons regarding whether a respondent experienced damage or was influenced by its severity.

Damage Prevention

One third of all respondents (33.6%, n = 245) reported using some type of deterrent method to prevent deer from damaging their plantings during 1995. Among those who used preventive methods, repellents (59.9%, n = 129) were cited most often as a means to prevent damage, followed by removal of deer by shooting (42.2%, n = 103), fencing to exclude animals (30.3%, n = 74), frightening devices (25.4%, n = 62), dogs (17.6%, n = 43), and physical deterrents (4.3%, n = 9). Overall, respondents rated physical deterrents (60.0%, n = 12) and removal by shooting (57.5%, n = 92) as most effective (i.e., "successful, but problem not eliminated" or "problem completely eliminated") and frightening devices (9.3%, n = 17) as least effective (Figure 22).

Producers (37.3%, n = 175) were more likely than homeowners (26.9%, n = 70) to use preventive measures to deter deer damage (G = 8.2, df = 1, P = 0.004, γ = 0.235). I also found differences in preference for some specific methods between producers and homeowners (Figure 23). Homeowners (42.0%, n = 29) used fencing more frequently than producers (25.7%, n = 45) (G = 6.0, df = 1, P = 0.016, γ = 0.354). In contrast, producers (54.3%, n = 95) were more likely than homeowners (11.6%, n = 8) to use removal of deer by shooting as a method of damage prevention (G = 41.5, df = 1, P < 0.001, γ = 0.801). However, because many homeowners lived in small cities or urban environments and may not have had the option of using shooting as a method of damage prevention, I examined responses of producers and homeowners who lived in rural or farm environments since 1990. In more rural areas, producers still were more likely than homeowners to use removal by shooting as a method of damage prevention in farm and rural environments (G = 5.0, df = 1, P = 0.025, γ = 0.604, G = 4.9, df = 1, P = 0.028, γ = 0.537; Figure 24).

Full-time producers were more likely than part-time producers to have used measures to deter deer from damaging their crops during 1995 (G = 16.9, df = 1, P < 0.001, γ = 0.412). No differences in preference among the control techniques were detected between full- and part-time producers, except that full-time producers (59.3%, n = 80) were more likely than part-time producers (37.8%, n = 14) to use removal by shooting (G = 5.4, df = 1, P = 0.02, γ = 0.410).

With small commodity groups removed from the analysis, I noted a difference in the implementation of preventive measures among those within different commodity groups (G = 54.3, df = 8, P < 0.001; Figure 25). Producers of tree fruits were most likely to implement deterrents during 1995 (Res_{adj} = 5.8) whereas producers of forages were least likely to take such action (Res_{adj} = -3.1). Although a large number of small expected values in cells prevented me from testing for differences in preferences for specific preventive techniques among commodity groups, a few subjective observations are worthy of mention (Table 9). Producers of nursery plants were more likely than others to use fencing as a means to minimize deer damage whereas producers of soybeans especially were unlikely to do so. Instead, producers of soybeans and other field crops (e.g., grains, peanuts, alfalfa, other forages) were most likely to use removal by shooting to prevent damage. Tree fruit producers were much more likely than any other group to use repellents to deter deer.

Respondents who reported experiencing damage (52.5%, n = 224) during 1995 were more likely than those not having any damage (7.0%, n = 21) to use some type of deterrent (G = 187.4, df = 1, P = 0.001, γ = 0.873). Use of preventive methods was related to a respondent's perception of

the level of damage incurred, where those reporting increasingly severe damage were more likely to adopt preventive measures (G = 211.3, df = 3, $P < 0.001$, $\gamma = 0.726$). Although producers overall were more likely than homeowners to use deterrents, the relationship did not hold among those who did not experience deer damage (G = 0.1, df = 1, P = 0.781, $\gamma = 0.016$). Among respondents claiming damage, homeowners (63.4%, n = 59) were more likely than producers (49.4%, n = 165) to use preventive measures (G = 5.8, df = 1, P = 0.016, $\gamma = 0.280$). Perceived level of damage severity affected homeowners' and producers' likelihood to implement preventive measures differently (Figure 26). Homeowners were more likely than producers to use preventive methods when perceiving only low or moderate damage (G = 6.3, df = 1, P = 0.012, $\gamma = 0.498$; G = 3.3, df = 1, P = 0.067, $\gamma = 0.339$, respectively). Among producers who did not report incurring damage, no differences between full- and part-time producers were noted regarding their likelihood to use preventive measures (G = 1.2, df = 1, P = 0.278). However, among those reporting damage, full-time producers (54.5%, n = 128) were more likely than part-time producers (37.6%, n = 35) to use deterrents (G = 7.6, df = 1, P = 0.006, $\gamma = 0.329$).

A respondent's decision to use a preventive method during 1995 also was related to their perception of damage over the previous 5 years (G = 128.6, df = 3, $P < 0.001$, $\gamma = 0.566$). A majority (61.2%, n = 126) of respondents who perceived an increase in deer damage over the previous 5 years used a preventive method during 1995. However, many (42.2%, n = 27) individuals who perceived that deer damage had declined over the preceding 5 years also used deterrents. Finally, only 26.3% (n = 79) of those who did not perceive any change in deer damage over this 5-year period used preventive measures during 1995.

To evaluate respondents' willingness to pay for deer damage preventive measures, I asked them to select 1 of 4 hypothetical payment options (see Appendix A, Q-18). A majority (51.3%, n = 354) were unwilling to pay for any preventive method and willingness to pay appeared to be inversely related to increasing cost of deterrence. I also detected a significant relationship between damage occurrence and a respondent's willingness to pay for damage prevention; those not incurring damage (65.3%, n = 190) were less willing to pay for preventive measures than those who experienced damage (41.1%, n = 164) (G = 47.3, df = 3, $P < 0.001$, $\gamma = 0.438$). Similarly, willingness to pay for damage prevention was positively correlated with perceived level of damage (G = 122.6, df = 9, $P < 0.001$, $\gamma = 0.465$, Figure 27).

I detected no difference in willingness to pay for damage prevention between homeowners and producers (G = 0.586, df = 3, P = 0.900). In contrast, full-time producers overall were more willing to pay for damage prevention than were part-time producers (G = 21.2, df = 3, $P < 0.001$, $\gamma = 0.326$). Full- and part-time producers who didn't report incurring damage during 1995 displayed a similar willingness to pay for damage prevention (G = 1.8, df = 3, P = 0.622); among producers who incurred damage during 1995, full-time producers were more willing to pay for preventive techniques than were part-time producers (G = 14.7, df = 3, P = 0.002, $\gamma = 0.338$; Figure 28). Among commodity groups, producers of tree fruits appeared most willing to pay for damage prevention, as comparatively few (22.4%, n = 13, $Res_{adj} = -4.6$) indicated they would not pay for deterrents. In contrast, 84.4% (n = 38, $Res_{adj} = 4.9$) of forage producers were not willing to pay for preventive measures (Table 10).

Vehicle/Deer Collisions

Overall, 9.2% (n = 67) of all respondents reported hitting a deer with a vehicle during 1995. Most respondents (79.1%, n = 53) experienced only 1 collision during the year; 15.9% (n = 10) reported having 2 collisions, 4.5% (n = 3) had 3 collisions, and 1.5% (n = 1) reported 6 vehicle/deer collisions during the year. Twenty-nine individuals (4.4%) had an accident because of a deer (e.g., accident occurred while trying to avoid a deer), but did not actually hit the animal.

When asked to consider only their first collision with a deer, most respondents (83.1%, n = 54) reported having sustained physical damage to the vehicle. Among those with vehicular damage, most (94.4%, n = 51) could provide an accurate estimate of the cost required to repair the vehicle ($\bar{x}$ = \$1,386, n = 51, SE = \$151, range = \$100 - \$4,700). Very few human injuries resulted from vehicle/deer collisions; only 3.1% (n = 2) of those who collided with a deer sustained injuries to themselves or reported injuries to other passengers. Neither of these individuals could estimate the cost of medical care necessary to treat the injuries. Most individuals (68.8%, n = 44) did not report the accident to a law enforcement agency. Collisions with deer were most likely to occur in September, October, and November; these 3 months accounted for 41.7% (n = 25) of all reported accidents (Figure 29). Collisions also occurred often during March (11.7%, n = 7) and July (10.0%, n = 6). Fewest collisions occurred among those living in urban areas (3.5%, n = 3) whereas those living on a farm were most likely to report a collision (11.9%, n = 45) during 1995 (G = 10.8, df = 3, P = 0.013, γ = 0.344; Figure 30).

Most respondents (52.8%, n = 383) characterized the danger of having a vehicle/deer collisions in their county as moderate (Figure 31). This perception was strongly influenced by a respondent's prior experience with vehicle/deer collisions; those who had had a collision during 1995 were much more likely to perceive the danger as being greater (G = 31.4, df = 2, P < 0.001, γ = 0.595; Figure 32). Producers and homeowners differed in their opinions about the danger of vehicle/deer collisions; producers generally perceived the threat of collisions with deer to be more dangerous (G = 42.9, df = 2, P < 0.001, γ = 0.446; Figure 33). I found no differences in BH/km^2 estimates between respondents who had and had not experienced a collision in Virginia during 1995 ($\bar{x}_d$ = 0.04, t = 0.7, df = 674, P = 0.506). However, I did note a significant positive linear relationship between respondents' perception of the danger of vehicle/deer collisions and the deer density in their home county (F = 15.7, df = 1, 24, P < 0.001; Figure 34). This trend existed for both producers and homeowners (F = 5.7, df = 1, 402, P = 0.017; F = 9.4, df = 1, 194, P = 0.002, respectively).

The likelihood of experiencing a vehicle/deer collision did not appear to differ for respondents living in different VDGIF administrative districts (G = 14.4, df = 9, P = 0.108). Higher incidences of collision occurred in Region 1, District 2 (14.8%, n = 16), Region 2, District 2 (16.0%, n = 8), and Region 4, District 1 (16.7%, n = 4). However, perceptions regarding the danger of vehicle/deer collisions differed significantly among those living in different VDGIF administrative districts (G = 35.4, df = 18, P = 0.008), but these differences appeared slight. Respondents living in Region 2, District 1 were more likely than others to perceive the danger of vehicle/deer collisions as being severe (Res_{adj} = 2.6). Respondents from Region 1, District 1 (Res_{adj} = 2.0), Region 3, District 2 (Res_{adj} = 2.2), and Region 5, District 1 (Res_{adj} = 2.5) were most likely to perceive the danger of vehicle/deer collisions as being negligible (Table 11).

Opinions about deer management options

Overall, most respondents (83.5%, $n = 611$) favored the use of recreational hunting as a means to manage deer populations in Virginia whereas introduction of predators to limit deer populations was not favored as a management tool (10.7%, $n = 78$) (Figure 35). To evaluate differences in attitudes about various deer management options, I compared homeowners' and producers' opinions about each listed management option (Figure 36). Producers were more likely than homeowners to favor hunting ($G = 13.4$, df = 2, $P = 0.001$, $\gamma = 0.316$). Homeowners were more likely to favor allowing nature to take its course ($G = 18.2$, df = 2, $P < 0.001$, $\gamma = 0.268$), use of contraception ($G = 22.3$, df = 2, $P < 0.001$, $\gamma = 0.290$), trapping and moving deer to another location ($G = 12.1$, df = 2, $P = 0.002$, $\gamma = 0.220$), and use of fencing and repellents as a means to manage conflicts ($G = 15.5$, df = 2, $P < 0.001$, $\gamma = 0.238$). Homeowners and producers did not differ in their opinion about supplemental feeding ($G = 4.5$, df = 2, $P = 0.107$), professional sharpshooters ($G = 2.1$, df = 2, $P = 0.348$), and the introduction of predators ($G = 3.6$, df = 2, $P = 0.163$). Regardless, these last 3 techniques were not deemed acceptable by either homeowners or producers.

The relationship between a respondent's activity and the opinion of hunting partially is explained by gender (Figure 37). Homeowners and producers who were females generally did not differ in their belief that recreational hunting was an appropriate means to manage Virginia's deer population ($G = 0.285$, df = 2, $P = 0.867$), nor did males in these two groups ($G = 1.2$, df = 2, $P = 0.550$, $\gamma = 0.146$). However, the strength of that belief among females was much lower than among males.

Because respondents viewed contraception as one of the most favored "non-lethal" management options, I chose this option as another means of contrasting opinions of homeowners and producers based upon gender. As before, homeowners and producers differed in their opinion on using contraception as a means to manage Virginia's deer population (Figure 38). Female homeowners were much more likely than female producers to agree with using contraception on deer ($G = 9.0$, df = 2, $P = 0.011$, $\gamma = 0.465$). However, I found no differences between male producers and male homeowners regarding their opinion about contraception ($G = 2.4$, df = 2, $P = 0.298$, $\gamma = 0.107$; Figure 39).

To allow a more comprehensive evaluation of factors that may affect people's attitudes about non-lethal management options, I selected options that generally are regarded as being non-lethal and that homeowners and producers expressed differing opinions of. Thus, I selected use of contraception, allowing nature to take its course, trapping and relocation, and fencing and repellents. Because the cells in these crosstabulations were not independent, I was unable to test for statistical independence.

Homeowners (39.8%) appeared more likely to agree with using non-lethal management options to manage Virginia's deer population than did producers (26.7%). These opinions about non-lethal management options also differed by gender (Figure 40). Respondents who were raised in urban situations were more likely to agree with the use of non-lethal management options (Figure 41). I found this trend in both producers and homeowners (Figure 42) and when contrasting males and females (Figure 43).

Deer Management Programs in Virginia

Overall, only 12.0% (n = 87) of respondents participated in $\geq$ 1 of the 3 deer management programs administered by VDGIF during 1995 (i.e., damage control assistance program [DCAP], deer management assistance program [DMAP], kill permit program [KPP]; see Appendix E for explanation of each program). Participation by respondents was greatest in KPP (70.1%, n = 61), followed by DCAP (33.3%, n = 29), and finally DMAP (28.7%, n = 25) (Figure 44). When asked to indicate satisfaction with each program they participated in during 1995 (see Q-28 in Appendix A), respondents gave DMAP the highest satisfaction ratings; 92.0% (n = 23) of all respondents reported moderate or complete satisfaction. DCAP received the lowest satisfaction ratings; 69.0% (n = 20) reported moderate or complete satisfaction with the program whereas 24.1% (n = 7) reported not being satisfied with the program at all. KPP was rated as being moderately satisfactory; 77.0% reported moderate or complete satisfaction with the program (Figure 44).

Respondents' stated activity was strongly related to their participation in VDGIF deer management programs; 18.1% (n = 85) of producers, but only 0.8% (n = 2) of homeowners participated in a VDGIF deer program during 1995 (G = 64.8, df = 1, P < 0.001, γ = 0.931). Similarly, participation by full-time producers (21.9%, n = 67) was greater than that of part-time producers (11.1%, n = 17) (G = 8.5, df = 1, P = 0.004, γ = 0.383). Participation in deer management programs also varied among commodity groups (G = 34.1, df = 8, P < 0.001; Figure 45). Peanut producers were most likely to participate in $\geq$ 1 VDGIF management programs (Res_{adj} = 3.7) whereas producers of Christmas trees (Res_{adj} = -2.7) and forages (Res_{adj} = -2.0) were least likely to do so.

Because so few (n = 2) homeowners participated in VDGIF deer management programs during 1995, I was unable to compare homeowner versus producer participation in a specific program (e.g., DMAP, DCAP, KPP). I found that production involvement and participation in DCAP were dependent, as 38.8% (n = 26) of full-time producers, but only 11.8% (n = 2) of part-time producers, participated in DCAP (G = 5.1, df = 1, P = 0.024, γ = 0.653). Full- and part-time producers did not differ in their participation in DMAP and KPP (G = 0.007, df = 1, P = 0.932; G = 0.932, df = 1, P = 0.932, respectively). It appeared that producers of tree fruits, shrub fruits, Christmas trees, strawberries, tobacco, and alfalfa were most likely to participate in KPP; every individual from these commodity groups who reported participating in a VDGIF program during 1995 participated in KPP. DMAP was most popular among those growing grains (30%), forages (50%), soybeans (50%), and strawberries (50%). DCAP also was popular among those growing grains (50%), tree fruits (42.9%), truck crops (42.9%), soybeans (41.7%), tobacco (50.0%), and alfalfa (100%) (Figure 46).

Producers who experienced damage (24.0%, n = 80) were much more likely than those who did not have damage (3.6%, n = 5) to participate in a VDGIF deer management program during 1995 (G = 34.2, df = 1, P < 0.001, γ = 0.786). This trend was stronger among full-time than part-time producers (G = 22.1, df = 1, P < 0.001, γ = 0.793; G = 7.0, df = 1, P = 0.008, γ = 0.696, respectively). Perceptions about damage severity and a respondent's participation in a VDGIF program were dependent; participation increased from 2.5% (n = 8) for those without damage to 36.0% (n = 41) for those reporting severe damage (G = 92.0, df = 3, P < 0.001, γ = 0.715). This

was true for all producers, but the trend among full-time producers was stronger than that among part-time producers (G = 47.3, df = 3, P < 0.001, γ = 0.657; G = 8.9, df = 3, P = 0.030, γ = 0.537, respectively; Figure 47). Among all producers, participation in KPP and DCAP increased as perceptions about the severity of damage grew increasingly severe, but participation in DMAP was not altered (G = 60.2, df = 3, P < 0.001, γ = 0.717; G = 31.3, df = 3, P = < 0.001, γ = 0.732; G = 6.1, df = 3, P = 0.108, γ = 0.367, respectively). Thus, perceptions about severity of damage greatly affected a producer's decision to first participate in a program and then about which program to participate in. With increasing damage, KPP was viewed as the program of choice, followed by DCAP, and then DMAP (Figure 48).

Attitudes about deer

To evaluate respondents' attitudes toward deer in Virginia during 1995 and to identify factors that may affect those opinions, respondents were asked to provide an opinion of 3 statements: 1) deer are a nuisance and should not be tolerated; 2) deer cause some problems, but I enjoy having them around; and 3) deer don't cause any problems (see in Appendix A, Q-52 – 54). Overall, most respondents (76.2%, n = 557) believed deer cause some problems in Virginia, but they enjoy them nevertheless. Deer were viewed as a nuisance by 19.3% (n = 141) of respondents whereas very few (7.4%, n = 54) respondents believed that deer don't cause any problems in Virginia (Figure 49).

Producers (24.7%, n = 116) were more likely than homeowners (9.6%, n = 25) to perceive deer as a nuisance species in Virginia (G = 27.3, df = 2, P < 0.001, γ = 0.326). In contrast, homeowners (83.1%, n = 217) were more likely than producers (72.3%, n = 340) to express their enjoyment of deer regardless of the problems they cause (G = 18.6, df = 2, P < 0.001, γ = 0.316). Producers and homeowners did not differ in their belief that deer are causing problems in Virginia (G = 4.5, df = 2, P = 0.105).

Full-time producers (31.0%, n = 95) were more likely than part-time producers (13.1%, n = 20) to perceive deer as being a nuisance in Virginia (G = 19.0, df = 2, P < 0.001, γ = 0.335). Part-time producers (82.4%, n = 126) more so than full-time producers (67.0%, n = 205) reported enjoying deer regardless of the problems they cause (G = 14.4, df = 3, P = 0.001, γ = 0.386). These groups did not differ with respect to their belief that deer are causing problems in Virginia (G = 0.915, df = 2, P = 0.633).

Respondents who did not experience deer damage during 1995 were more likely than those who incurred damage to express enjoyment of deer regardless of problems and to believe that deer don't cause any problems in Virginia (G = 35.0, df = 2, P < 0.001, γ = 0.458; G = 33.6, df = 2, P < 0.001, γ = 0.400, respectively). In contrast, respondents who incurred damage during 1995 were much more likely to perceive deer as a nuisance (G = 77.9, df = 2, P < 0.001, γ = 0.566). Perceptions about the level of damage incurred also affected a respondent's opinion of deer; those reporting severe deer damage displayed an increased likelihood to perceive deer as a nuisance (G = 132.3, df = 6, P < 0.001, γ = 0.544; Figure 50). Those reporting more severe damage also were less likely to believe that deer don't cause any problems or to enjoy deer regardless of problems (G = 31.0, df = 6, P < 0.001, γ = 0.278; G = 94.9, df = 6, P < 0.001, γ = 0.510, respectively; Figure 50).

Homeowners and producers differed in their belief that "deer are a nuisance" and whether "they enjoy deer regardless of the problems they cause," but these differences appeared to stem from whether the respondent had experienced any damage. However, the strength of the relationship between a respondent's activity and the belief that deer are a nuisance among those reporting low or moderate deer damage was greatly reduced (γ =0.107; γ = 0.085, respectively). Likewise, I found relationships among homeowners and producers who reported either no damage or severe damage (G = 6.6, df = 2, P = 0.037, γ = 0.235; G = 10.4, df = 2, P = 0.005, γ = 0.285; Figure 51). A similar situation was detected for expressed enjoyment of deer regardless of the problems they cause among homeowners and producers when segregated by perceptions regarding damage (Figure 52). Again, those who didn't report damage or reported low or moderate damage had similar beliefs regarding this statement whereas those reporting severe damage differed marginally (G = 6.1, df = 2, P = 0.047, γ = 0.324).

As noted above, full-time producers were more likely than part-time producers to perceive deer as being a nuisance. By comparing respondents based upon whether they reported deer damage during 1995, I found that the differences in this attitude partially were affected by the likelihood of having experienced damage. When considering only producers who had not experienced any damage during 1995, the relationship between production involvement and the belief that "deer are a nuisance" was virtually eliminated (γ = 0.091). In contrast, a weak relationship still existed between production involvement and the belief that "deer are a nuisance" among producers who experienced damage during 1995 (γ = 0.390) (Figure 53). Low expected values did not allow me to make comparisons among part- and full-time producers based on perception of damage.

Opinions on these 3 attitudinal statements varied among producers of different agricultural commodities (Table 12). Following the omission of small commodity groups, I found commodity group and the belief that "deer are a nuisance" were statistically dependent (G = 62.3, df = 16, P < 0.001). Producers of tree fruits (53.1%, n = 34, Res_{adj} = 5.6) were most likely to believe deer are a nuisance whereas producers of forages (6.4%, n = 3, Res_{adj} = -2.3) and Christmas trees (11.4%, n = 5, Res_{adj} = -2.2) were not. I also detected differences of opinion among commodity groups in their enjoyment of deer (G = 36.3, df = 16, P = 0.003). Producers of forages (85.1%, n = 40, Res_{adj} = 2.2) and Christmas trees (84.1%, n = 40, Res_{adj} = 2.0) were most likely to express enjoyment whereas producers of tree fruits (48.4%, n = 31, Res_{adj} = -4.4) did not agree with this view. Due to the high number of cells with expected values < 5, I could not test for differences in the belief that "deer don't cause any problems" among producers in the various commodity groups. However, a subjective evaluation suggests that differences do not exist because a vast majority of all group disagreed with this view. Similarly, a large numbers of cells with expected values < 5 prevented me from determining whether experience with damage affected attitudes about deer among commodity groups.

Respondents who believed the threat of vehicle/deer collisions was dangerous were increasingly likely to perceive deer as a nuisance (G = 71.5, df = 4, P < 0.001, γ = 0.486) and less likely to indicate an enjoyment of deer regardless of problems (G = 34.5, df = 4, P < 0.001, γ = 0.420; Figure 54). Similarly, those perceiving the threat of vehicle/deer collisions as increasingly dangerous were unlikely to believe that deer don't cause problems (G = 44.7, df = 4, P < 0.001, γ = 0.404; Figure 54). Though homeowners and producers often differed in their opinion of deer,

perceptions regarding the danger of vehicle/deer collisions strongly affected both groups' perceptions about deer.

Future Management of Virginia's Deer Population

Overall, most respondents (35.8%, $n = 262$) believed that Virginia's deer population should be subjected to a moderate reduction; very few (0.5%, $n = 4$) supported a dramatic increase of deer (Figure 55). Because so few individuals expressed a desire for any population increase (5.8%, $n = 38$), a large percentage (> 20%) of cells often had values < 5 when I made comparisons. Thus, I regrouped responses into 3 categories reflecting the respondents' general desire for future deer management: increase population, stabilize population, or decrease population. In many instances, I compared respondents who suggested dramatically reducing the population (the greatest level of population reduction offered as a choice to respondents) against all other respondents to identify factors that may produce the greatest level of intolerance.

I noted no difference in the desire for deer population management between homeowners and producers ($G = 2.6$, df = 2, $P = 0.269$). Although both homeowners and producers typically suggested a population decrease, producers (22.6%, $n = 106$) more often opted for the most extreme reduction (e.g., "dramatic" reduction) than did homeowners (14.2%, $n = 37$) ($G = 7.8$, df = 1, $P = 0.005$, $\gamma = 0.276$). Similarly, no differences were noted between full- and part-time producers with respect to their general opinion for deer population management (i.e., both groups wanted a population reduction) ($G = 1.4$, df = 2, $P = 0.508$, $\gamma = 0.108$). However, I did note a slight difference between these groups regarding the level of reduction desired; 25.2% ($n = 77$) of full-time producers, but only 17.0% ($n = 26$) of part-time producers, desired a "dramatic" population reduction ($G = 4.1$, df = 1, $P = 0.044$, $\gamma = 0.243$).

Whether a respondent experienced damage during 1995 influenced attitude concerning future deer population management; 65.2% ($n = 161$) of those who had not incurred damage believed the population should be reduced whereas 84.7% ($n = 350$) of those who had damage believed so ($G = 34.3$, df = 2, $P < 0.001$, $\gamma = 0.483$). Further, a greater percentage (29.8%, $n = 127$) of respondents who had damage desired a dramatic reduction in the population that did those without damage (5.2%, $n = 16$) ($G = 78.1$, df = 1, $P < 0.001$, $\gamma = 0.769$).

A respondent's perception of the level of damage incurred also greatly influenced the desire concerning future management of Virginia's deer population; 64.8% ($n = 171$) of those who had no damage wanted to decrease the population, but 94.7% ($n = 108$) of those who characterized their damage as severe wanted fewer deer ($G = 66.4$, df = 6, $P < 0.001$, $\gamma = 0.517$; Figure 56). Comparing only the specific desire for a "dramatic" population decrease among all levels of damage severity yielded an even stronger relationship; the percentage of respondents desiring a "dramatic" reduction ranged from 5.9% ($n = 19$) of those without damage to 53.8% ($n = 63$) of those claiming severe damage ($G = 122.3$, df = 3, $P < 0.001$, $\gamma = 0.676$; Figure 57).

Perceptions regarding damage severity had less of an effect on homeowners' future deer management desires than on producers'. Among homeowners, the percentage of respondents who wanted a population reduction increased from 71.6% ($n = 96$) among those with no damage to 95.2% ($n = 20$) among those with severe damage ($G = 21.5$, df = 6, $P = 0.001$, $\gamma = 0.502$). In contrast, only 57.7% ($n = 75$) of producers with no damage wanted a population reduction

whereas 94.6% (n = 88) of those with severe damage desired the same (G = 56.0, df = 6, P < 0.001, γ = 0.565; Figure 58).

Respondents' experience with vehicle/deer collisions did not affect their overall desire for future deer population management; a majority of those who reported experiencing a vehicle/deer collision as well as a majority of those who did not report a collision (79.1% and 77.3%, respectively) desired a general population reduction (G = 0.3, df = 2, P = 0.877). More specifically, respondents' experience with vehicle/deer collisions affected their opinion on whether Virginia's deer populations should be "dramatically" reduced; 18.0% (n = 119) of those who had not experienced a collision and 35.8% (n = 24) of those who experienced a vehicle/deer collision during 1995 expressed this desire (G = 10.7, df = 1, P = 0.001, γ = 0.435). More respondents who perceived a greater potential danger of vehicle/deer collisions wanted to see Virginia's deer population reduced in the future than did those who believed vehicle/deer collisions were less dangerous (G = 66.5, df = 4, P < 0.001, γ = 0.631; Figure 59). Similarly, those perceiving a greater threat of vehicle/deer collisions were much more likely to want a "dramatic" decrease of deer populations (G = 82.5, df = 2, P < 0.001, γ = 682; Figure 60).

Opinions regarding future deer population management varied by commodity group (Table 13). However, due to a large number of cells with expected values < 5, I was unable to test for statistical independence. Producers of tree fruits (92.1%, n = 58, Res_{adj} = 3.0) were most likely to want a population decrease whereas producers of forages (32.6%, n = 14, Res_{adj} = 2.7) were most likely to desire a stabilization of Virginia's deer population. Opinions on whether the herd should be reduced "dramatically" also differed among commodity groups (G = 37.6, df = 8, P < 0.001). Producers of tree fruits (45.3%, n = 29, Res_{adj} = 4.4) were more likely to want a "dramatic" reduction in deer populations whereas producers of Christmas trees (2.3%, n = 1, Res_{adj} = -3.5) were least likely to agree with such a view.

I found a significant positive linear relationship between a respondent's desire for future deer management and deer density (BH/km^2) in a respondent's county (F = 10.2, df = 1, 611, P = 0.001; Figure 61). The mean deer density index increased consistently from 1.03 (SE = 0.077) among those who desired a moderate population increase to 1.52 (SE = 0.044) among those who wanted a dramatic population reduction. Similarly, respondents who wanted a "dramatic" population reduction lived in counties with greater deer density (BH/km^2) than did others ($\bar{x}_d$ = -0.150, t = -3.0, df = 674, P = 0.003). The relationship between deer density (BH/km^2) and population management desires held among producers (F = 8.9, df = 2, 426, P = 0.003), but was only marginal for homeowners (F = 3.1, df = 2, 189, P = 0.080) (Figure 62).

Role of Recreational Hunting on Respondents' land

Among all respondents, 50.3% (n = 363) allowed others (e.g., non-family) to hunt for deer on their land during 1995. Similarly, 50.2% (n = 361) allowed others to hunt for deer on their land at some point during the preceding 5-year period (1990 – 1994). Also, 40.5% (n = 293) hunted for deer themselves or allowed other family members to hunt on their land. Also, 42.9% (n = 310) hunted or allowed other family members to hunt for deer on their land during the preceding 5 years (1990 – 1994). Overall, 34.5% (n = 249) respondents allowed family members and other individuals to hunt for deer on their lands during 1995.

Producers (70.9%, n = 332) were much more likely than homeowners (12.2%, n = 31) to allow others to hunt on their land during 1995 (G = 248.3, df = 1, P < 0.001, γ = 0.892). Also, producers (55.9%, n = 262) were more likely (12.2%, n = 31) to hunt or allow family members to hunt on their land than were homeowners (G = 144.0, df = 1, P < 0.001, γ = 0.802). Producers also were more likely than homeowners to allow others to hunt on their land and hunt or allow other family members to hunt on their land during the previous 5 years (G = 257.4, df = 1, P < 0.001, γ = 0.901; G = 171.4, df = 1, P < 0.001, γ = 0.835, respectively).

Full-time producers allowed others to hunt on their land during 1995 and during the preceding 5-year period (1990 – 1994) more often did part-timers (G = 7.4, df = 1, P = 0.007, γ = 0.284; G = 14.1, df = 2, P < 0.001, γ = 0.385, respectively). Full-time producers hunted or allowed family members to hunt on their land during 1995 and during the previous 5 years more commonly than did part-timers (G = 6.6, df = 1, P = 0.010, γ = 0.250; G = 4.7, df = 1, P = 0.030, γ = 0.214, respectively).

The tendency to allow hunting varied by commodity group (Figure 63), but high numbers of cells with expected values < 5 did not allow me to test this observation for statistical independence. Following the omission of small commodity groups, I did find that commodity groups differed in their tendency to allow others to hunt on their land during 1995 and over the previous 5 years (G = 52.8, df = 8, P < 0.001; G = 55.0, df = 8, P < 0.001, respectively). Producers of soybeans (91.2%, %, n = 52, Res_{adj} = 3.9) and peanuts (100%, n = 19, Res_{adj} = 3.0) were most likely to allow others to hunt on their land during 1995 whereas producers of nursery plants (47.8%, n = 11, Res_{adj} = -4.4) and truck crops (47.8%, n = 11, Res_{adj} = -2.3) did not. Similarly, the likelihood of whether a respondent hunted or allowed family members to hunt on their land during 1995 and the previous 5 years differed significantly by commodity group (G = 54.3, df = 8, P < 0.001; G = 54.3, df = 8, P < 0.001, respectively). Producers of soybeans (73.7%, n = 42, Res_{adj} = 3.5), peanuts (94.7%, n = 18, Res_{adj} = 3.8), and grains (71.2%, n = 37, Res_{adj} = 2.9) were most likely to hunt or allow family members to hunt on their land during 1995 whereas producers of nursery plants (36.6%, n = 30, Res_{adj} = -3.2) and truck crops (26.1%, n = 6, Res_{adj} = -2.6) were least likely to do so.

Respondents with the most severe deer damage were more likely to hunt or allow family members to hunt on their land during 1995 (G = 111.4, df = 3, P < 0.001, γ = 0.555). A similar relationship was observed when considering only homeowners or only producers (G = 18.5, df = 3, P < 0.001, γ = 0.569; G = 42.0, df = 3, P < 0.001, γ = 0.434, respectively; Figure 64). Respondents with more severe damage were more likely to have allowed others to hunt on their land during 1995 (G = 149.3, df = 3, P < 0.001, γ = 0.612). This same relationship was observed among homeowners and producers (G = 19.4, df = 3, P < 0.001, γ = 0.568; G = 59.6, df = 3, P < 0.001, γ = 0.511, respectively; Figure 65).

A respondent's gender influenced whether they hunted or allowed family members to hunt on their land during 1995; females (13.7%, n = 18) were less likely than males (47.0%, n = 271) to do so (G = 55.1, df = 1, P < 0.001, γ = 0.696). These same tendencies existed among producers and homeowners, but the relationships were not as strong (G = 5.9, df = 1, P = 0.015, γ = 0.417; G = 6.3, df = 1, P = 0.012, γ = 0.499, respectively; Figure 66). Respondents' gender and whether they allowed others to hunt on their land during 1995 were also dependent; 17.4% (n = 23) of

females and 57.8% (n = 332) of males allowed others to hunt on their property (G = 75.0, df = 1, $P < 0.001$, $\gamma = 0.733$). Again, gender affected both producers' and homeowners' decision on whether to allow others to hunt on their land during 1995, but the relationships were not as strong (G = 6.2, df = 1, P = 0.013, $\gamma = 0.431$; G = 6.5, df = 1, P = 0.011, $\gamma = 0.506$, respectively).

A respondent's opinion on the use of recreational deer hunting as a management tool in Virginia and whether they allowed hunting (respondent or family) during 1995 were dependent (G = 29.6, df = 2, $P < 0.001$, $\gamma = 0.468$). The percentage of respondents that hunted or allowed family members to hunt on their land during 1995 increased consistently from 9.6% (n = 5) among those who disagreed with hunting to 44.0% (n = 267) among those who agreed with the use of hunting as a management tool. I found this relationship among both producers and homeowners (G = 10.6, df = 2, P = 0.005, $\gamma = 0.293$; G = 16.6, df = 2, $P < 0.001$, $\gamma = 1.000$, respectively; Figure 67). I observed this same pattern with respect to respondents' allowance of others hunting on their land during 1995; the percentage of respondents who allowed others to hunt on their property increased from 11.8% (n = 6) among those who disagreed with hunting to 55.4% (n = 336) among those who favored hunting as a management tool. Again, similar patterns existed among both producers and homeowners (G = 26.9, df = 2, $P < 0.001$, $\gamma = 0.591$; G = 11.2, df = 2, P = 0.004, $\gamma = 0.814$, respectively; Figure 68).

Among all respondents, the likelihood of hunting or allowing family members to hunt for deer on their land increased consistently over the 1990 – 1995 period. During 1990, only 36.3% (n = 266) of respondents hunted or allowed family members to hunt deer on their land; by 1995, this figure had increased to 40.0% (n = 293). I found a similar trend among producers, but only marginally so among homeowners (Figure 69). Respondents increasingly allowed others to hunt on their land over the 1990 – 1995 period. The percentage of respondents who allowed others to hunt for deer on their land increased from 41.4% (n = 303) during 1990 to 49.6% (n = 363) during 1995. Again, this trend was especially apparent among producers, but less so among homeowners (Figure 70).

Overall, respondents or other family members spent an average of 21.0 (n = 267, SE = 3.1) hunter-days (1 individual hunting for 8 hours) hunting for deer on the respondent's land. Additionally, respondents reported that other individuals spent an average of 50.3 (n = 314, SE = 10.9) hunter-days hunting for deer on their land. The mean number of hunter-days (by the respondent, family members, or other individuals) spent hunting for deer on respondents' land was 58.8 days (n = 363, SE = 11.1).

Producers reported a greater number of hunter-days ($\bar{x}$ = 61.2, n = 329, SE = 12.2) spent deer hunting on their land during 1995 than did homeowners ($\bar{x}$ = 35.2, n = 34, SE = 10.6), but this difference was not significant (t = 0.7, df = 361, P = 0.497). Full-time producers reported a greater number of hunter-days being spent hunting for deer on their land than did part-time producers ($\bar{x}_d$ = 46.8, t = 2.4, df = 298.9, P = 0.016).

The mean number of hunter-days spent hunting for deer on respondents' land varied by commodity during 1995. With small commodity groups and 1 outlier removed from the analysis, I found a significant difference among commodities in the total number of hutner-days spent deer hunting on respondents' land (F = 2.3, df = 8, 265, P = 0.023; Figure 71). Producers

of soybeans ($\bar{x}$ = 97.2, n = 48, SE = 21.3) reported the most hunter-days spent deer hunting on their land whereas producers of alfalfa ($\bar{x}$ = 14.8, n = 7, SE = 6.4) reported the fewest.

Overall, the mean number of hunter-days spent deer hunting on respondents' land did not differ according to respondents' perceptions regarding the level of damage incurred (F = 1.9, df = 3, 359, P = 0.136), but, when considering only producers (with small commodity groups and 1 outlier removed), I did note a significant positive linear relationship between the total number of hunter-days spent hunting on the respondents' land and the respondents' characterization of damage severity (F = 11.4, df = 1, 270, P = 0.001; Figure 72). I did not observe this relationship among homeowners (F = 0.0, df = 1, 30, P = 0.983).

Among all respondents, 67.5% (n = 488) could identify the number of other properties that bordered their land ($\bar{x}$ = 5.7, SE = 0.26). Of those, 71.5% (n = 348) also knew how many of the bordering lands were hunted during 1995 ($\bar{x}$ = 3.0, SE = 0.22). With these estimates, I calculated the ratio of the number of hunted bordering landholdings to the total number bordering landholdings (referred to as "hunted lands to total lands" hereafter). Overall, the average ratio of hunted lands to total lands was 0.54 (SE = 0.02). Producers (69.9%, n = 328) were better than homeowners (63.0%, n = 160) in knowing the number of bordering lands, but I detected no difference in their ability to estimate the number that were hunted during 1995 (G = 3.6, df = 1, P = 0.058, γ = 0.155; G = 1.1, df = 1, P = 0.288, respectively). Producers reported a greater number of bordering lands and hunted bordering lands than did homeowners ($\bar{x}_d$ = 2.78, t = 5.5, df = 388.5, P < 0.001; $\bar{x}_d$ = 3.38, t = 10.5, df = 280.1, P < 0.001, respectively). Similarly, producers reported a higher ratio of hunted lands to total lands than did homeowners ($\bar{x}_d$ = 0.429, t = 11.0, df = 346, P < 0.001). Part-time producers (77.1%, n = 118) were more likely than full-time producers (66.2%, n = 202) to know how many landholdings bordered their land (G = 5.9, df = 1, P = 0.015, γ = 0.264), but full-time producers could estimate the number of bordering lands that were hunted during 1995 better than could part-timers (64.4%, n = 76) (G = 2.9, df = 1, P = 0.089, γ = 0.210). Full-time producers also reported a greater number of bordering lands and hunted bordering lands than did part-time producers ($\bar{x}_d$ = -1.90, t = -3.2, df = 308.7, P = 0.001; $\bar{x}_d$ = -1.78, t = -3.4, df = 220.0, P = 0.001, respectively). Also, the ratio of hunted lands to total lands was greater for full-time producers than for part-time producers, but this difference was only marginally significant ($\bar{x}_d$ = -0.092, t = -1.9, df = 221, P = 0.054).

I found a significant positive linear relationship between respondents' perception of damage severity and the ratio of hunted lands to total lands surrounding their property (F = 3.9, df = 1, 344, P < 0.001). This relationship persisted when I considered only producers, but did not exist when I evaluated only homeowners (F = 12.0, df = 1, 224, P = 0.001; F = 1.1, df = 1, 116, P = 0.305, respectively; Figure 73). Similarly, a linear relationship existed between the ratio of hunted lands to total lands and respondents' perceived damage severity among full-time producers (F = 9.5, df = 1, 143, P = 0.003), but not among part-time producers (F = 1.2, df = 1, 72, P = 0.274) (Figure 74).

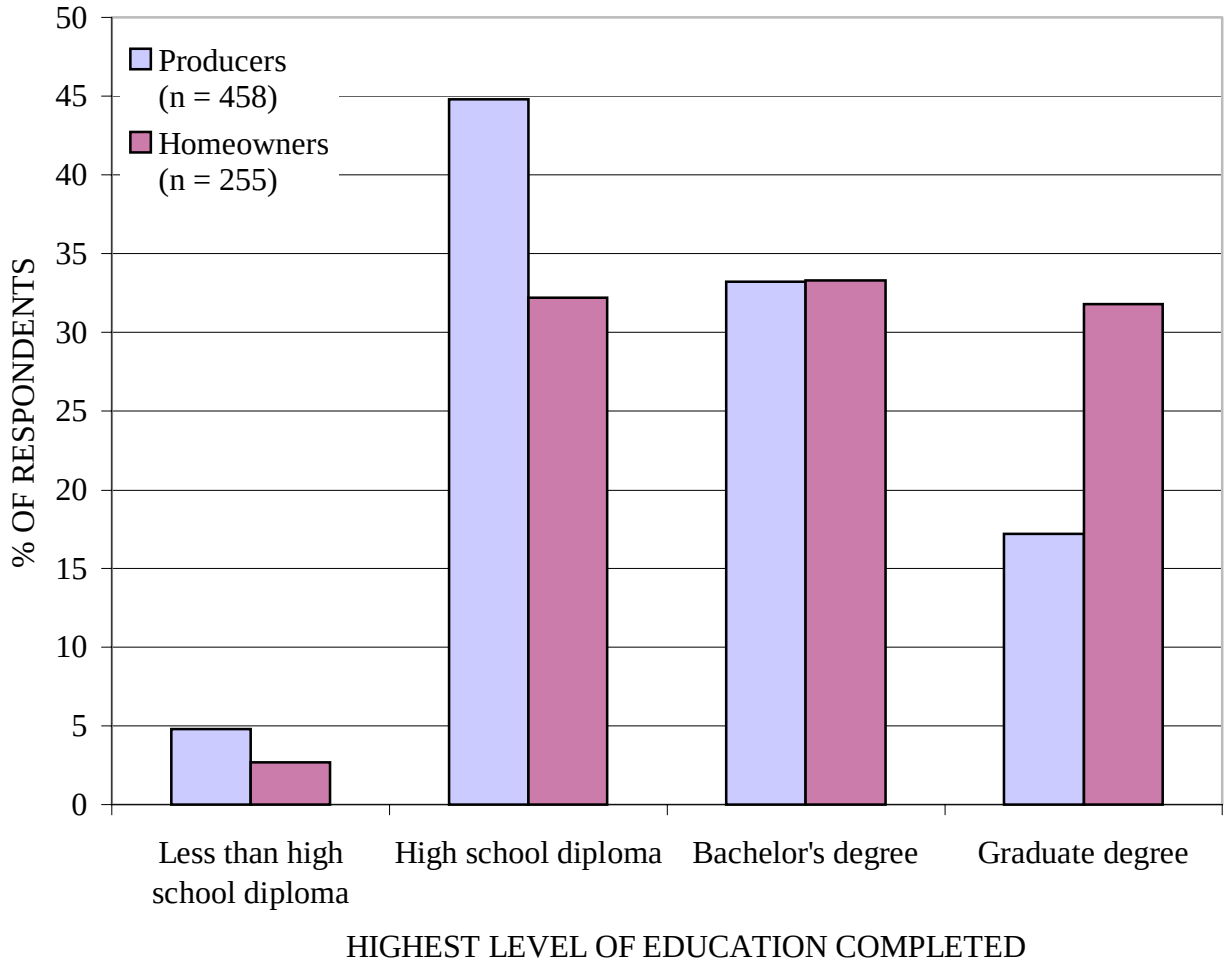

Figure 1. Highest level of education completed by producers and homeowners, as reported by respondents to a survey on deer damage in Virginia during 1995.

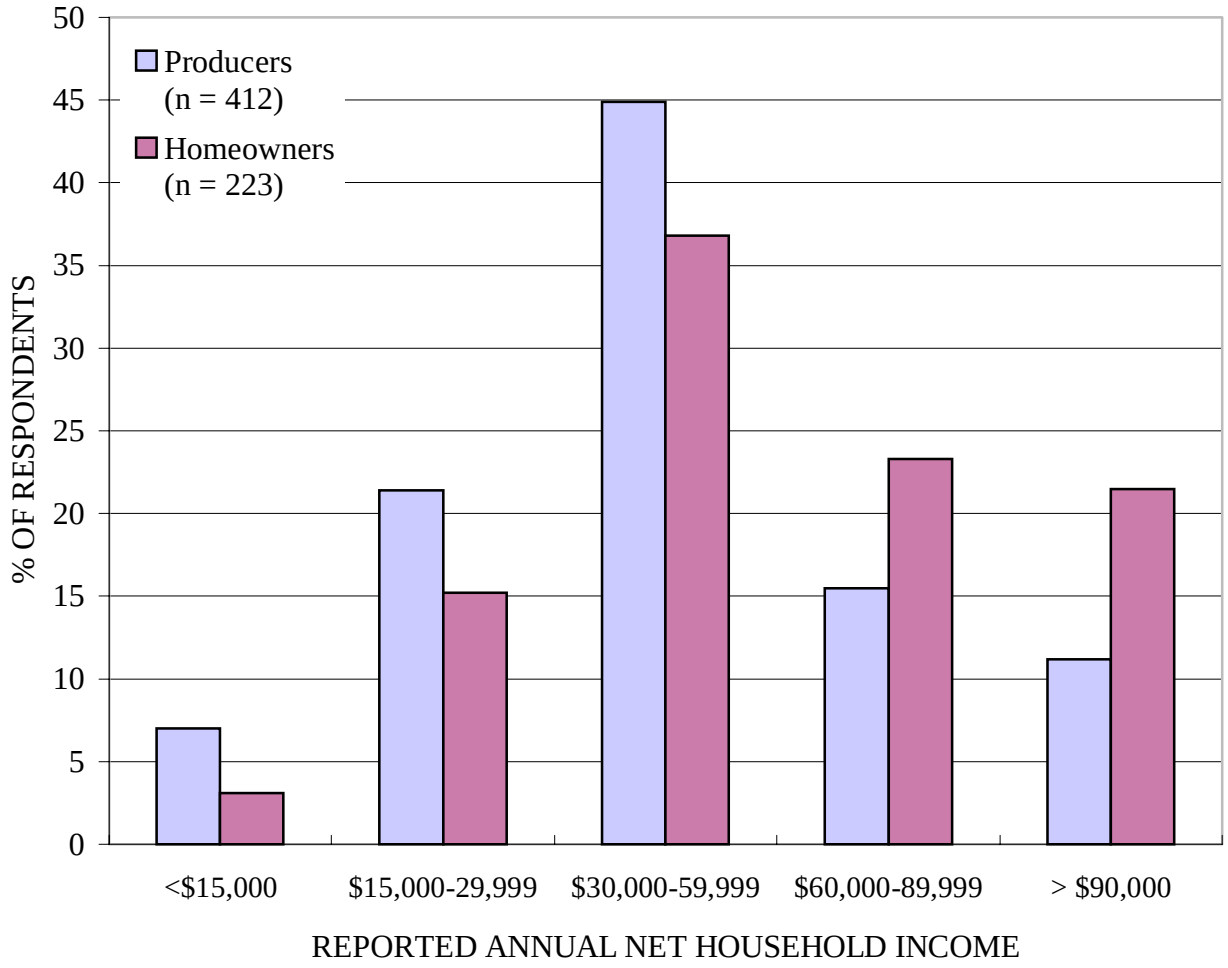

Figure 2. Annual net household income, as reported by producers and homeowners to a survey on deer damage in Virginia during 1995.

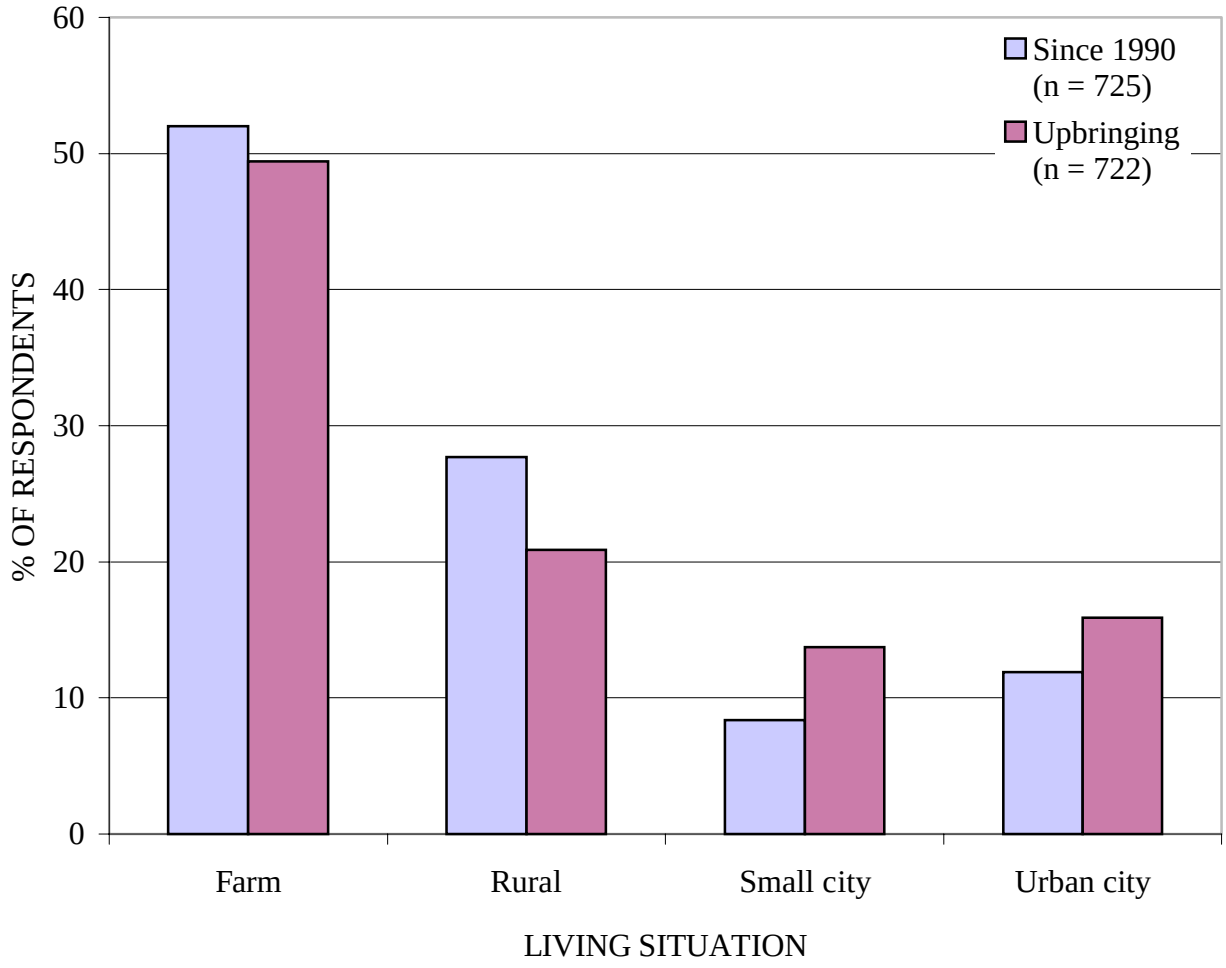

Figure 3. Environment in which respondents to a survey on deer damage in Virginia initially were raised and then lived during the period 1990 through 1995 (see Q-59 in Appendix A for a description of each living situation).

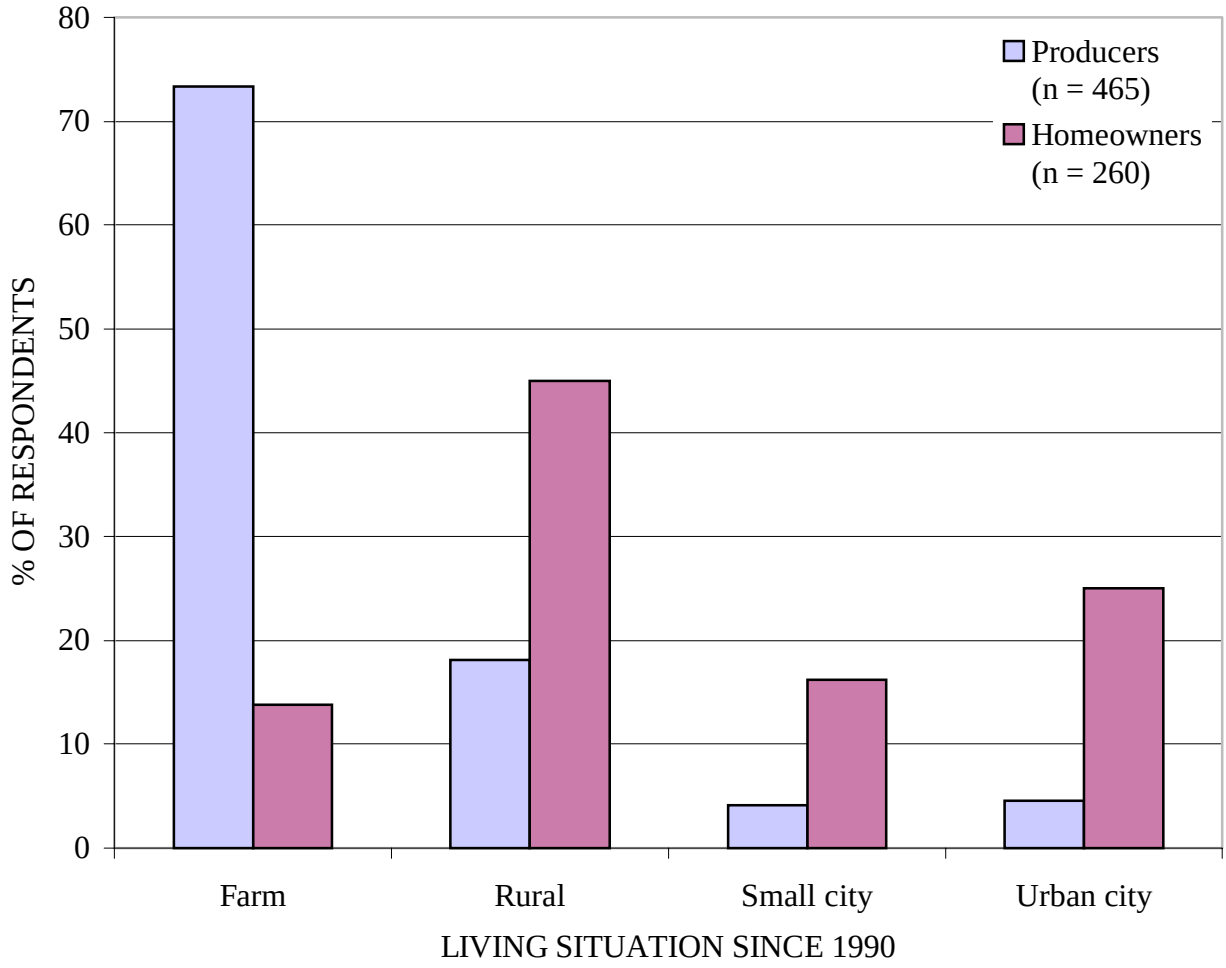

Figure 4. Environment in which respondents (homeowners versus producers) to a survey on deer damage lived from 1990 through 1995 (see Q-59 in Appendix A for a description of each living situation).

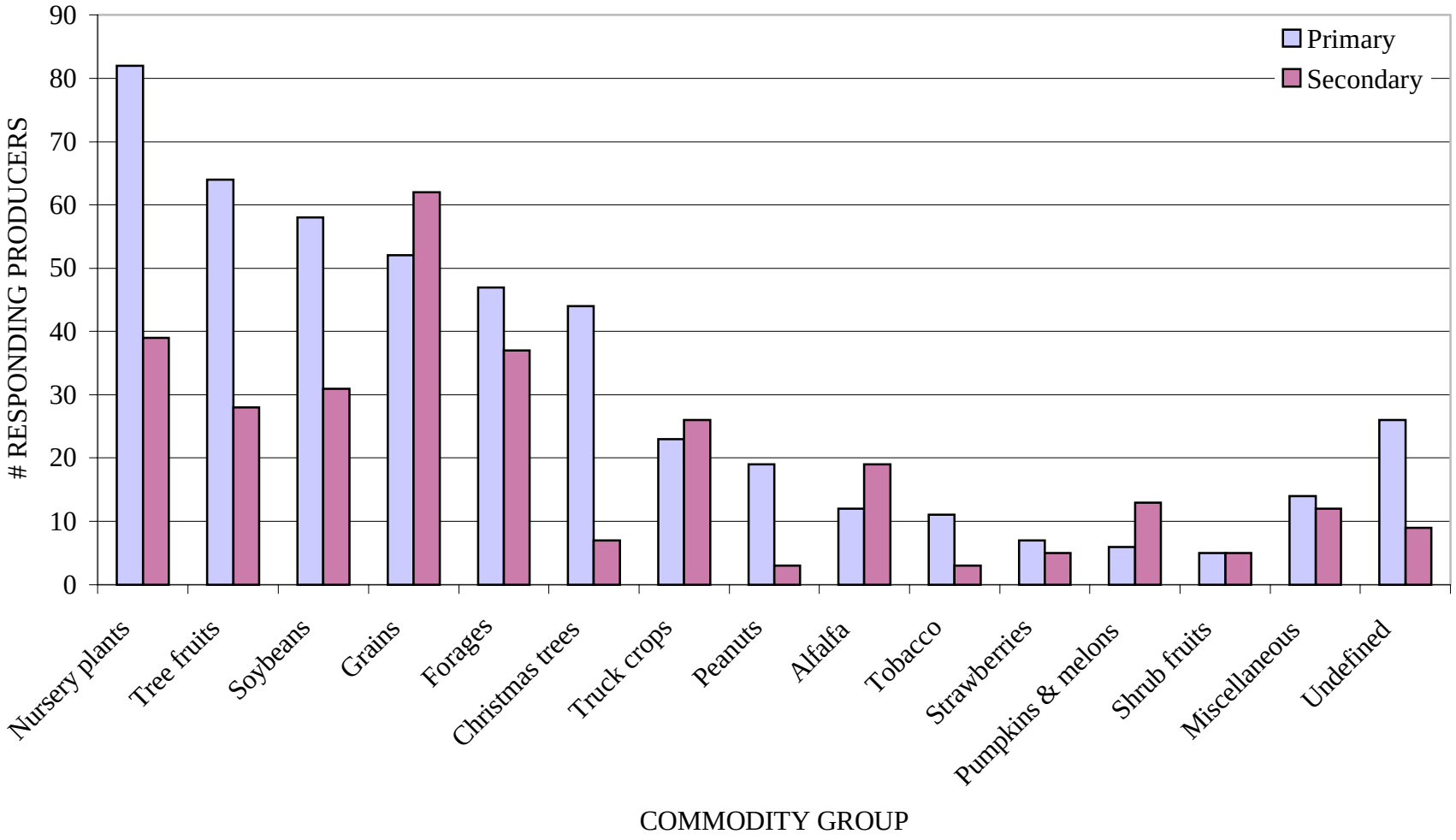

Figure 5. Distribution of primary and secondary crops raised by agricultural producers in Virginia during 1995, as reported by respondents to a survey on deer damage (see Appendix B for explanation of each group).

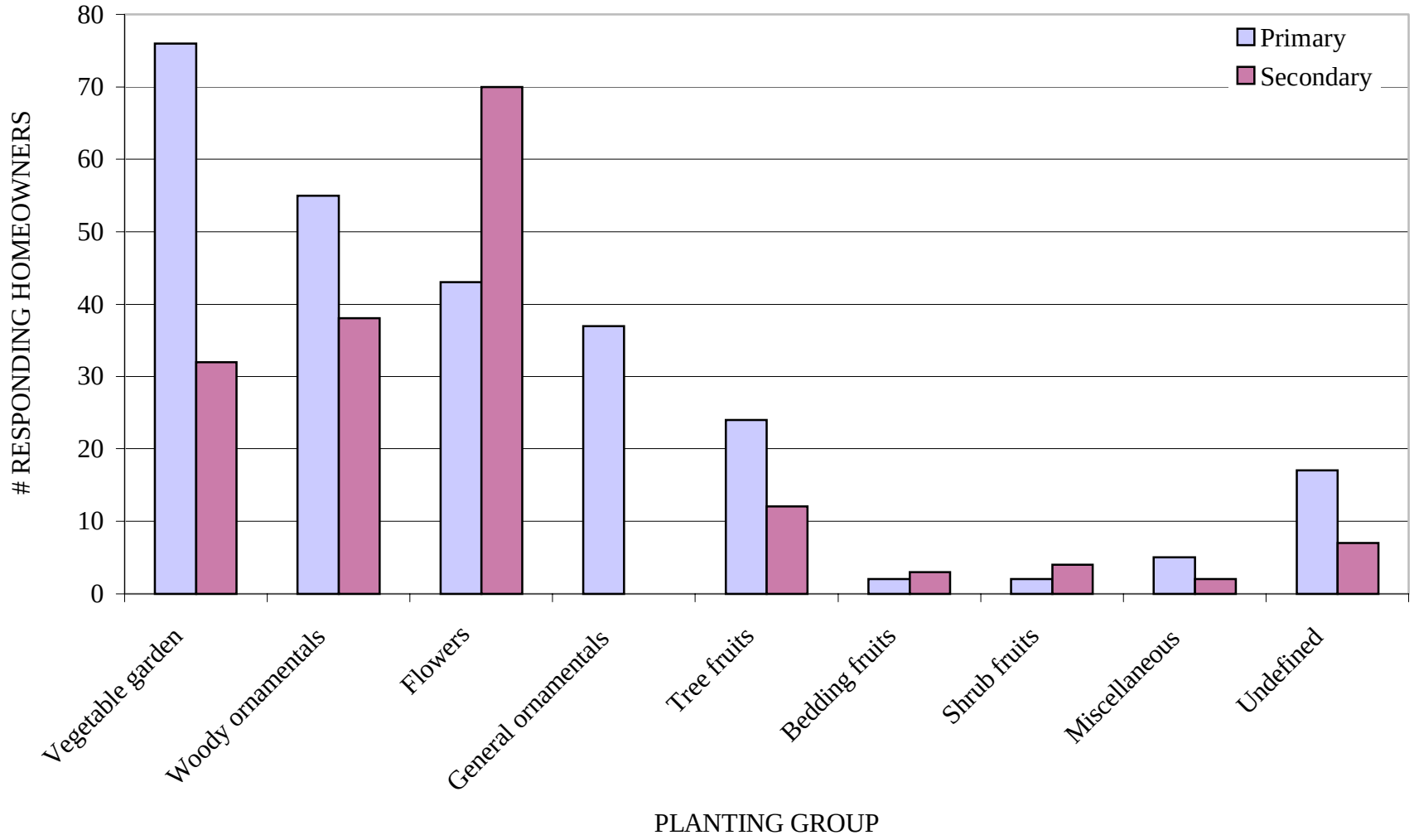

Figure 6. Distribution of primary and secondary plantings raised by homeowners in Virginia during 1995, as reported by respondents to a survey on deer damage (see Appendix C for explanation of each group).

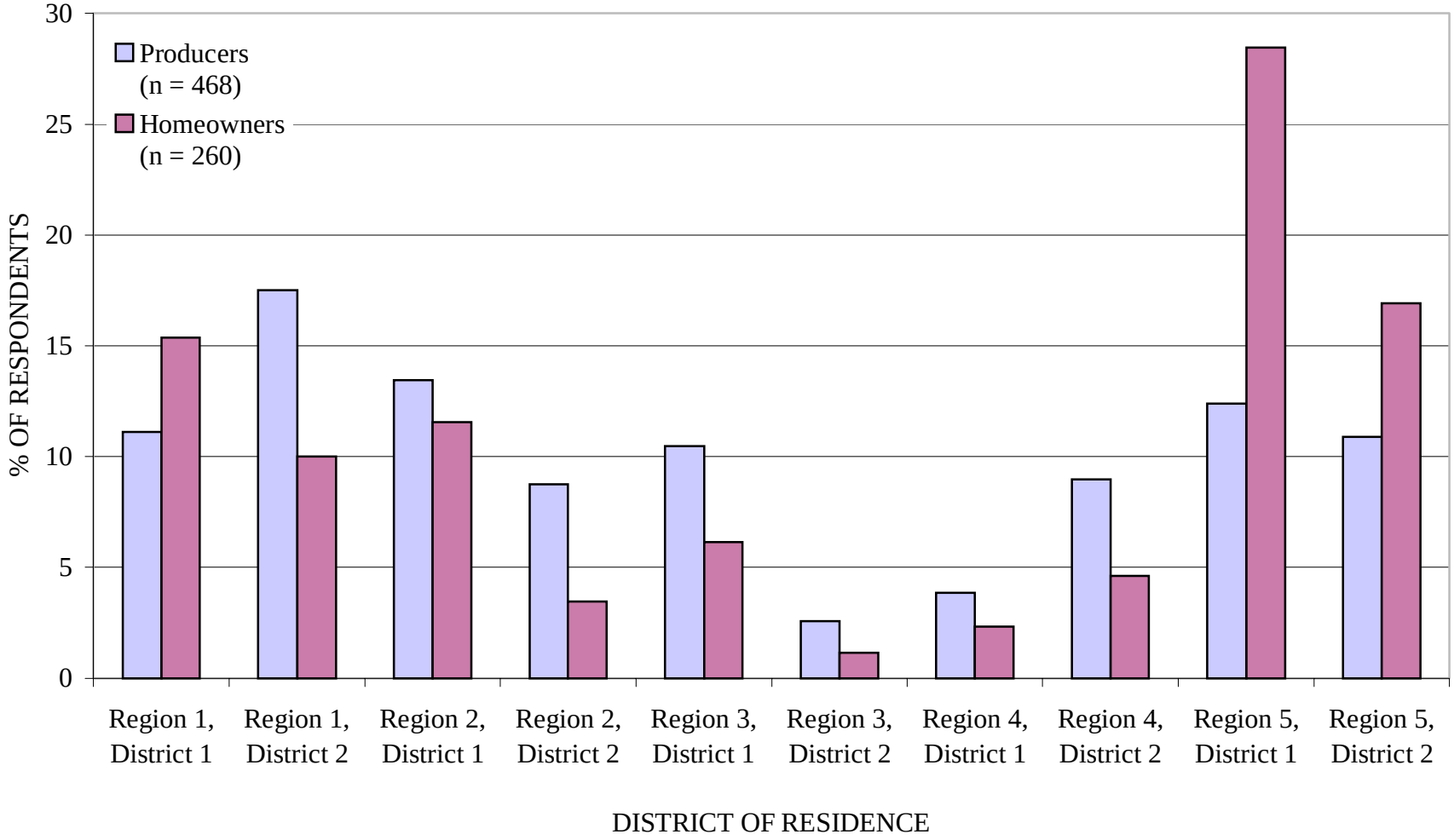

Figure 7. Place of residence for producers and homeowners responding to a survey on deer damage in Virginia during 1995, based on Virginia Department of Game and Inland Fisheries wildlife administrative districts (see Appendix D for specific counties within regions and districts).

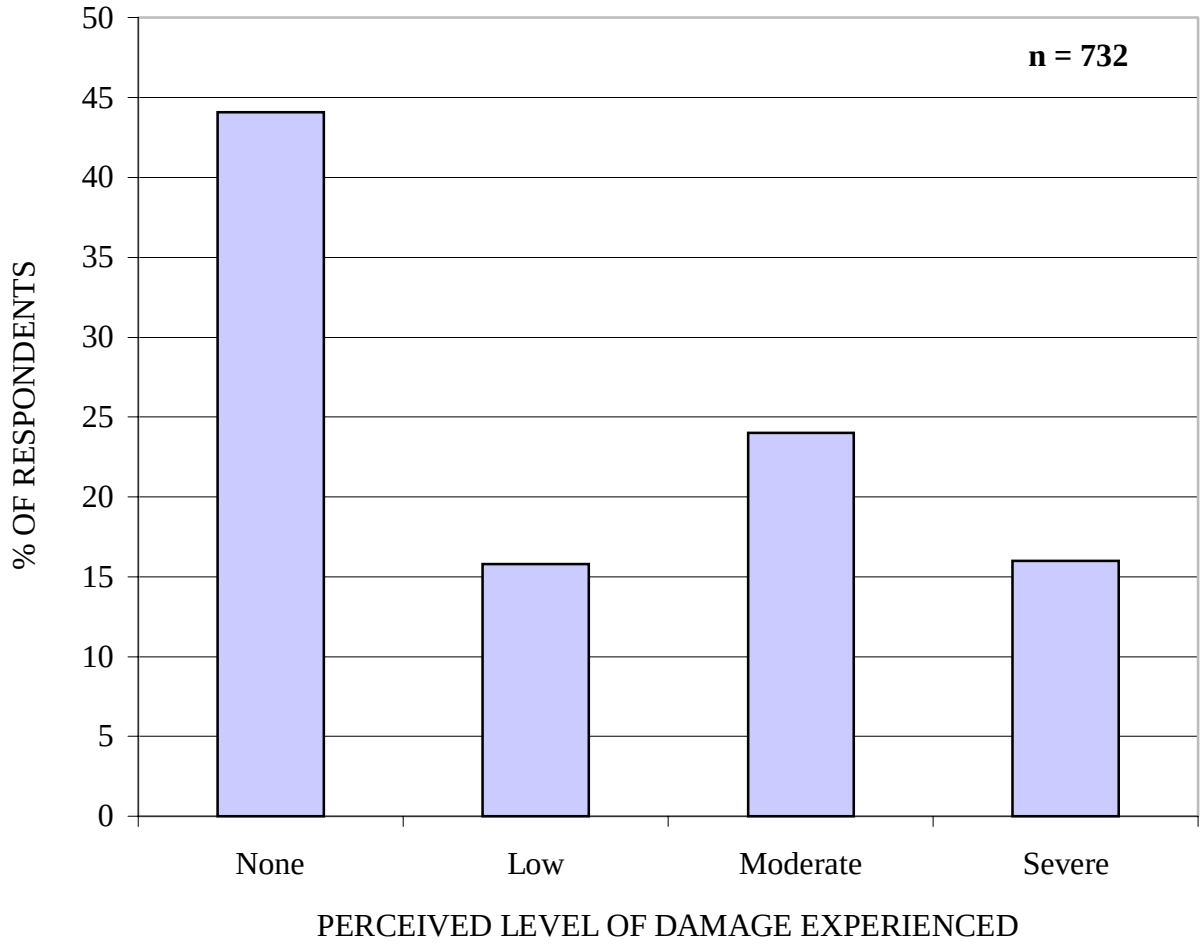

Figure 8. The level of deer damage to primary plantings in Virginia during 1995, as reported by all respondents.

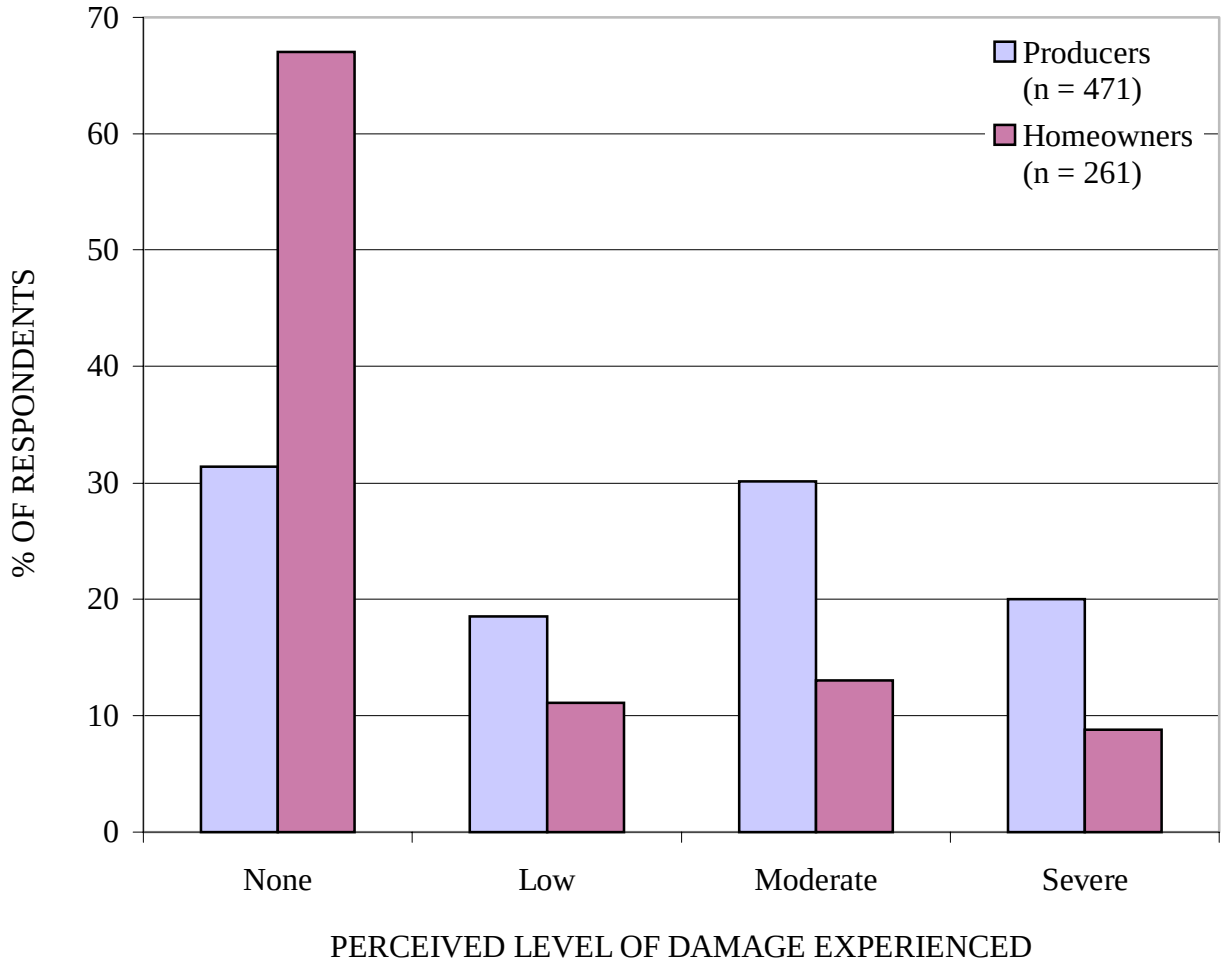

Figure 9. The level of deer damage to primary plantings in Virginia during 1995, as reported by producers and homeowners.

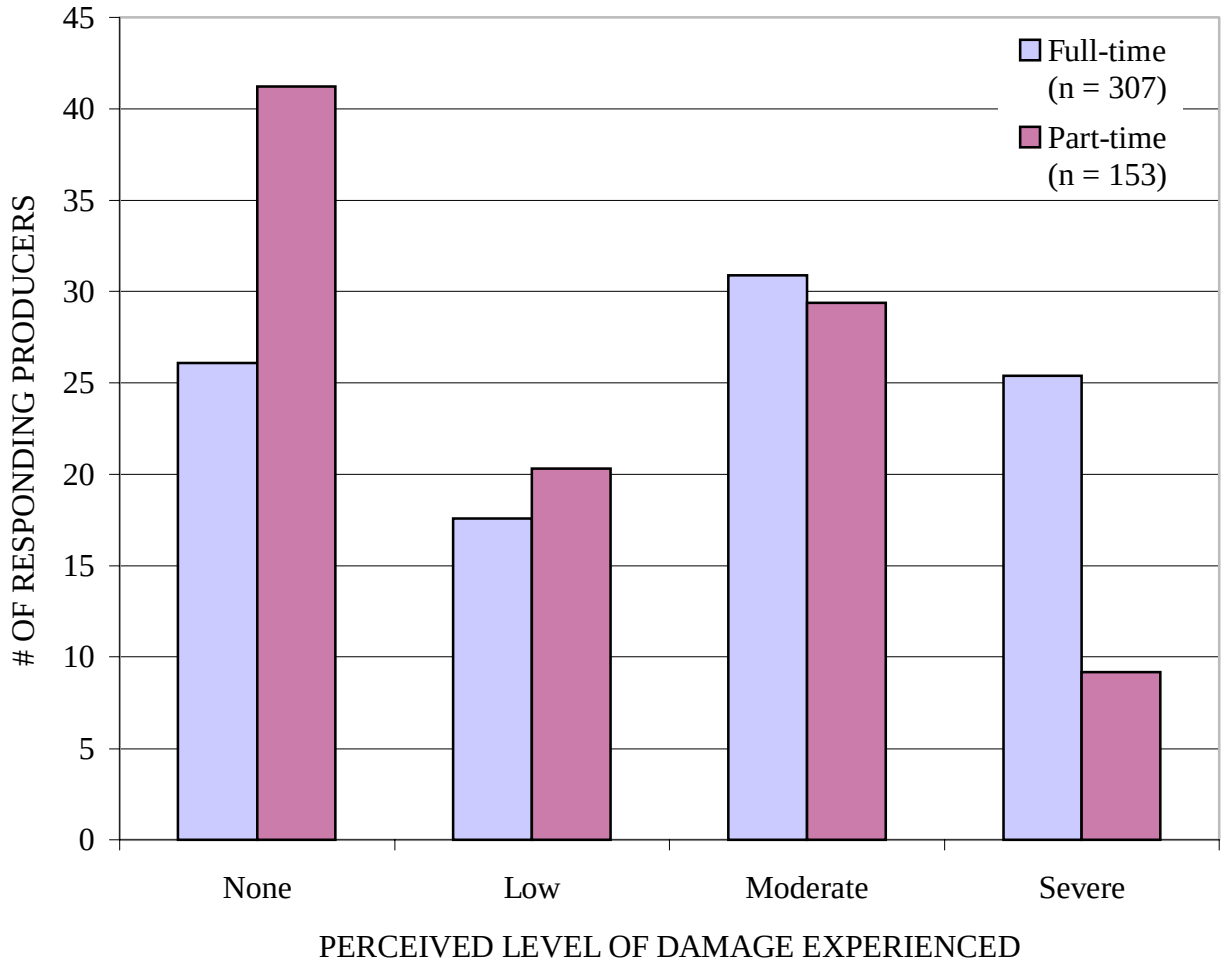

Figure 10. The level of deer damage to primary plantings in Virginia during 1995, as reported by full- and part-time producers.

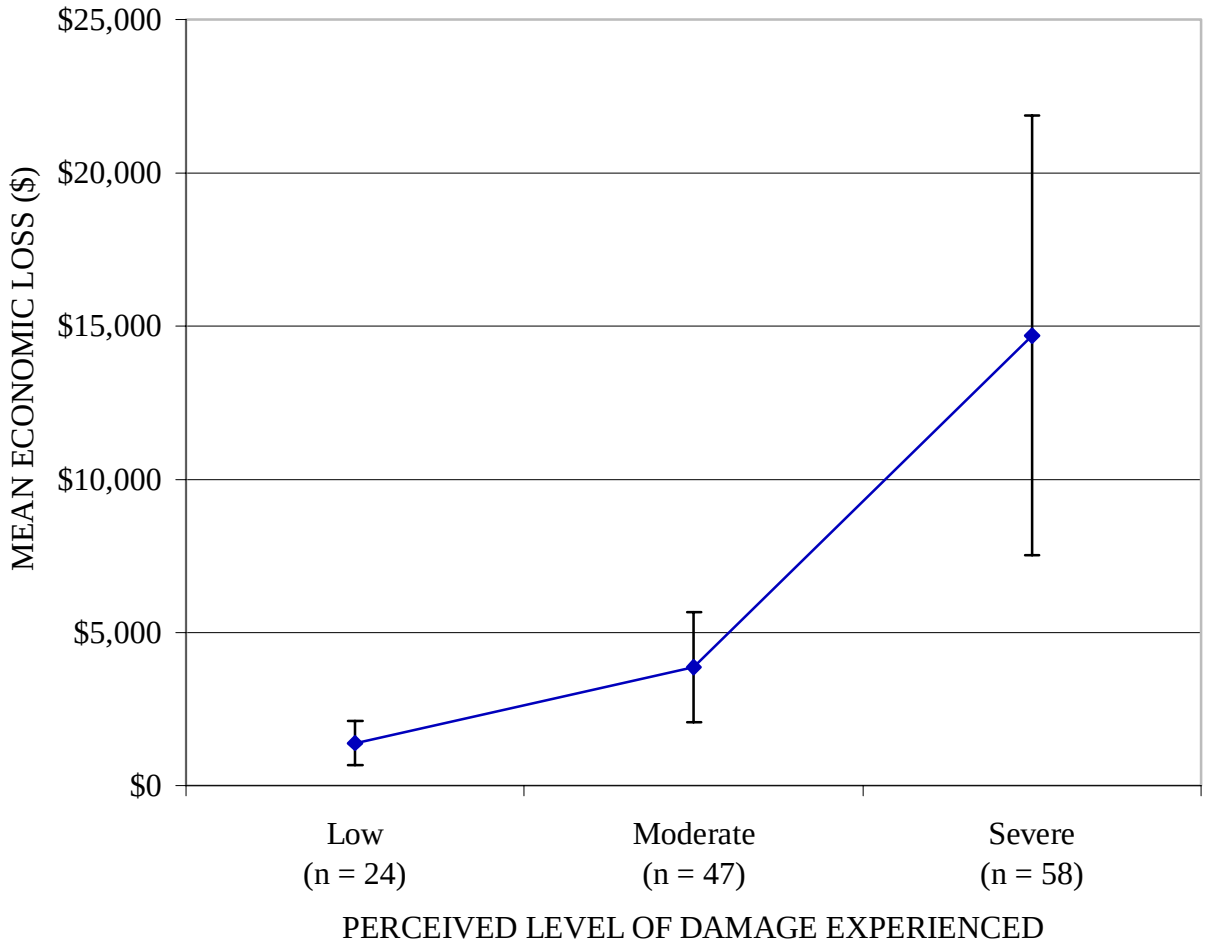

Figure 11. Relationship between producers' perception of damage and their estimate of economic loss because of deer damage in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

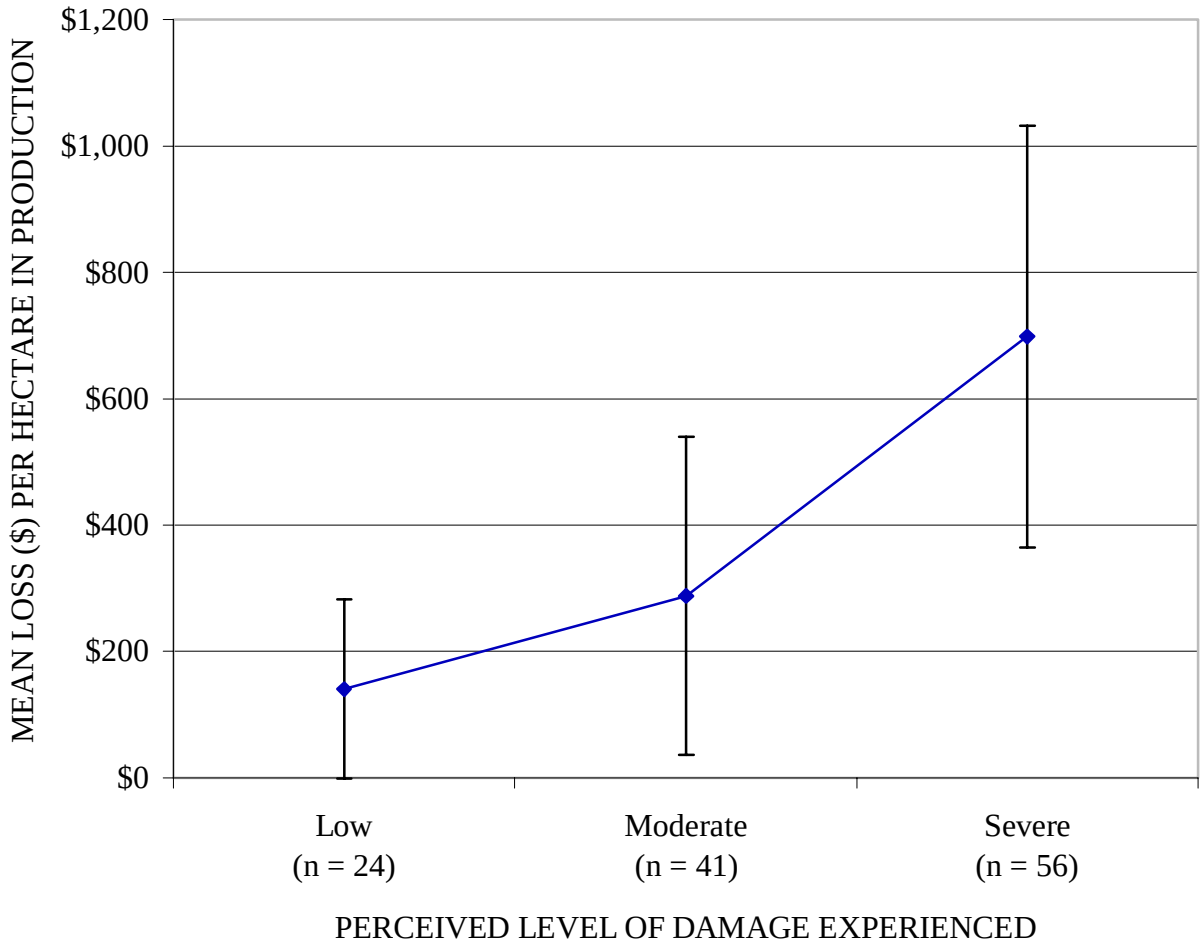

Figure 12. Relationship between producers' perception of damage and their estimated economic loss/hectare because of deer damage in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

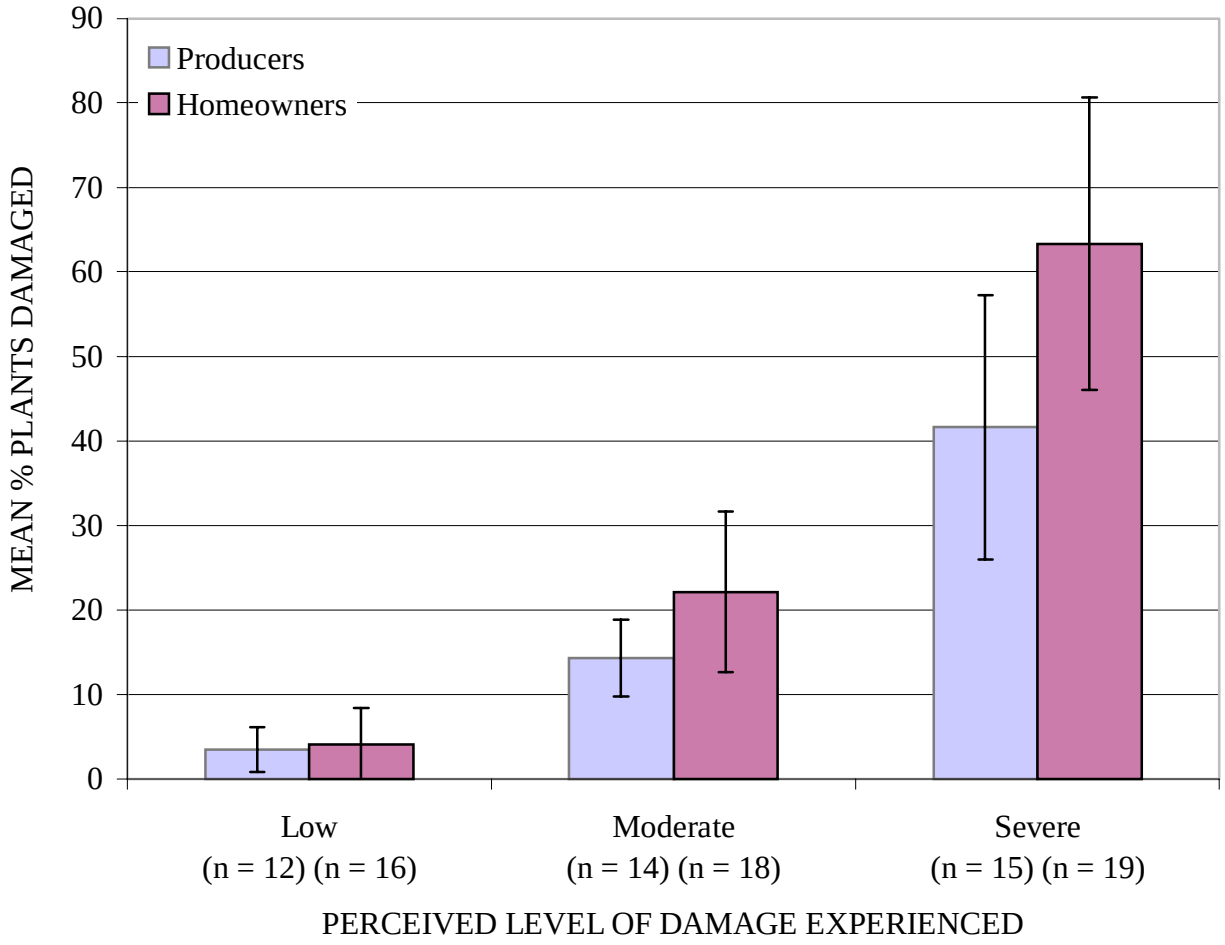

Figure 13. Relationship between producers' and homeowners' perceptions about damage and their estimate for the percentage of plants damage by deer in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

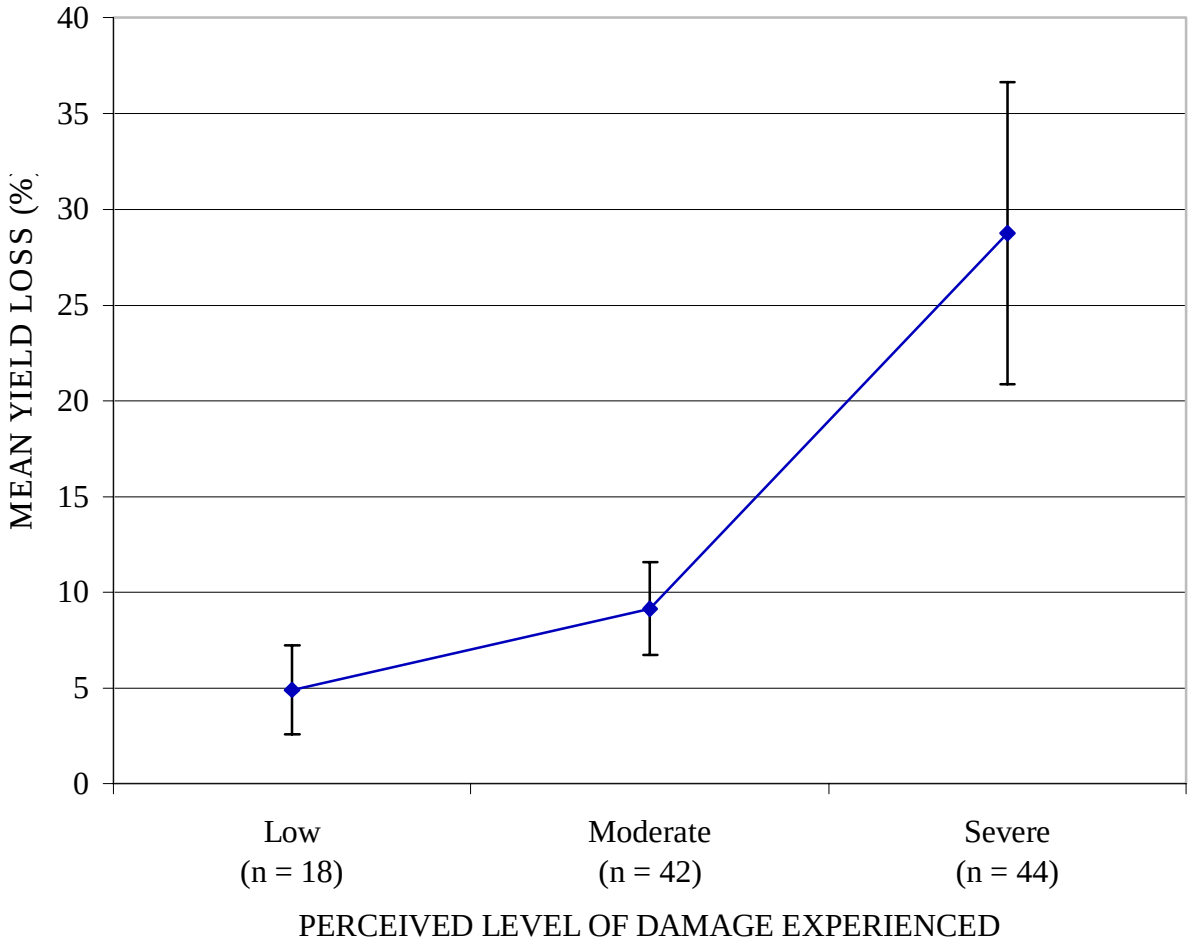

Figure 14. Relationship between producers' perception about damage and the reported yield loss (%) because of deer damage in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

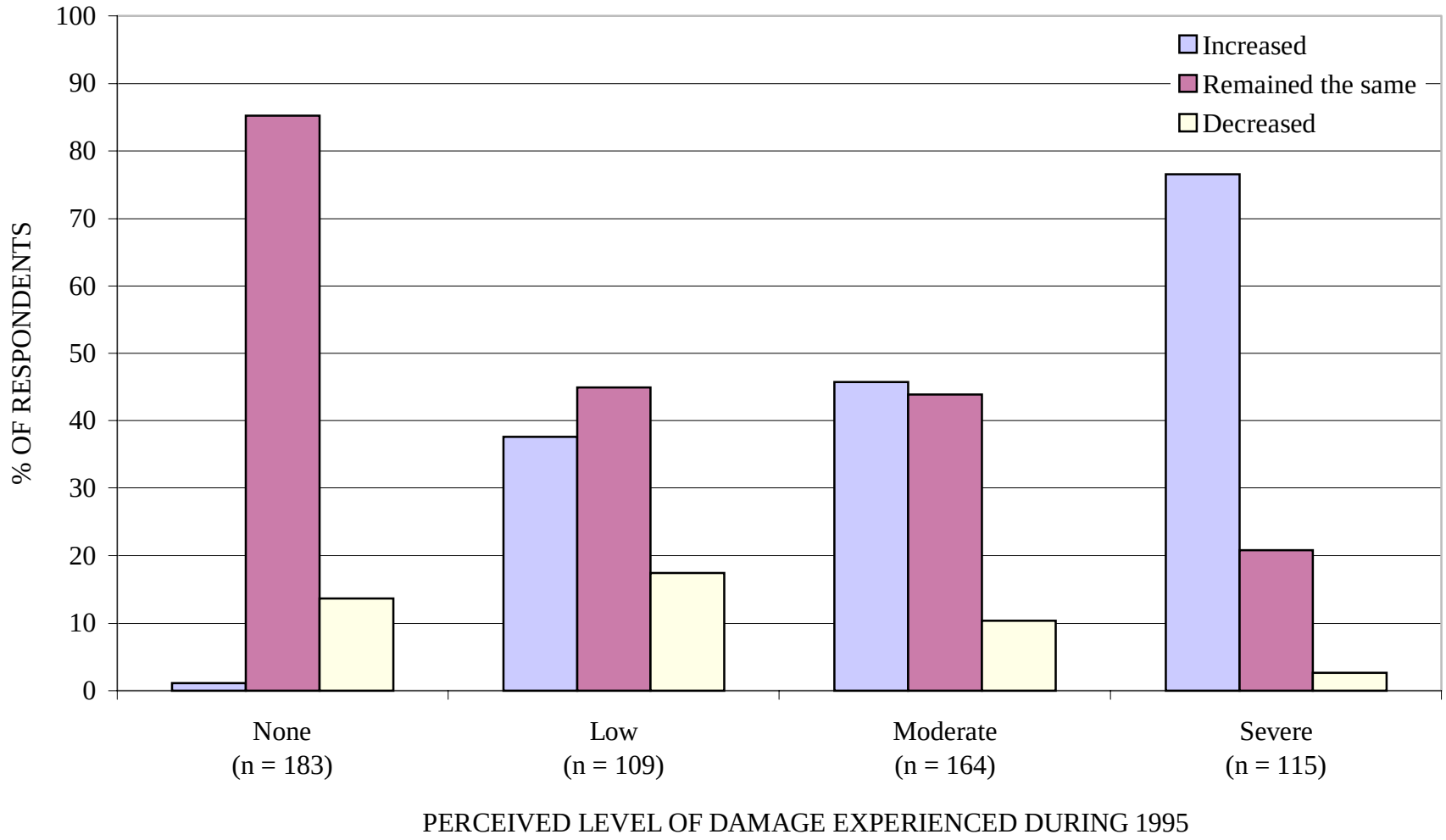

Figure 15. Relationship between a respondent's perceptions about deer damage in Virginia during 1995 with that of the preceding 5-year period (1990 – 1994).

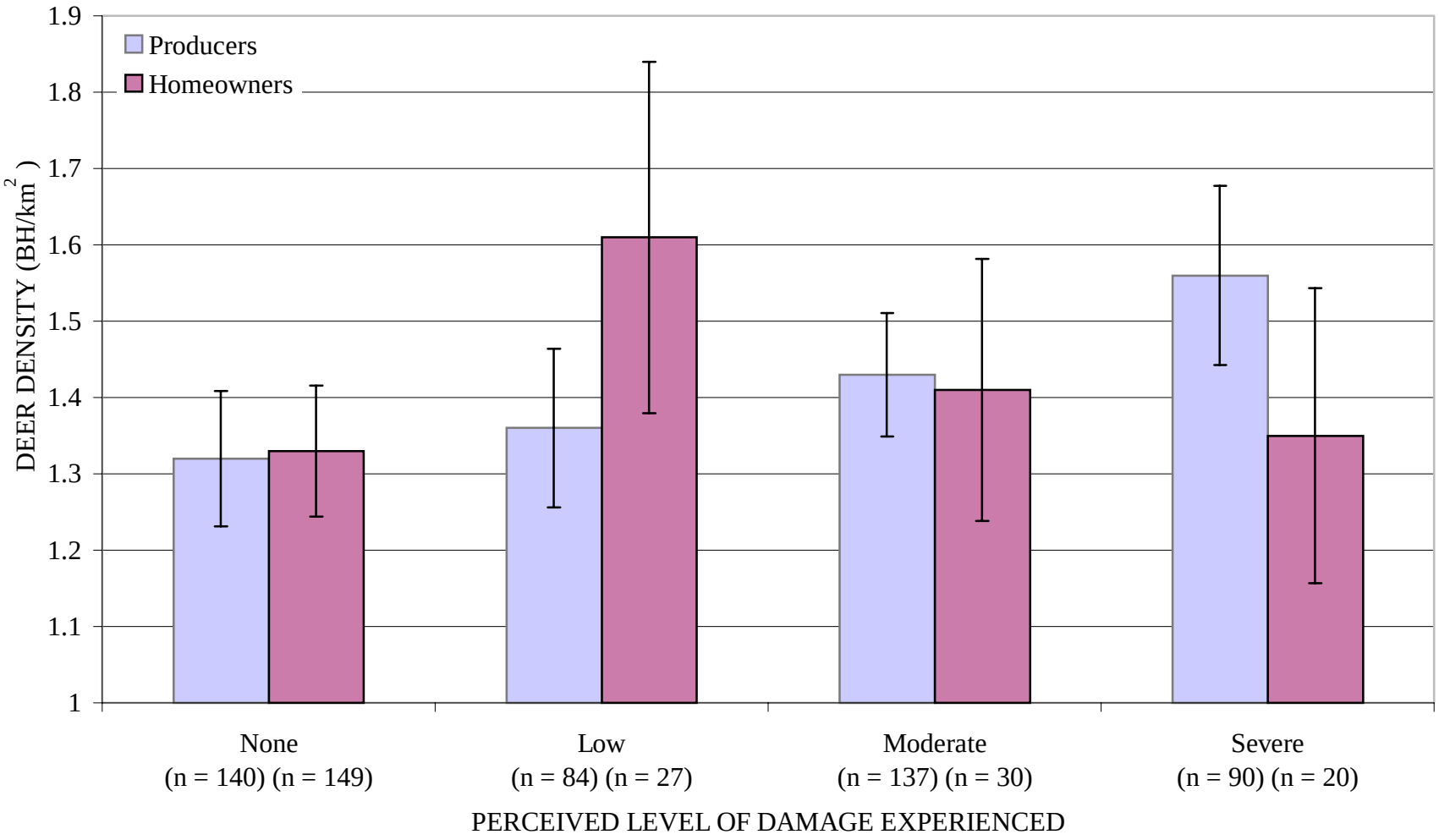

Figure 16. Relationship between producers' and homeowners' perceptions about deer damage in Virginia during 1995 and deer density in their county of residence, as measured by mean number of antlered bucks harvested/km^2 (BH/km^2) (error bars represent 95% confidence interval for the mean).

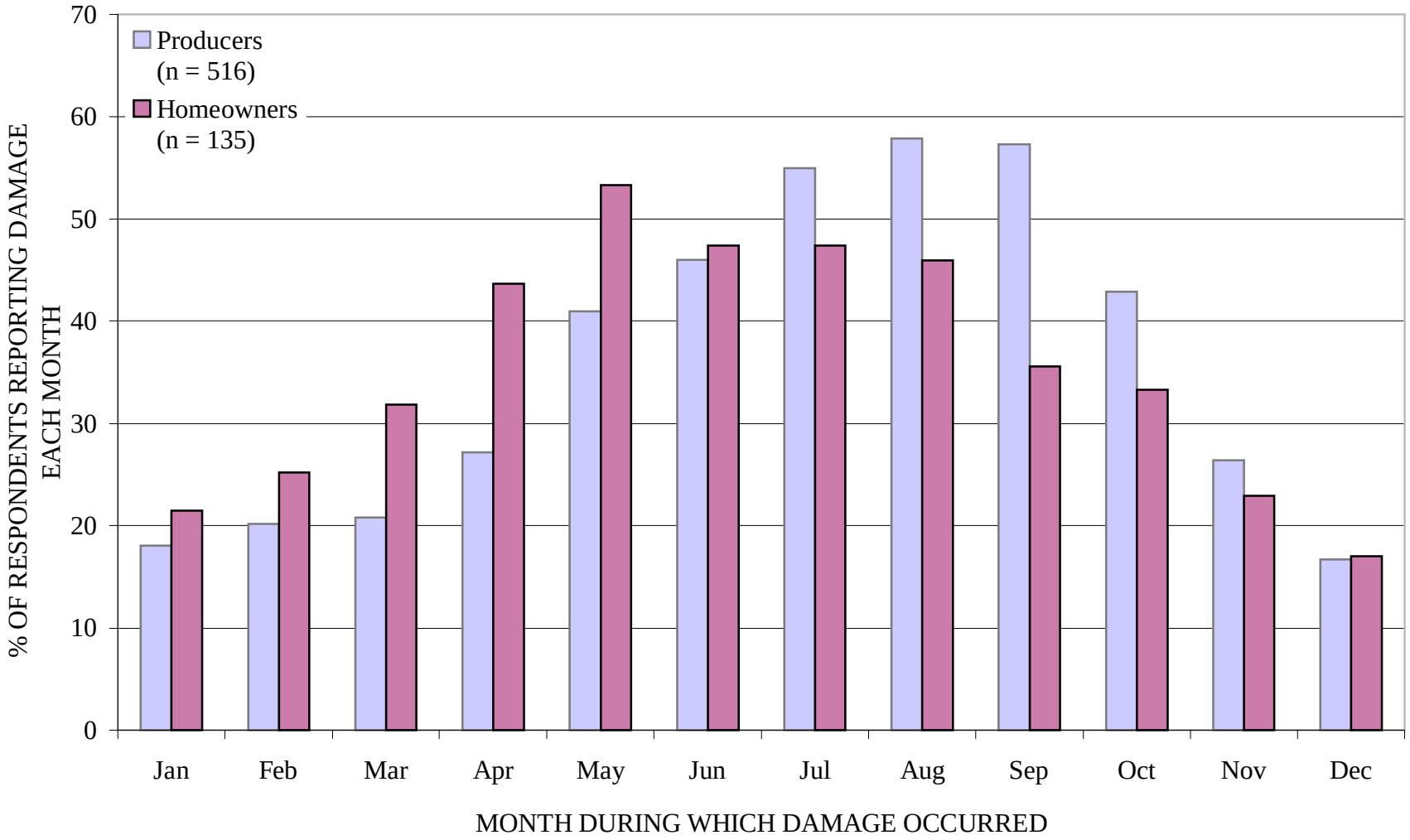

Figure 17. Months of the year during which producers and homeowners observed deer damage to their plantings in Virginia during 1995.

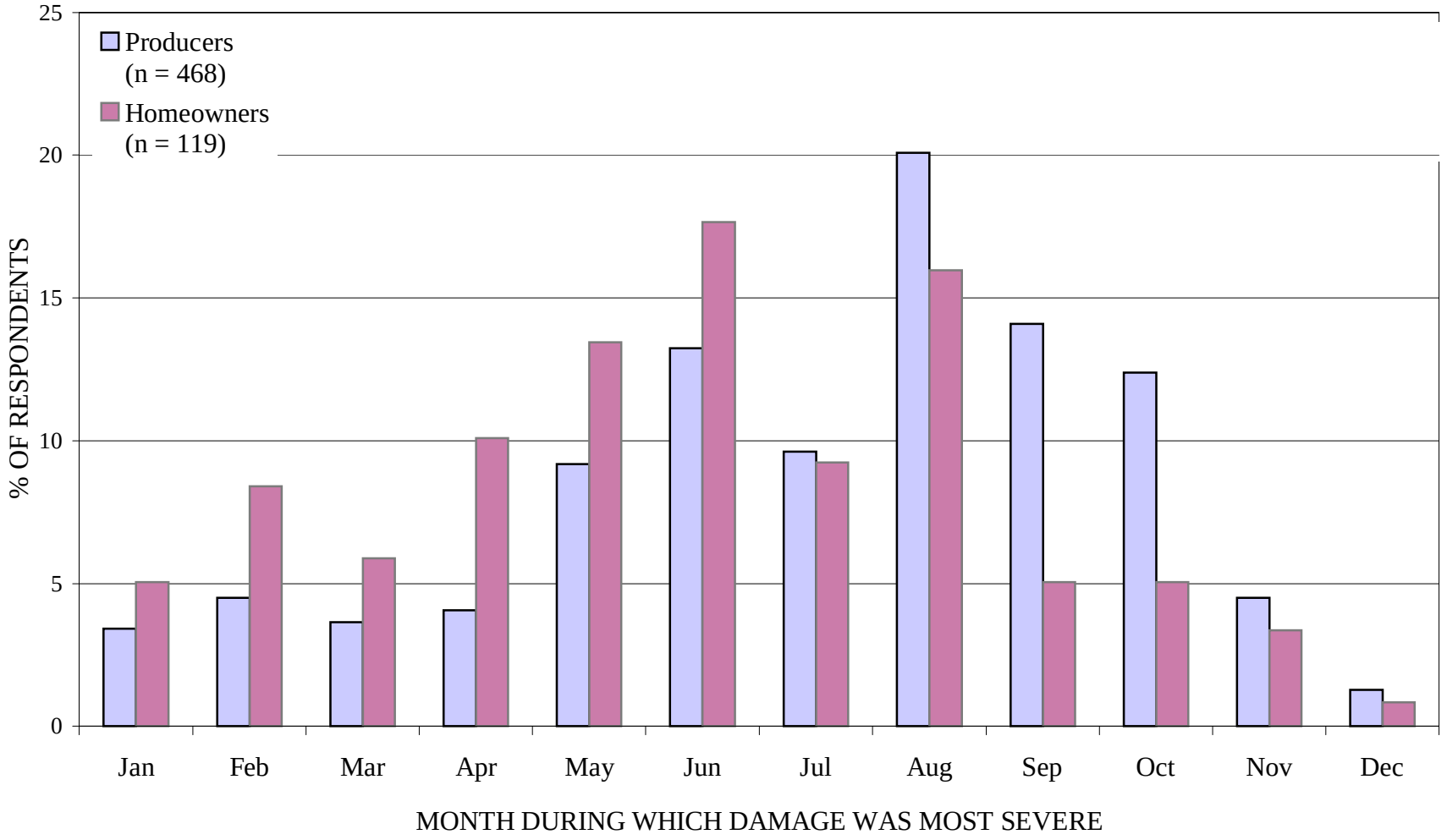

Figure 18. Months of the year during which producers and homeowners in Virginia reported most severe damage to their plantings by deer during 1995.

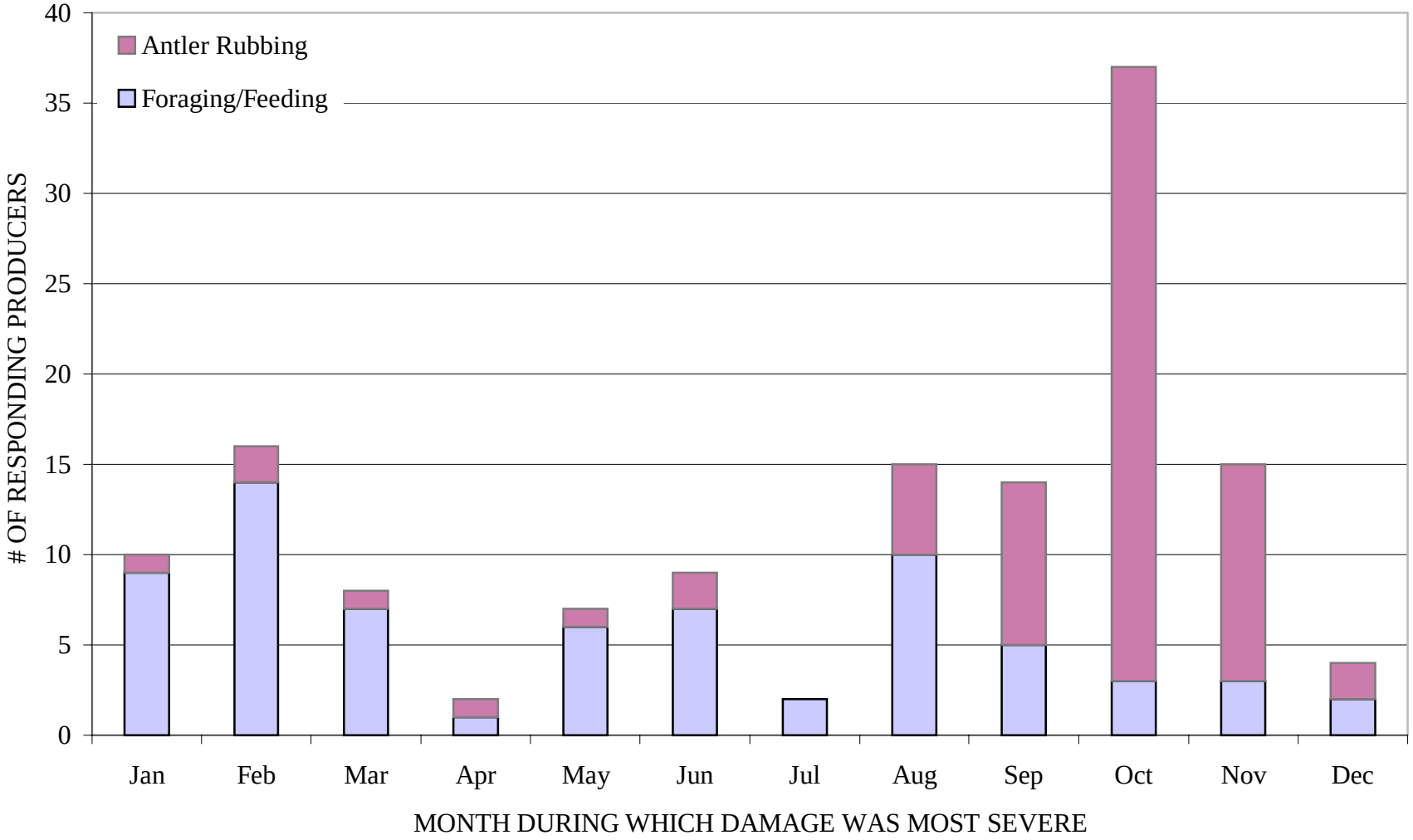

Figure 19. Time of year during which damage by deer, either antler rubbing or direct feeding, was reported as most severe by producers of Christmas trees, nursery plants, and tree fruits in Virginia during 1995.

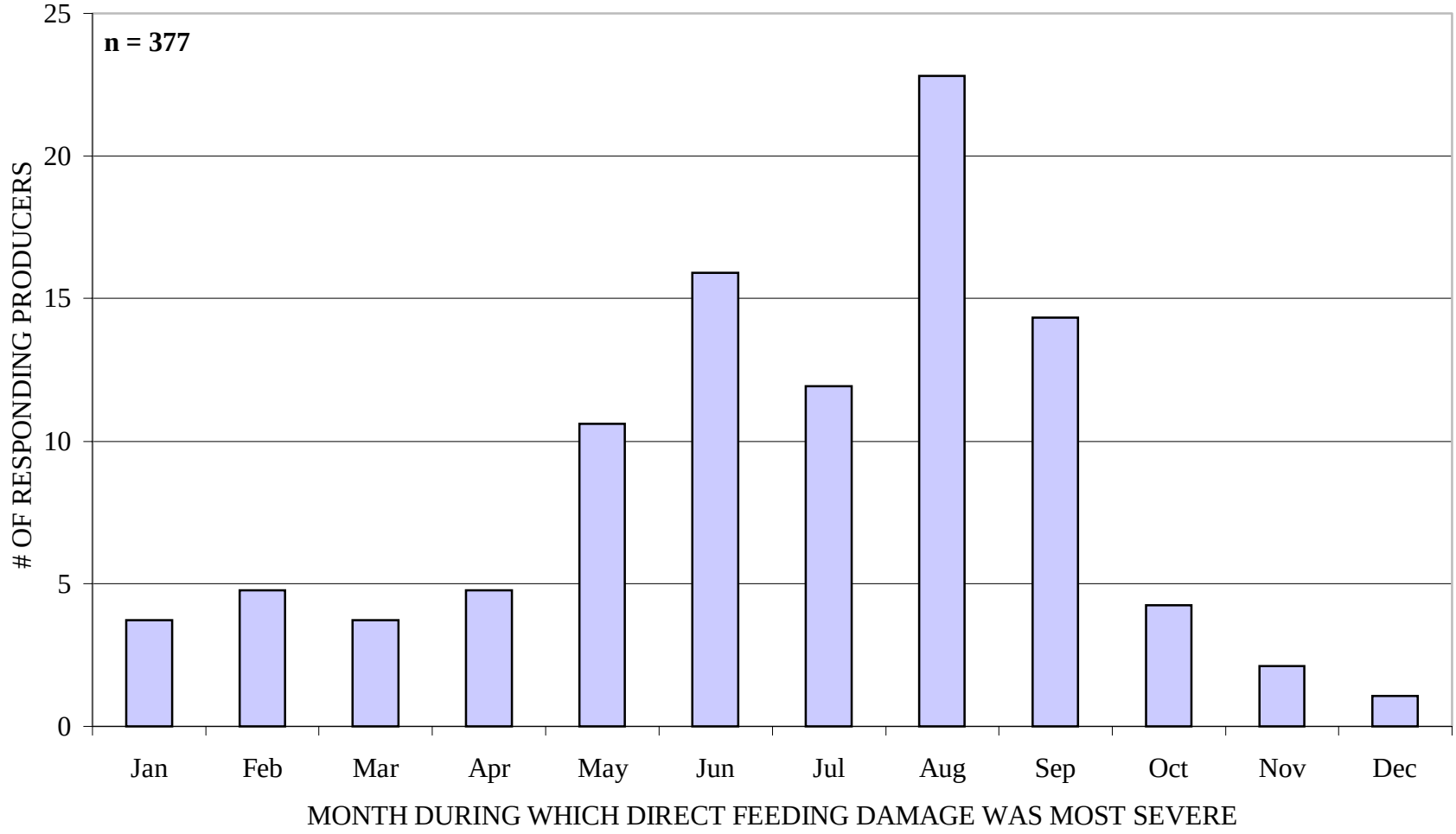

Figure 20. Time of year during which most severe damage attributed to direct feeding by deer occurred, as reported by agricultural producers in Virginia during 1995.

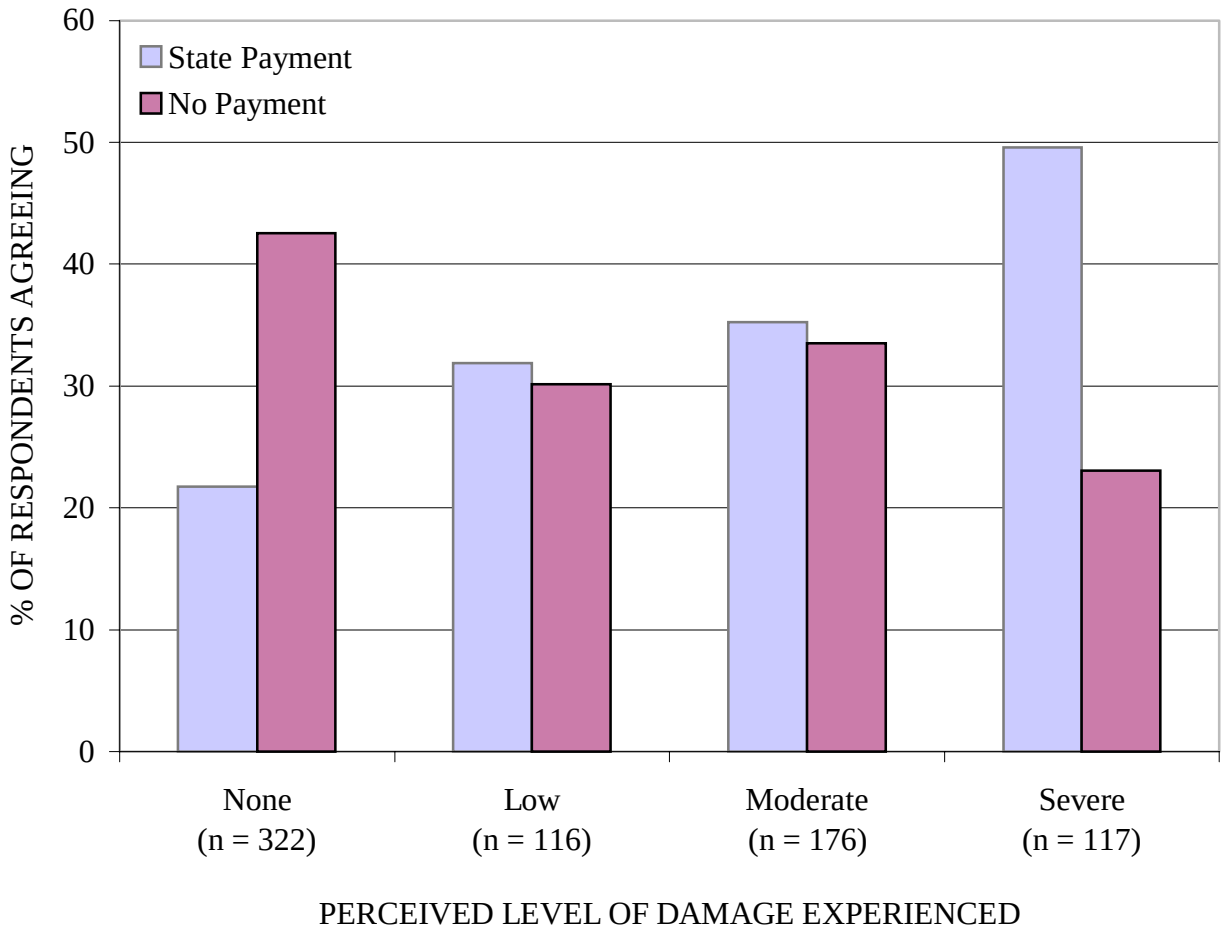

Figure 21. Relationship between a respondent's perception about severity of damage by deer and opinion on whether an individual affected by damage should receive state-funded compensation versus the belief that compensation should not be paid to those experiencing deer damage, as expressed by respondents in Virginia during 1995.

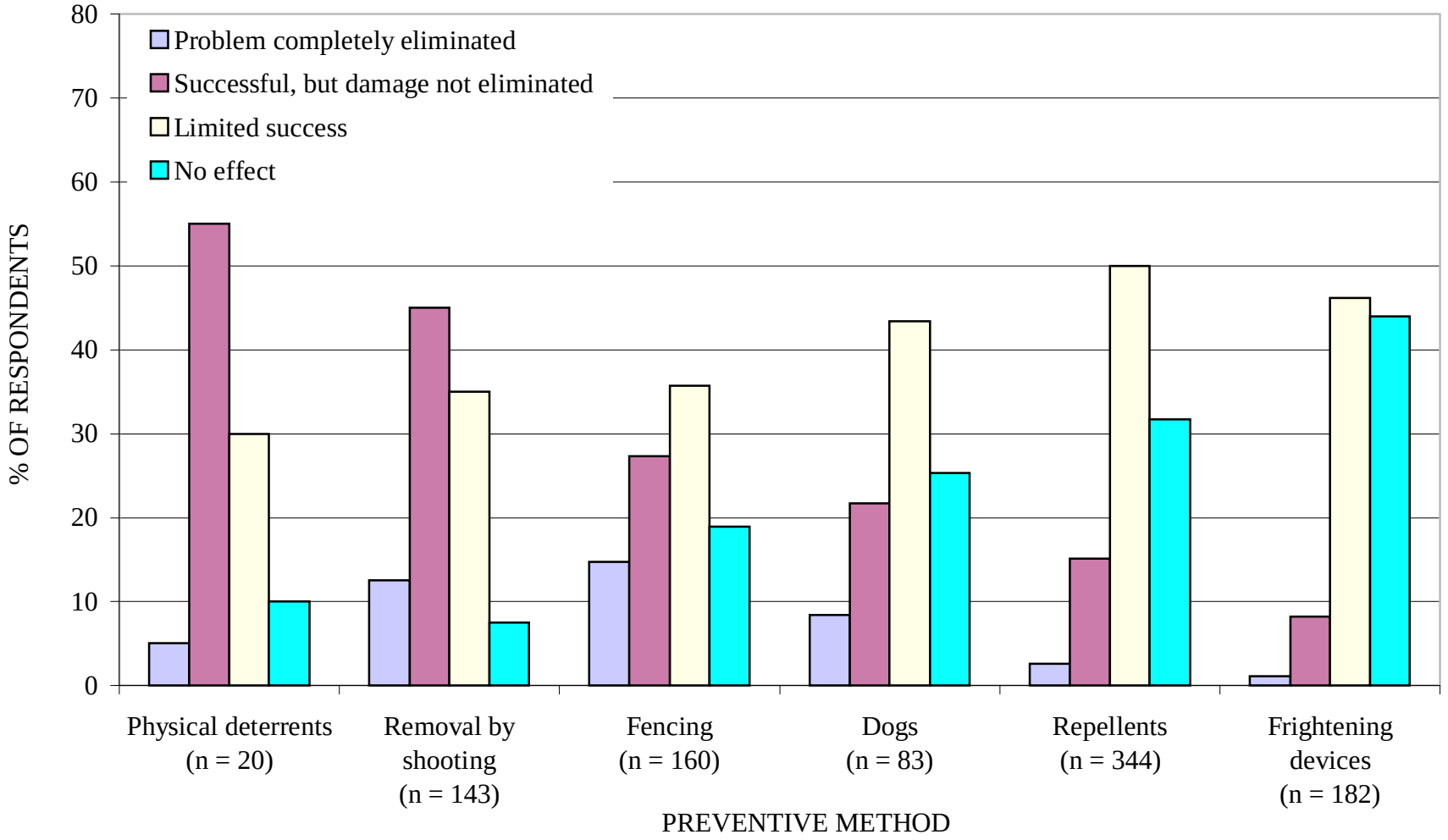

Figure 22. Perceived effectiveness of preventive methods used by respondents to deter deer damage during 1995 in Virginia (see Q-19 in Appendix A for specific methods that are included in each group).

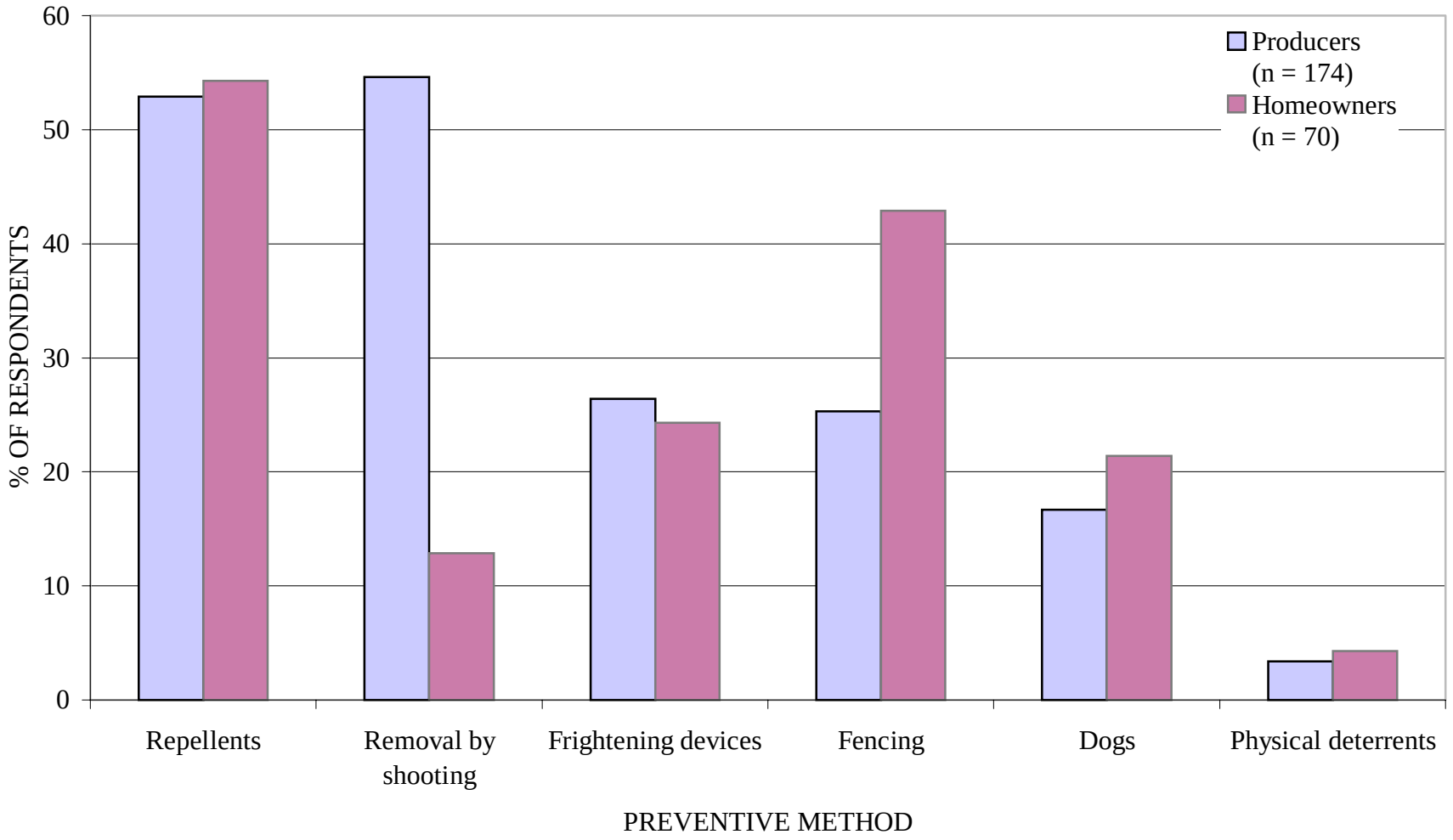

Figure 23. Percentage of producers and homeowners using different preventive methods to deter deer damage during 1995 in Virginia (see Q-19 in Appendix A for specific methods that are included in each group).

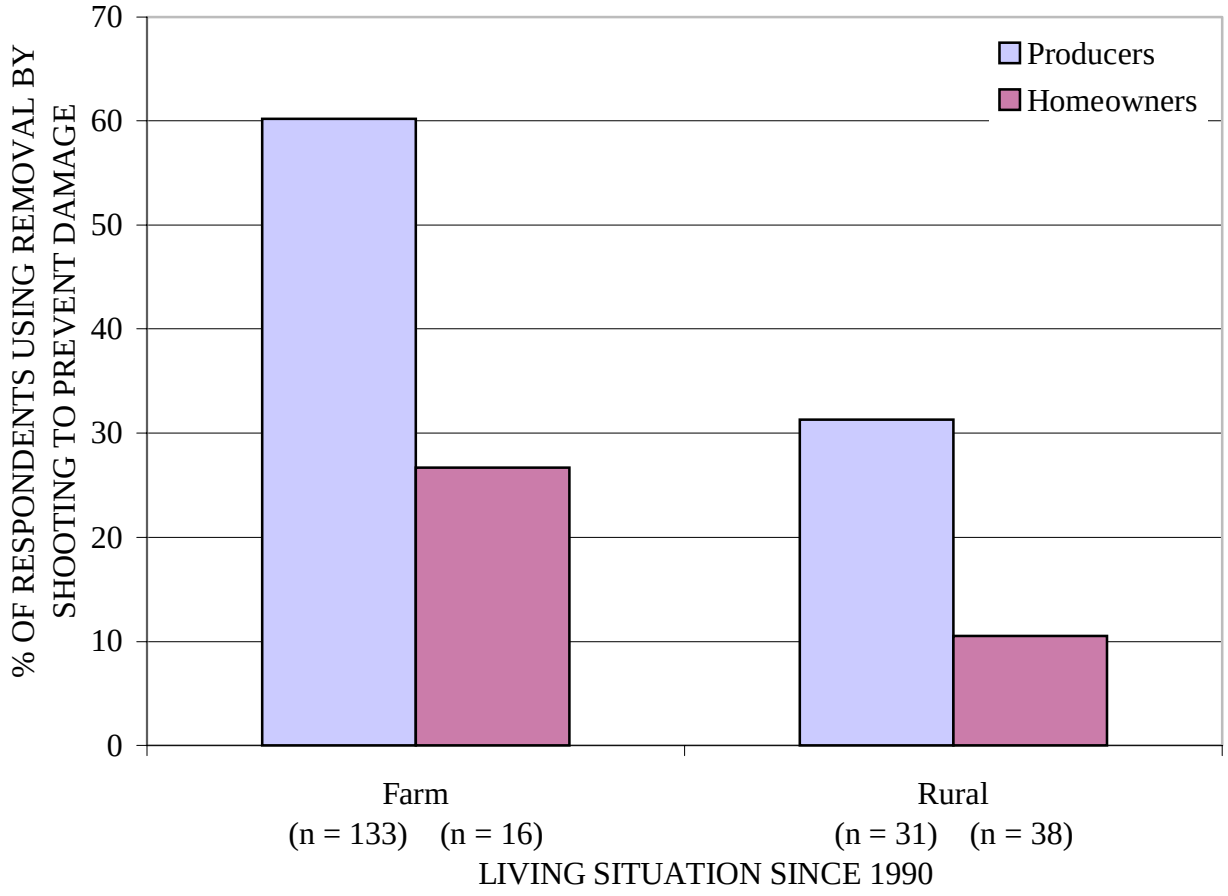

Figure 24. Percentage of producers and homeowners living on farms or in rural environments that used removal by shooting to deter deer damage during 1995 in Virginia (percentages are based on the number of respondents who used any preventive method during 1995).

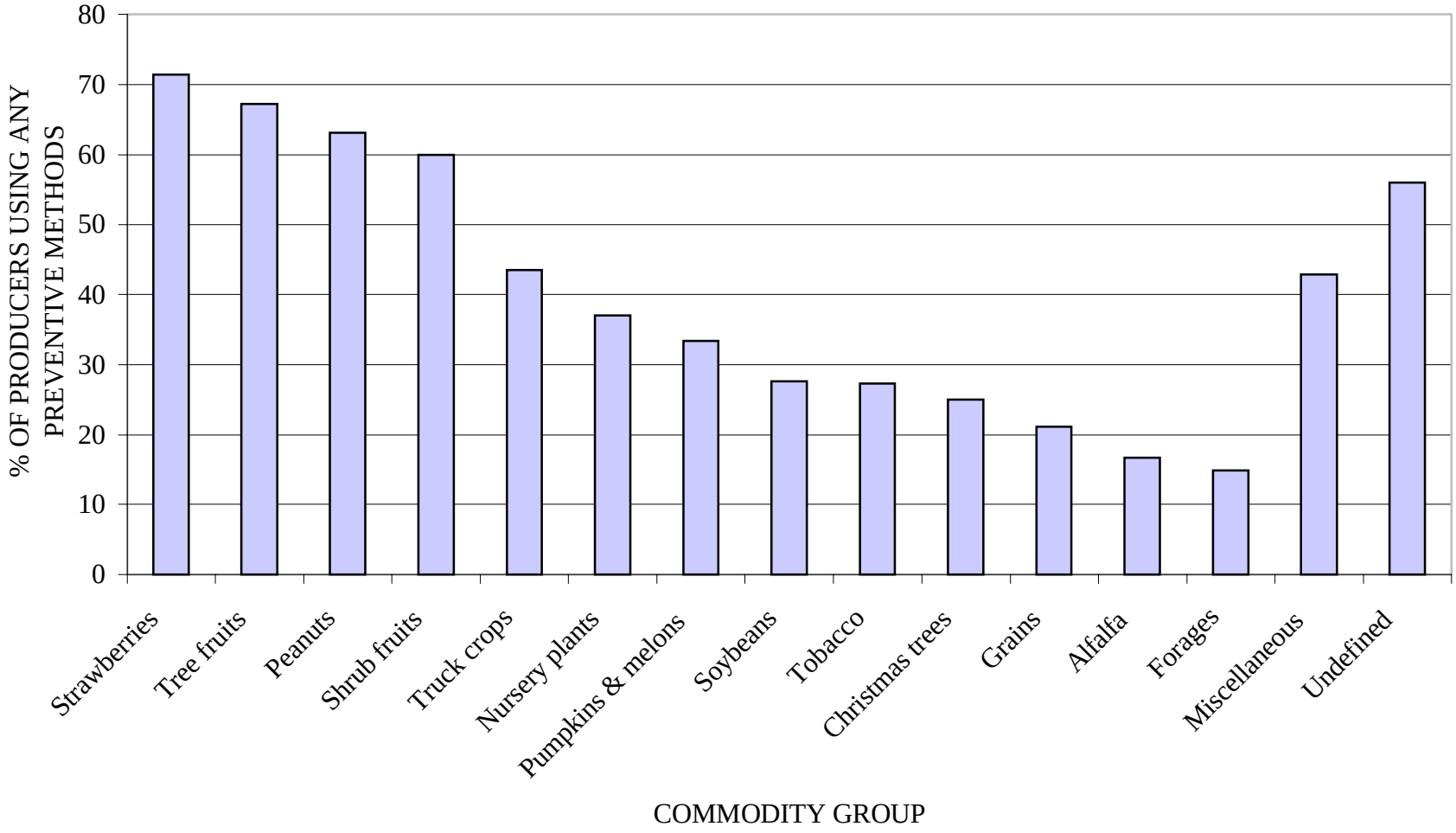

Figure 25. Percentage of producers within a commodity group who used any preventive measure to deter deer damage during 1995.

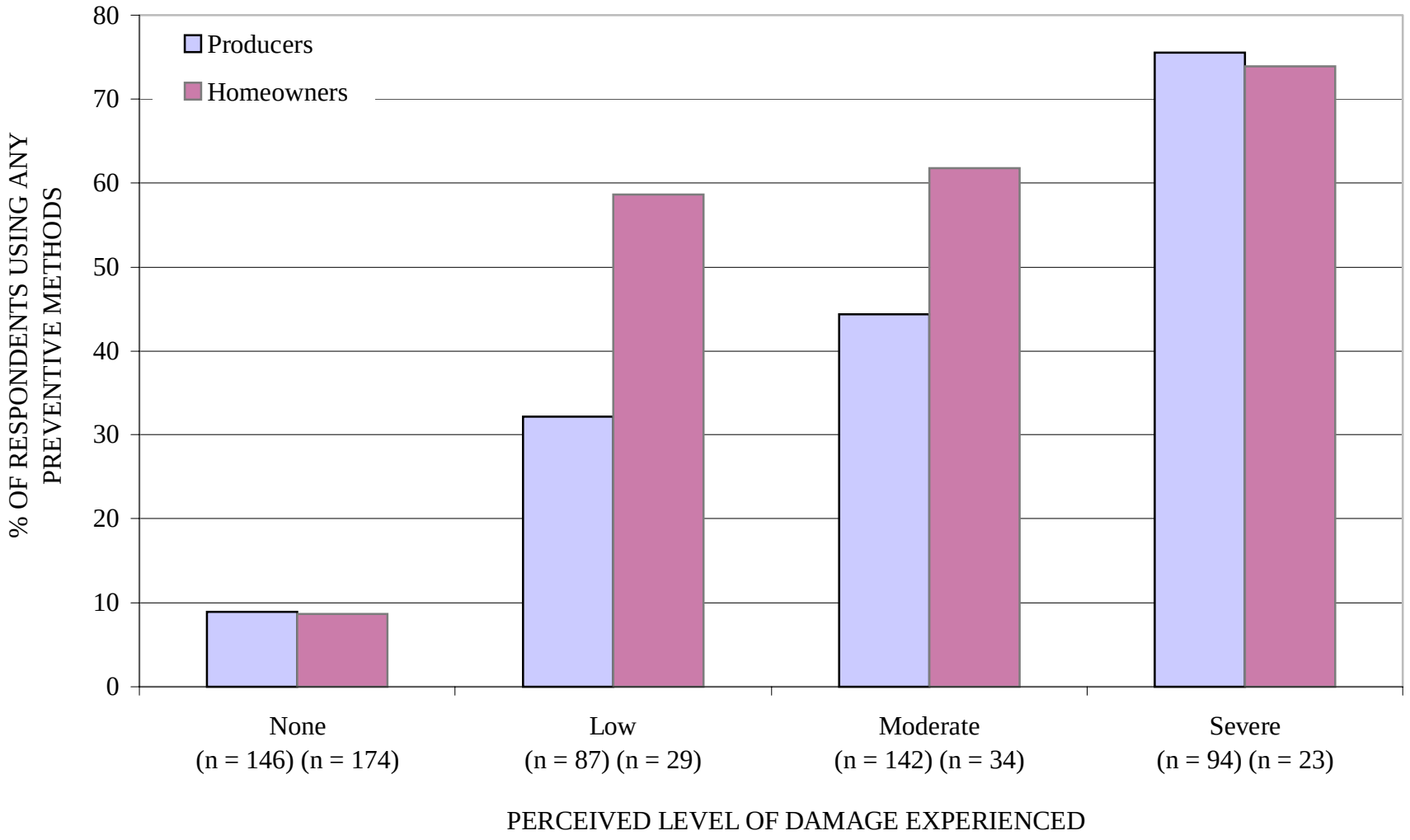

Figure 26. Relationship between perception about damage severity and likelihood to implement preventive measures to deter deer damage, as reported by producers and homeowners in Virginia during 1995.

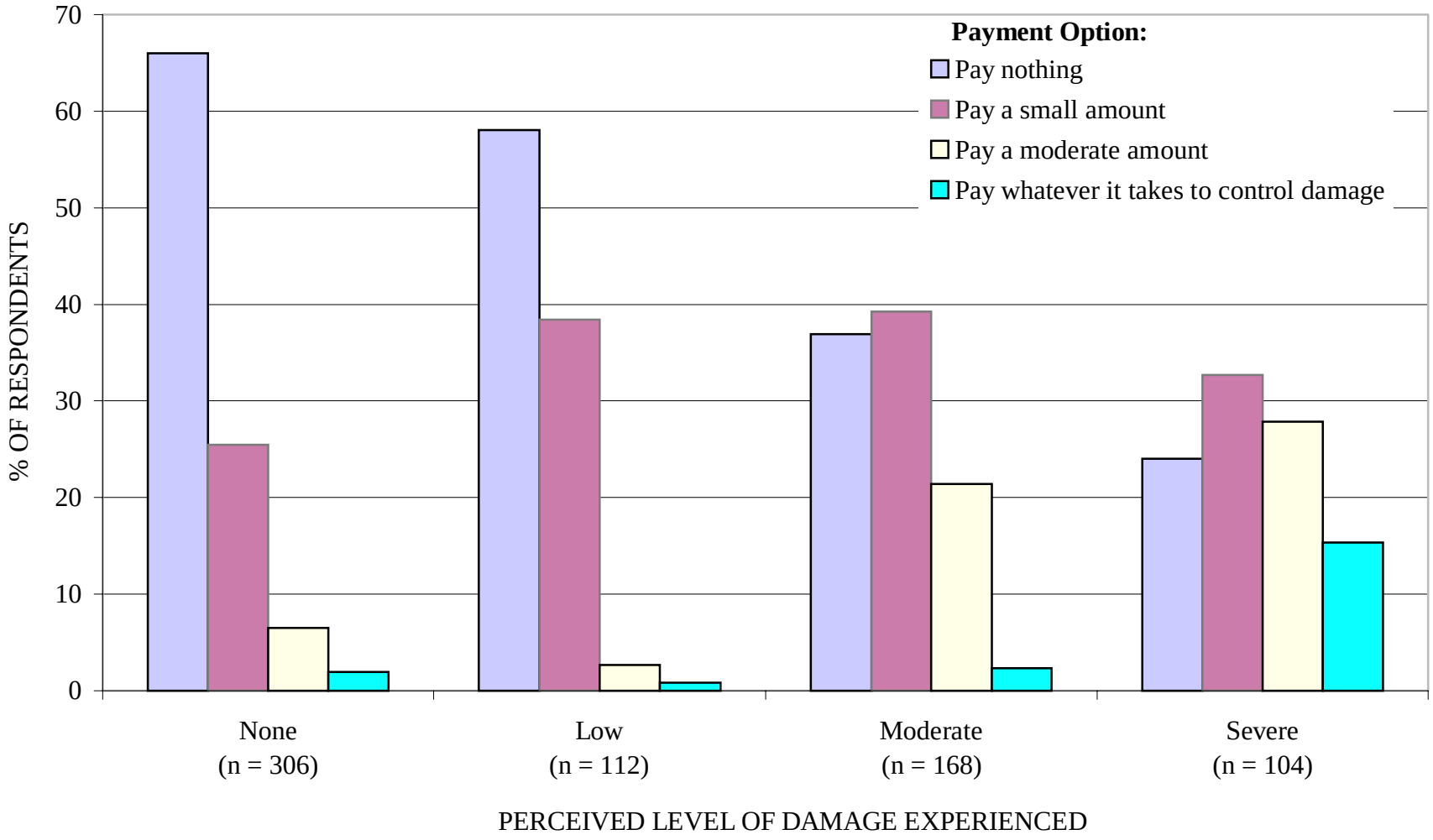

Figure 27. Relationship between a respondent's perception about damage severity and expressed willingness to pay for preventive methods to deter deer damage in Virginia during 1995.

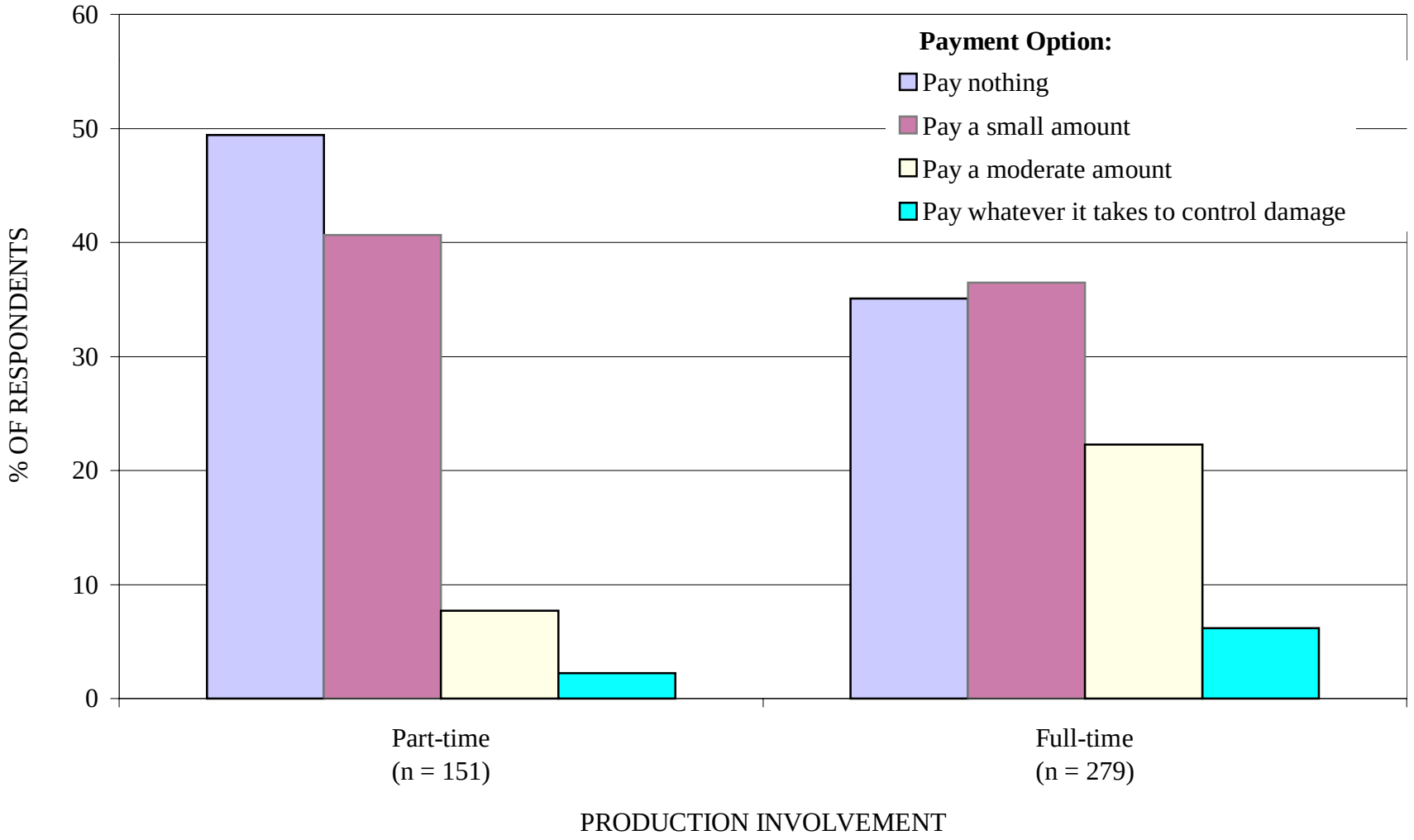

Figure 28. Expressed willingness to pay for preventive methods to deter deer damage, as reported by full- and part-time producers who experienced damage by deer in Virginia during 1995.

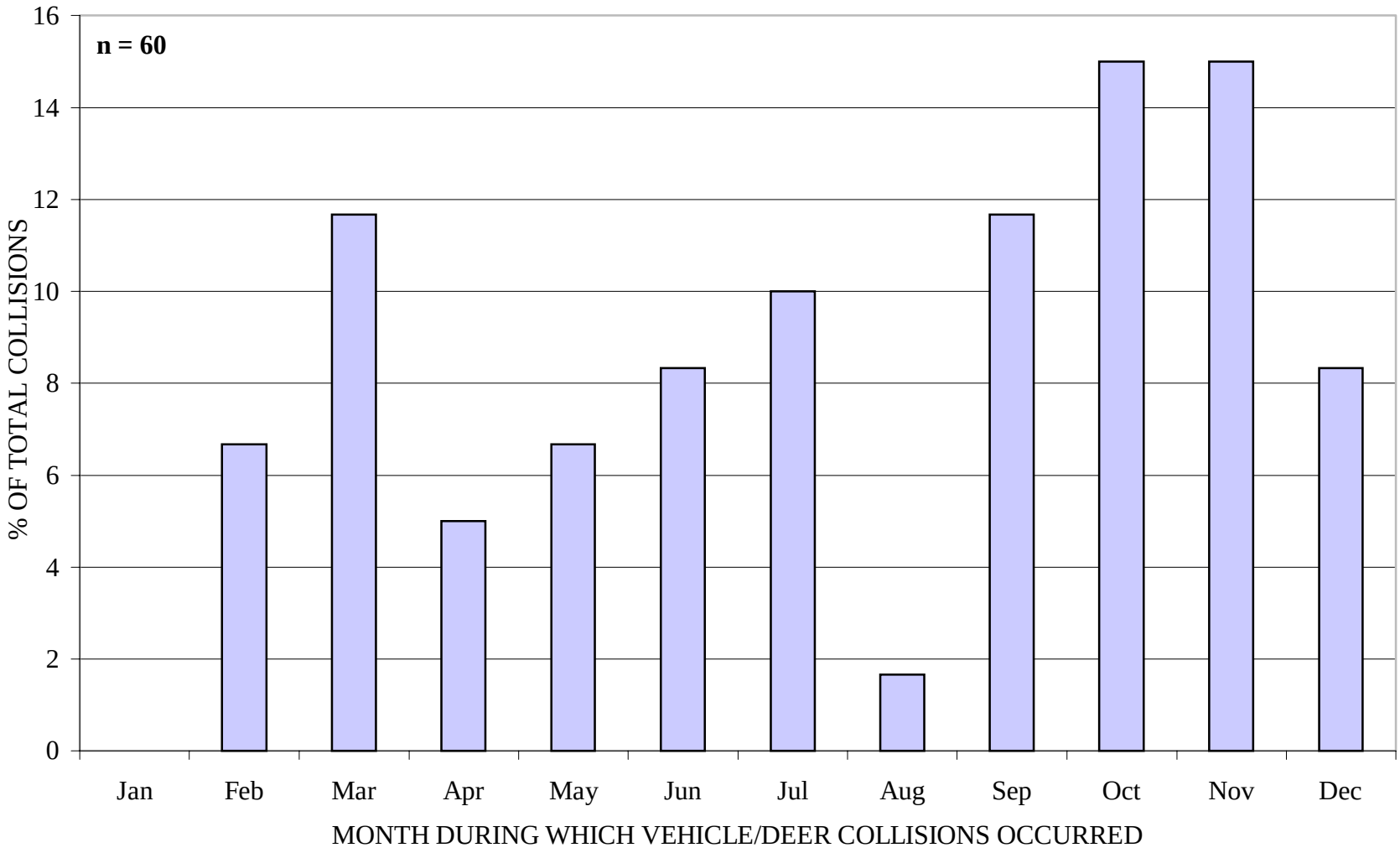

Figure 29. Time of year during which respondents reported experiencing a vehicle/deer collision in Virginia during 1995 (percentages are based on the total number of collisions reported).

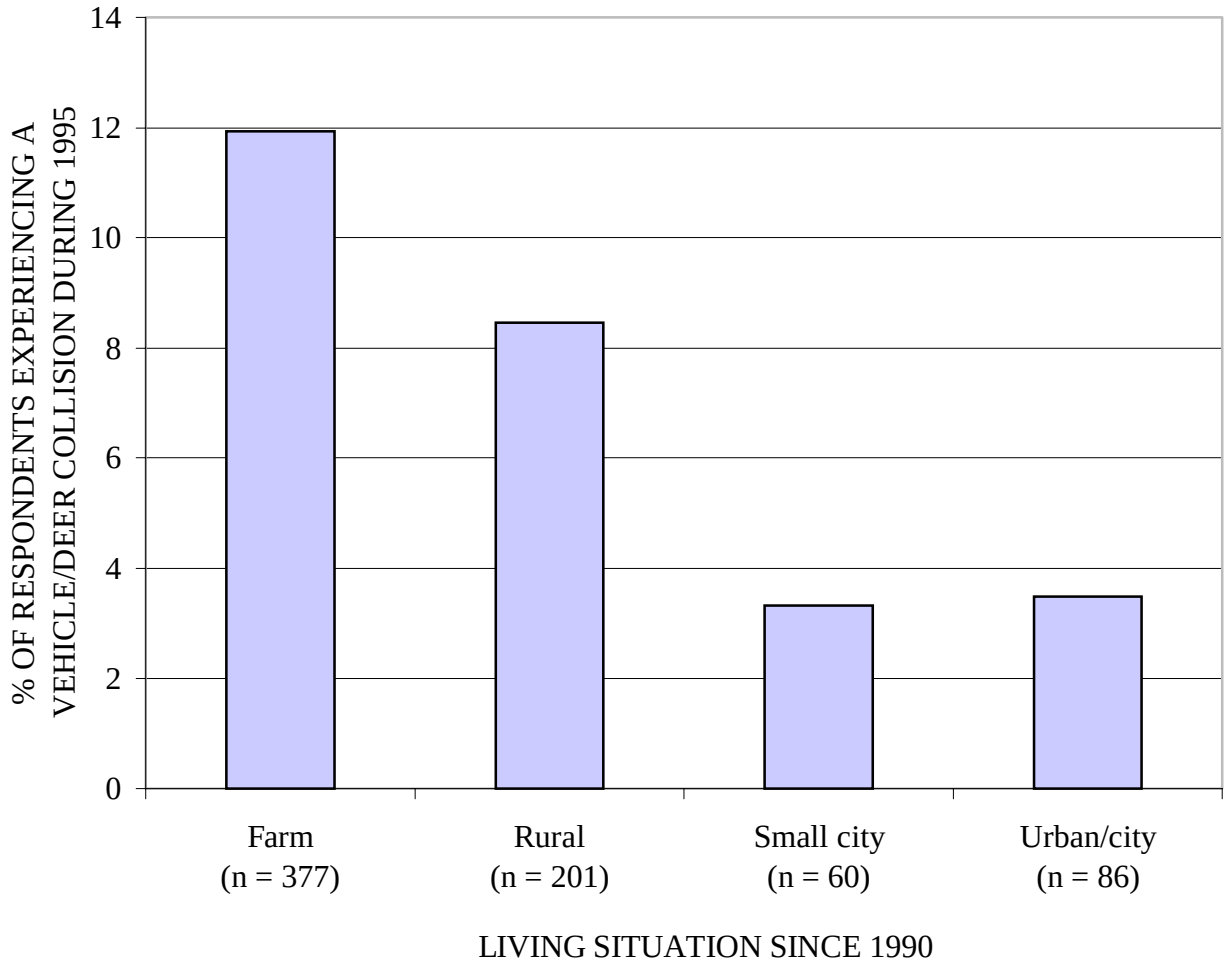

Figure 30. Relationship between a respondent's experience with a vehicle/deer collision in Virginia during 1995 and their living situation since 1990 (see Q-59 in Appendix A for a description of each living situation).

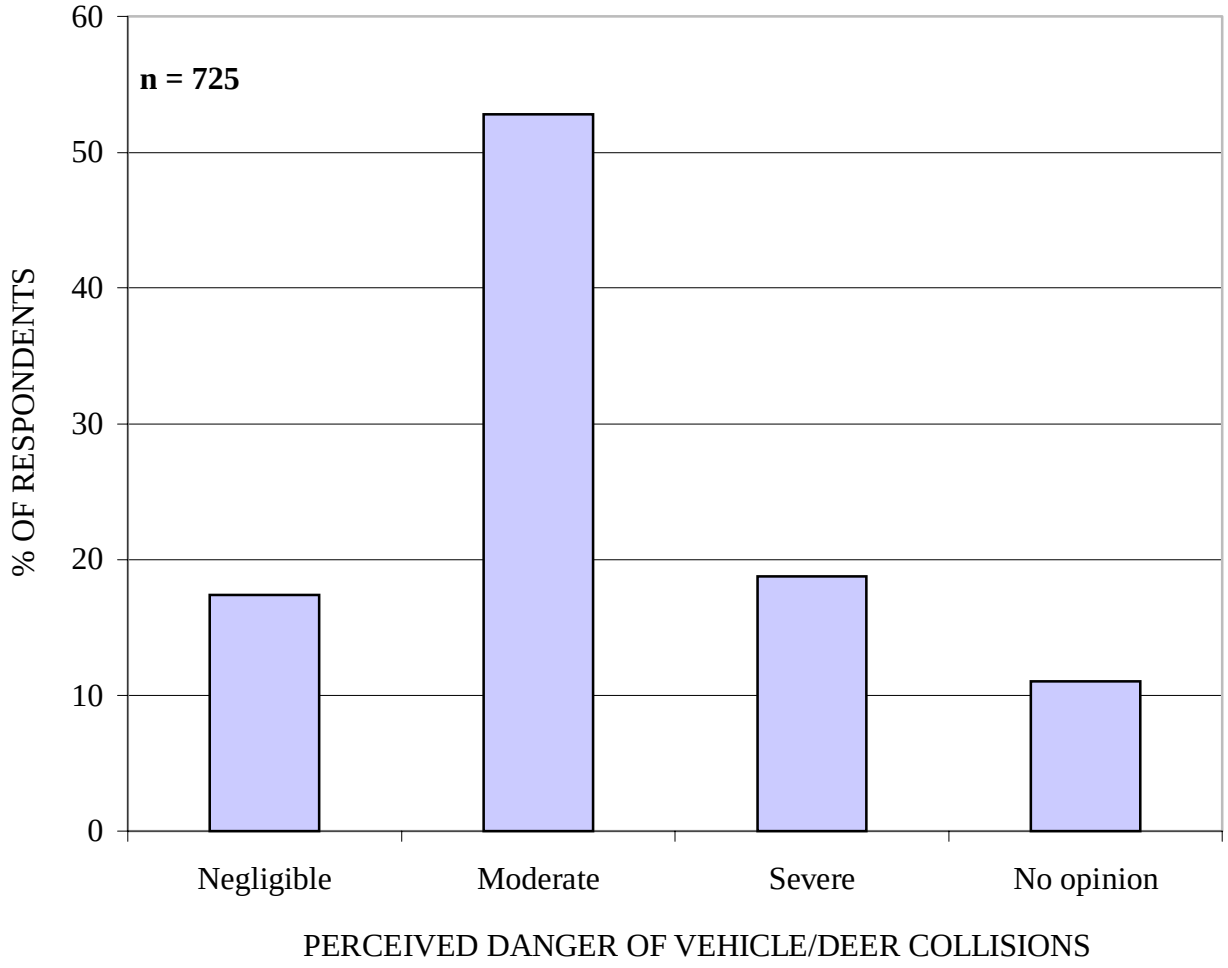

Figure 31. Perceptions about the danger of having a vehicle/deer collision within their county of residence among all respondents in Virginia during 1995.

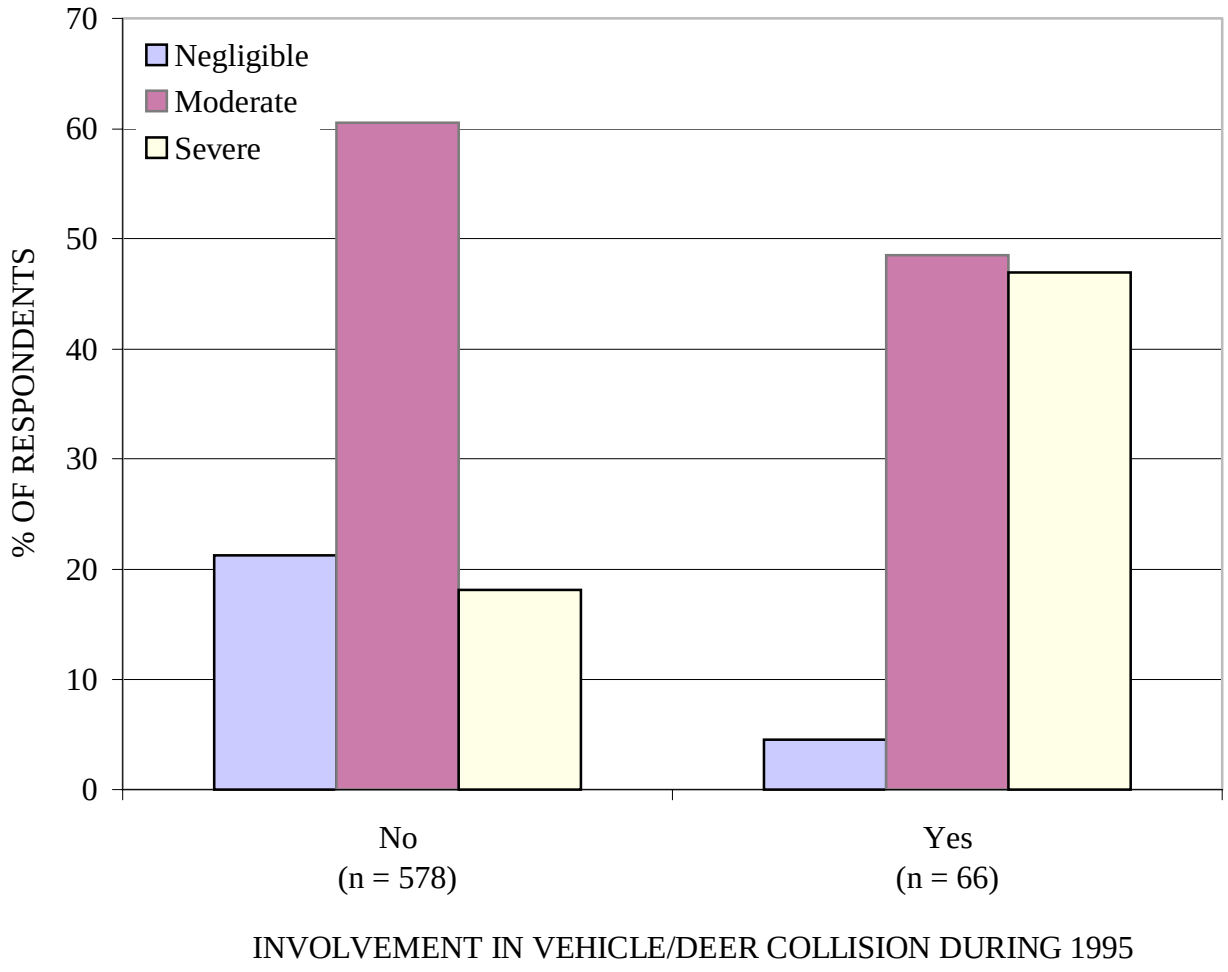

Figure 32. Relationship between a respondent's involvement in a vehicle/deer collision in Virginia during 1995 and their perception about the danger of having a vehicle/deer collision.

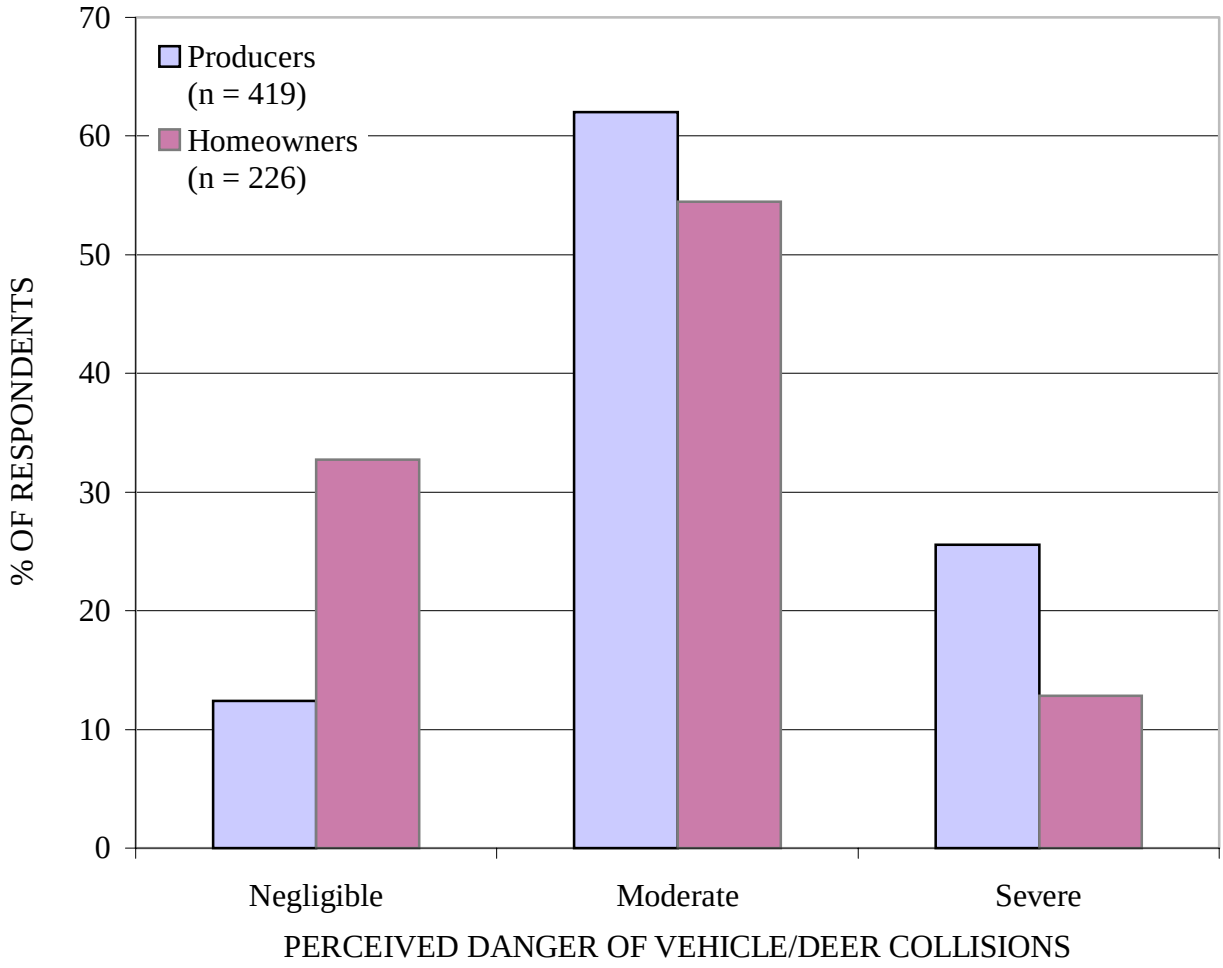

Figure 33. Perceptions about the danger of vehicle/deer collisions, as reported by producers and homeowners in Virginia during 1995.

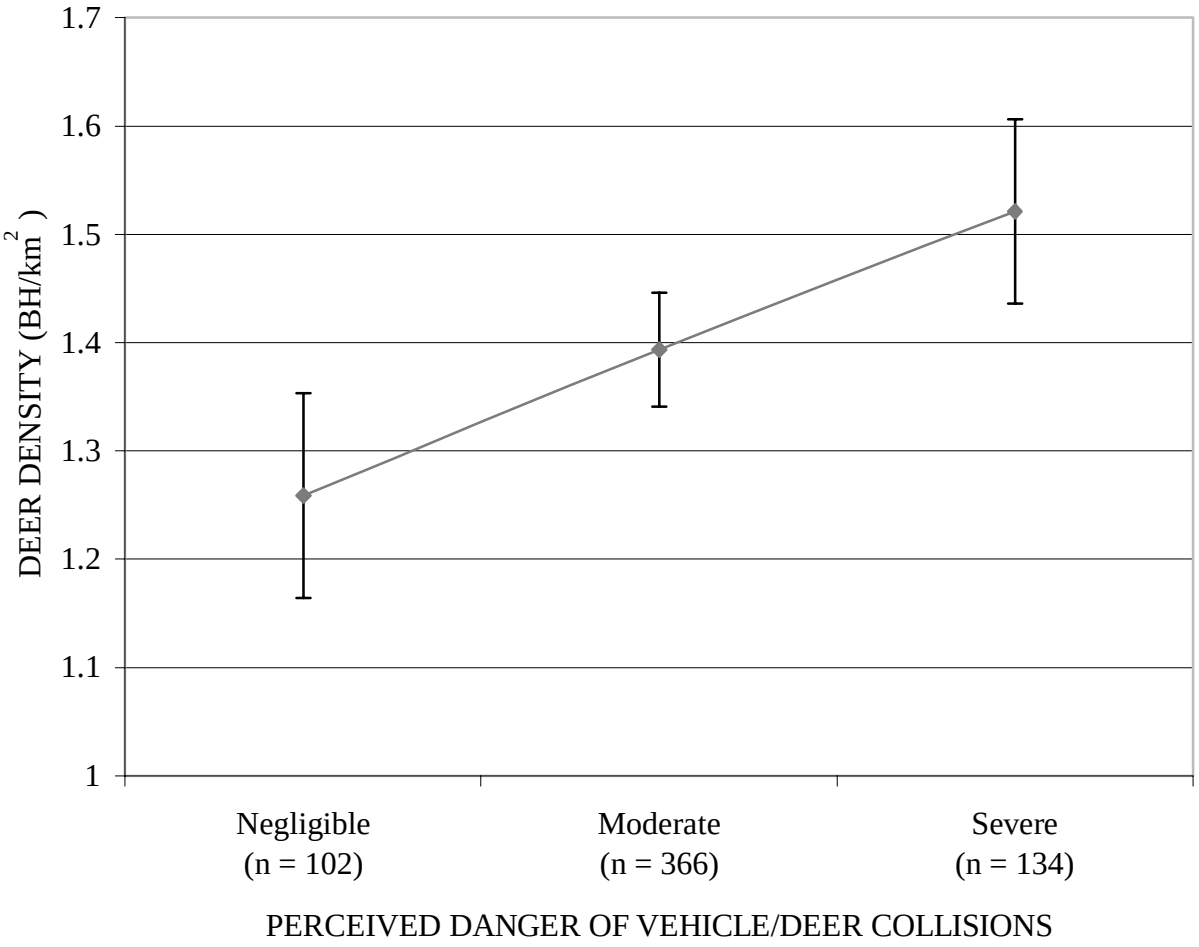

Figure 34. Relationship between deer density (BH/km^2) in county of residence and a respondent's perception about the danger of having a vehicle/deer collision in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

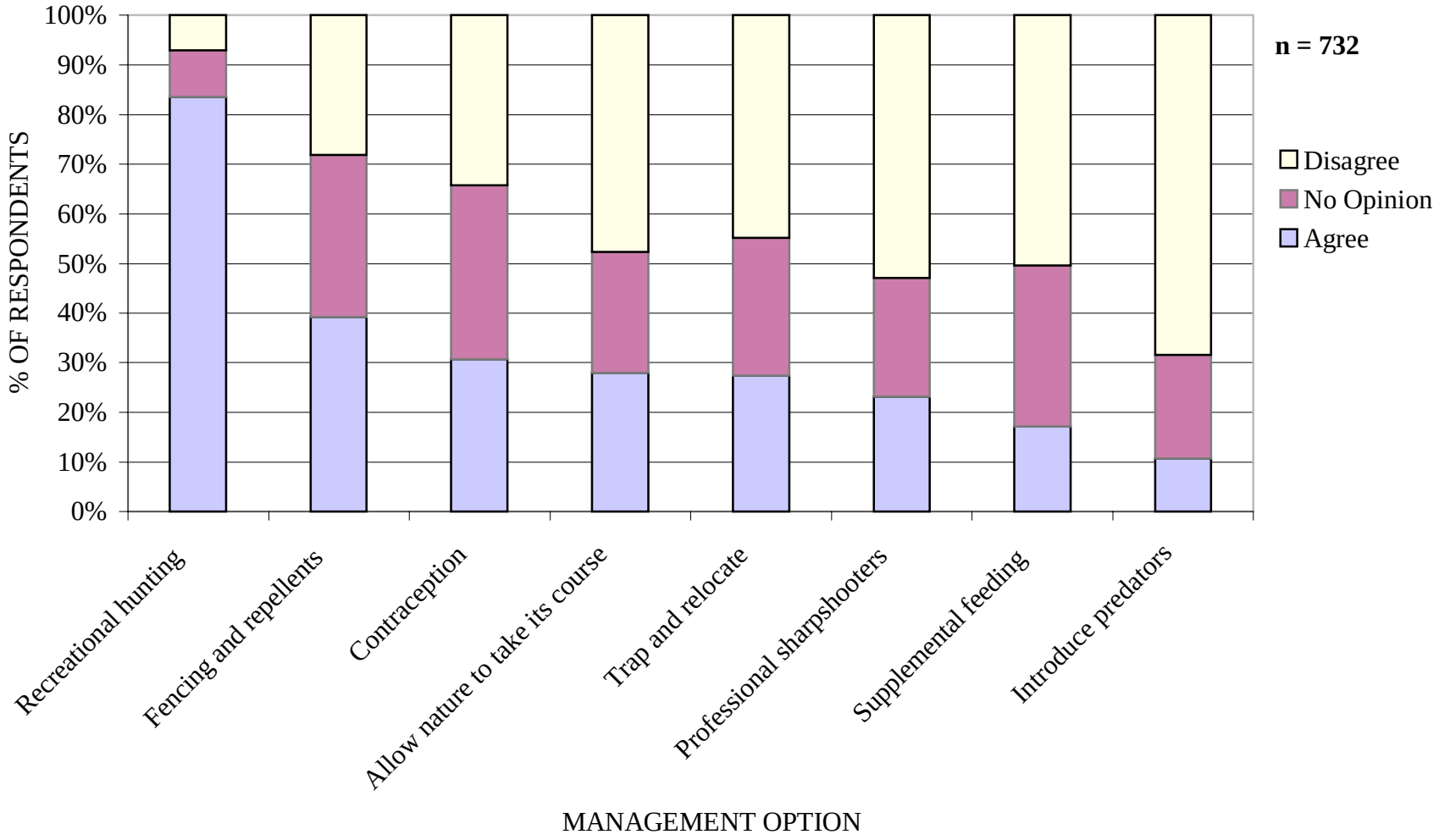

Figure 35. Opinions among all respondents about the use of different options to manage the deer population in Virginia during 1995.

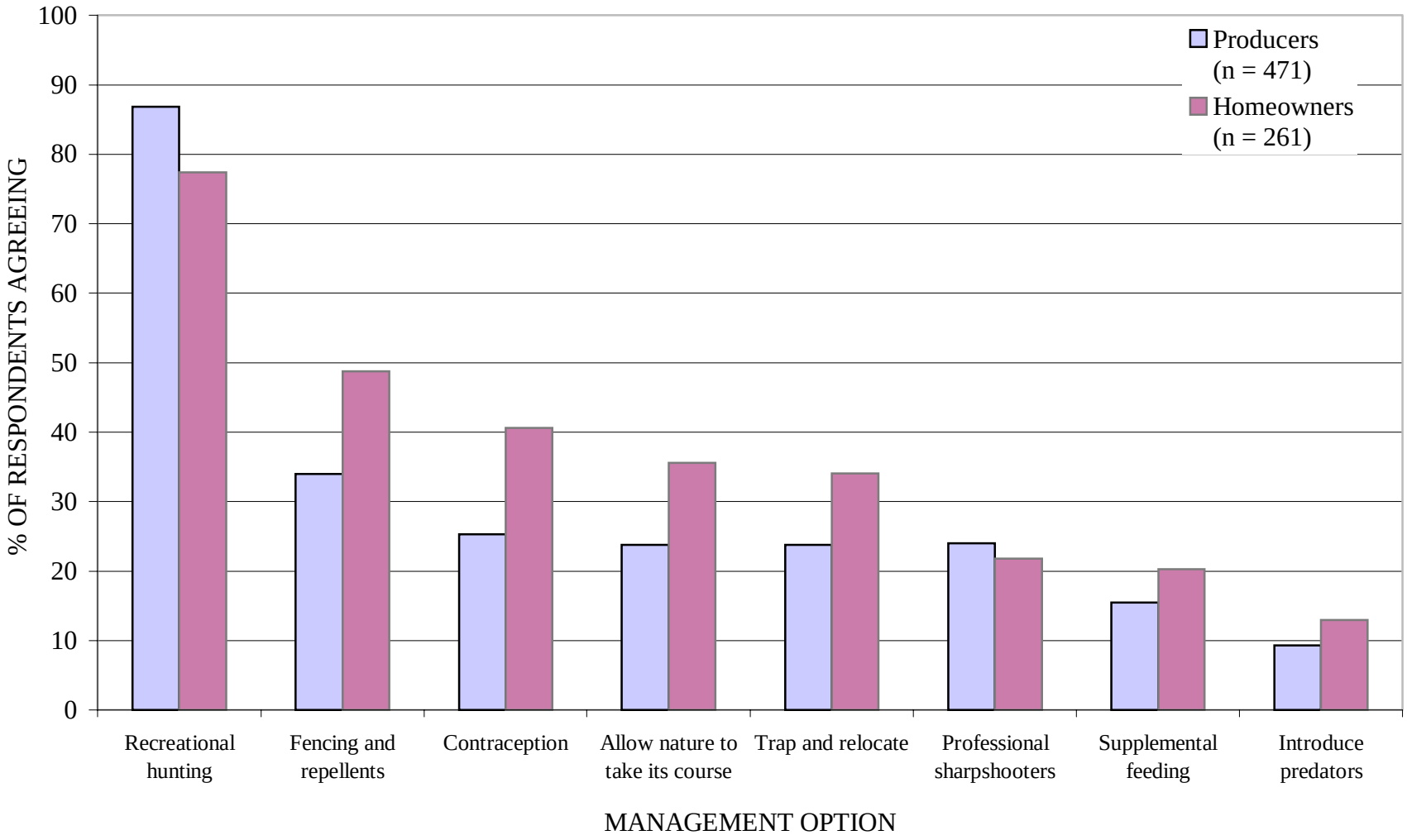

Figure 36. Percentage of respondents agreeing with the use of different options to manage Virginia's deer population during 1995, as expressed by producers and homeowners.

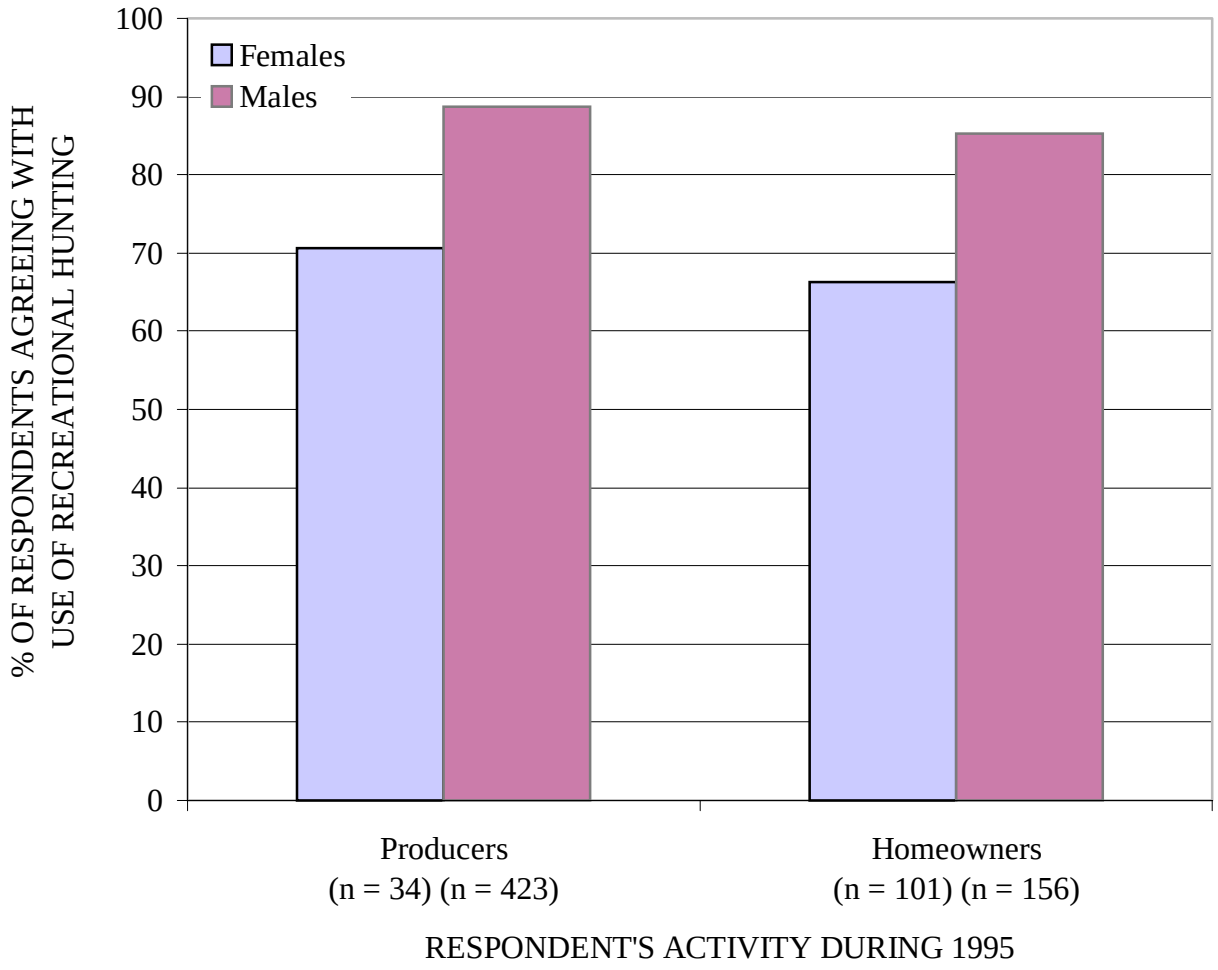

Figure 37. Relationship between a respondent's activity and their opinion of using recreational hunting to manage deer populations in Virginia during 1995, as expressed by male and female respondents.

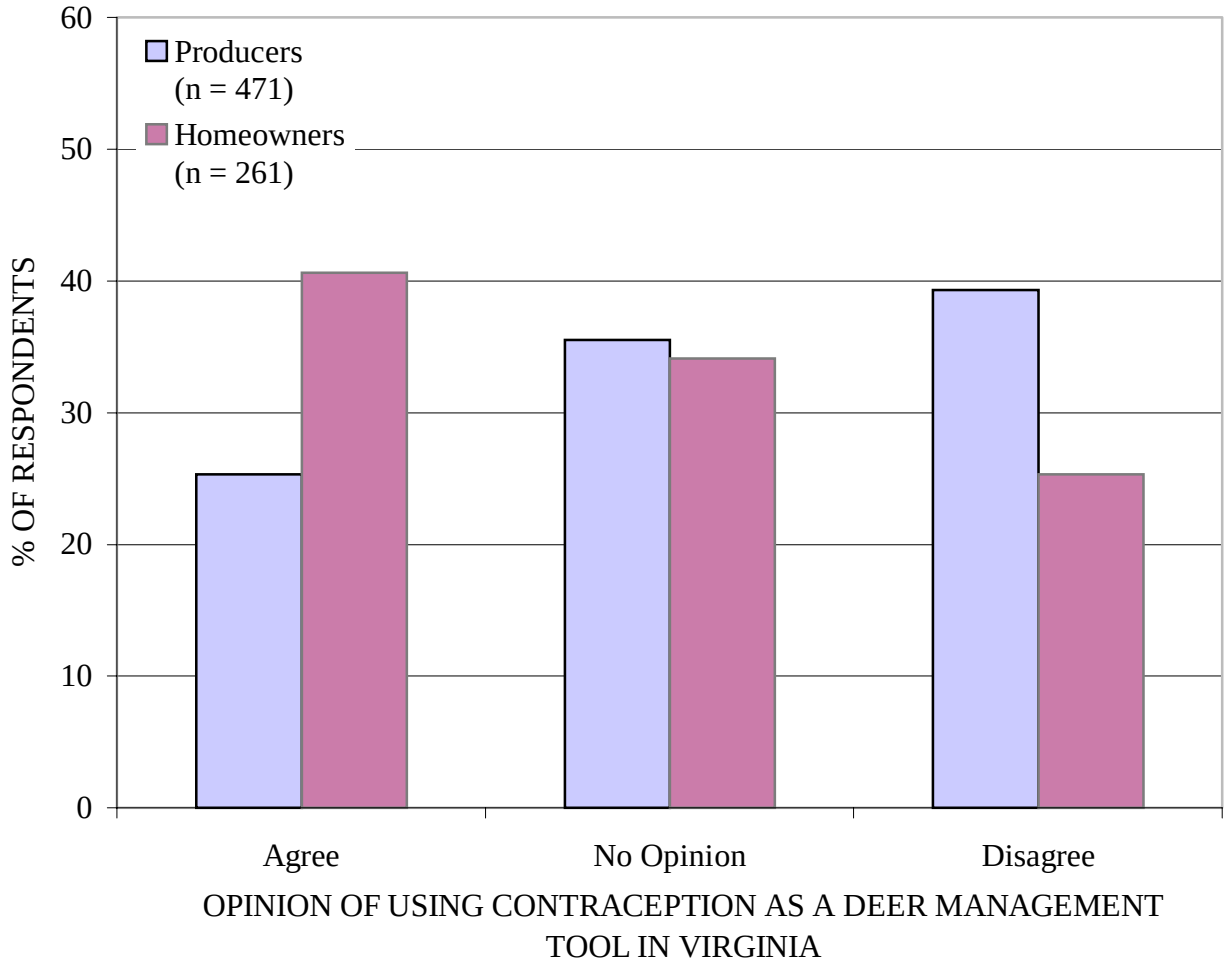

Figure 38. Attitudes among producers and homeowners about the use of contraception as a means to manage deer populations in Virginia during 1995.

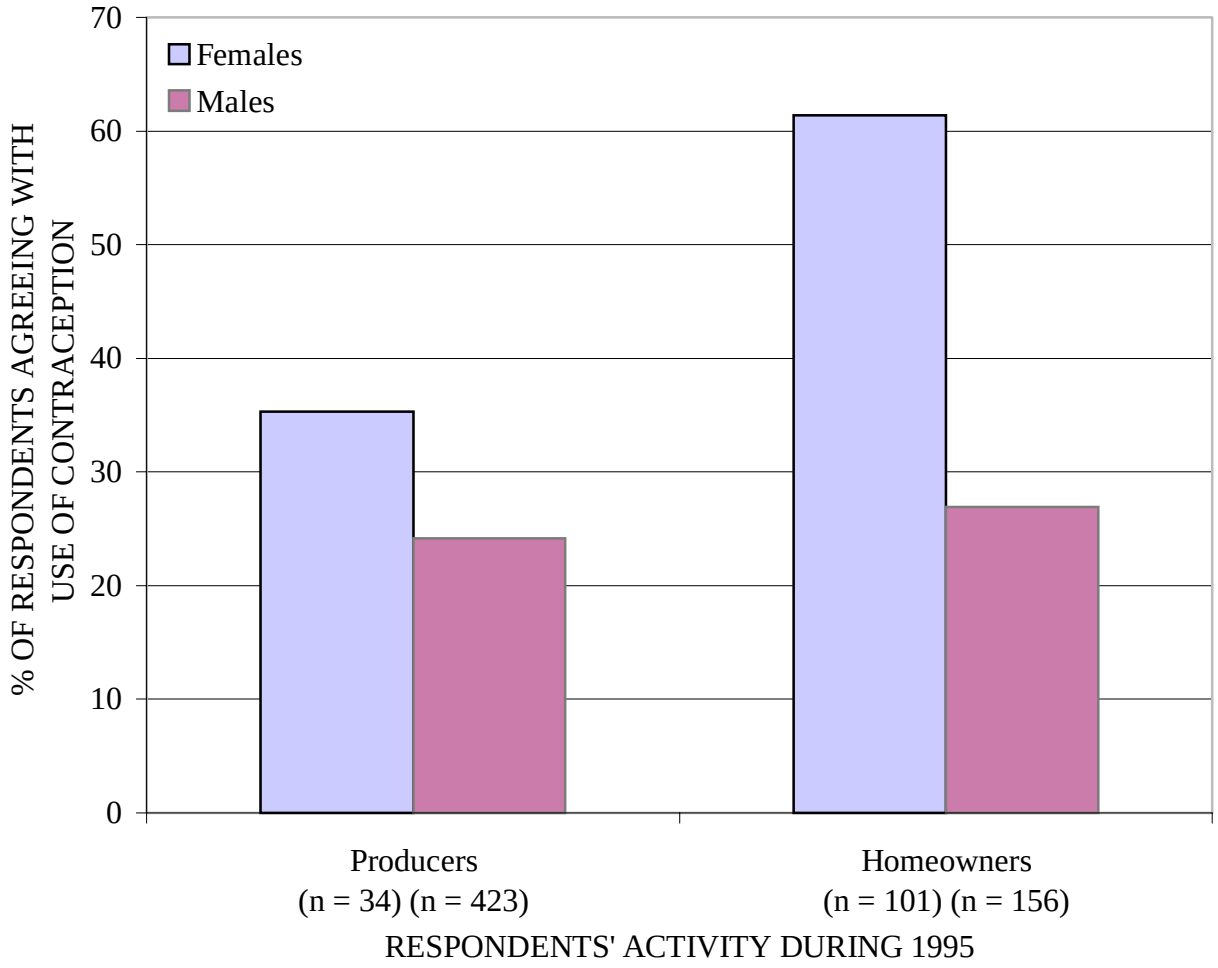

Figure 39. Relationship between a respondent's activity and their view on the use of contraception to manage deer populations in Virginia during 1995, as expressed by male and female respondents.

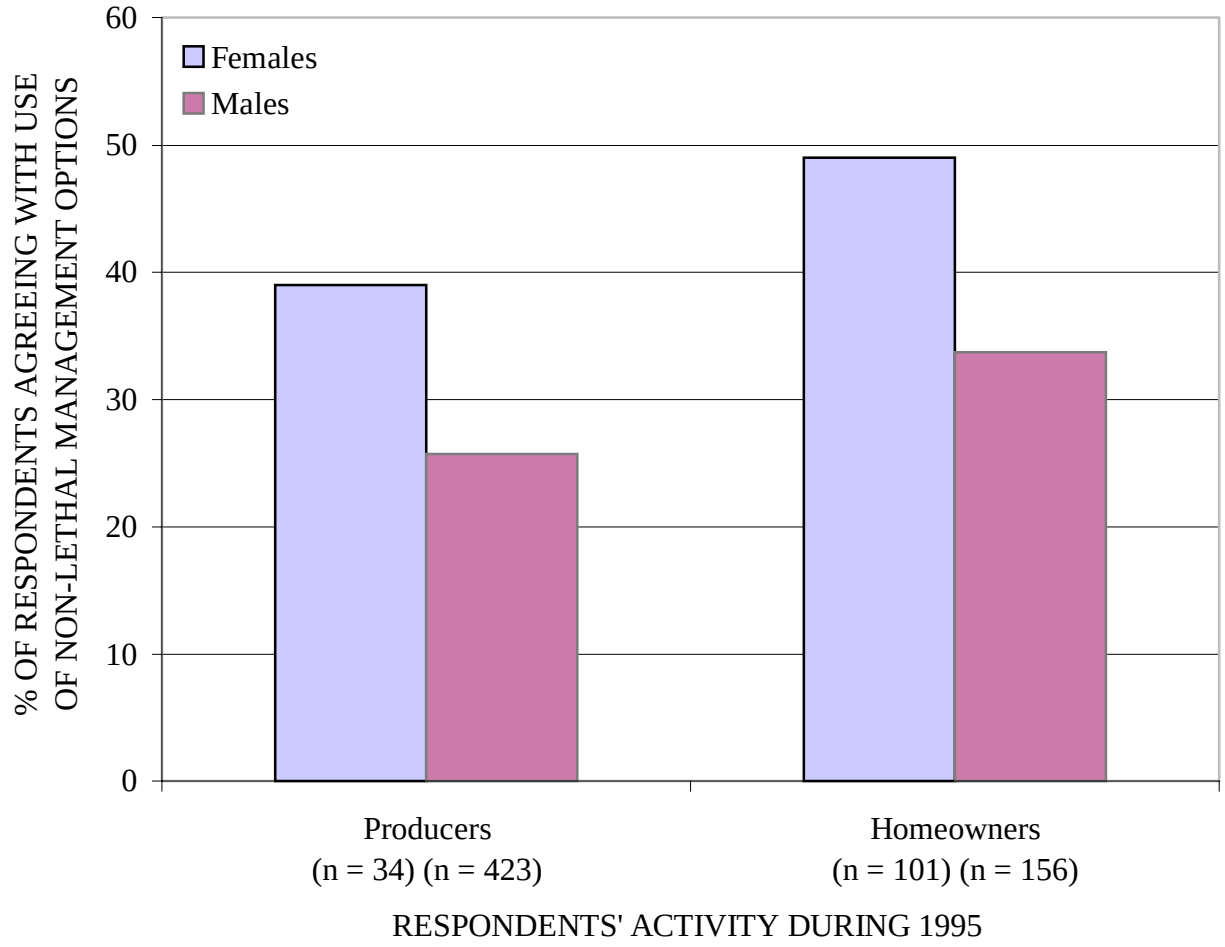

Figure 40. Relationship between a respondent's activity and their opinion on the use of non-lethal options to manage deer populations in Virginia during 1995, as expressed by male and female respondents (non-lethal options considered were: contraception, trapping and relocating individuals, fencing and repellents to manage conflicts, and allowing nature to take its course).

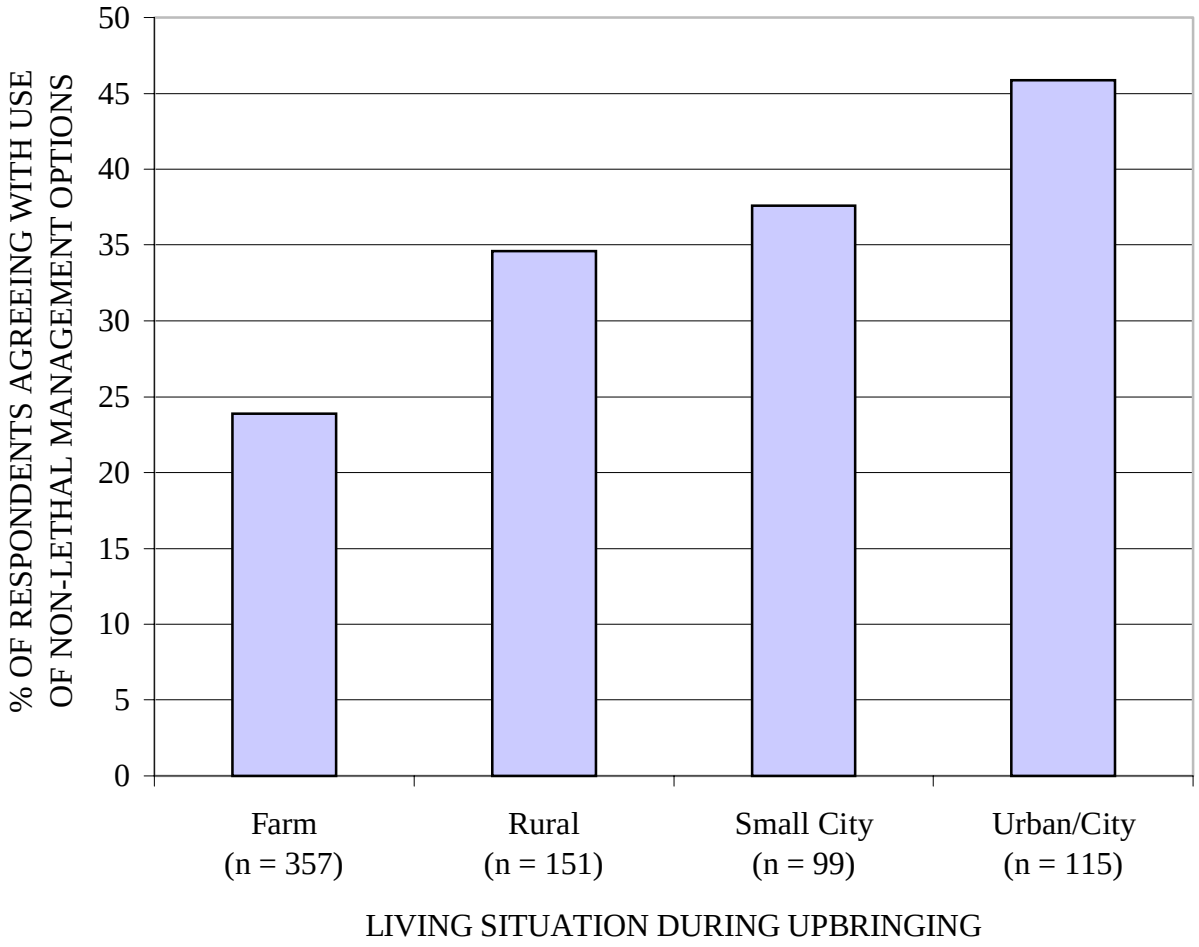

Figure 41. Relationship between the living situation in which a respondent was raised and their opinion on the use of non-lethal options to manage deer populations in Virginia during 1995 (non-lethal options considered were: contraception, trapping and relocating individuals, fencing and repellents to manage conflicts, and allowing nature to take its course; see Q-59 in Appendix A for a description of each living situation).

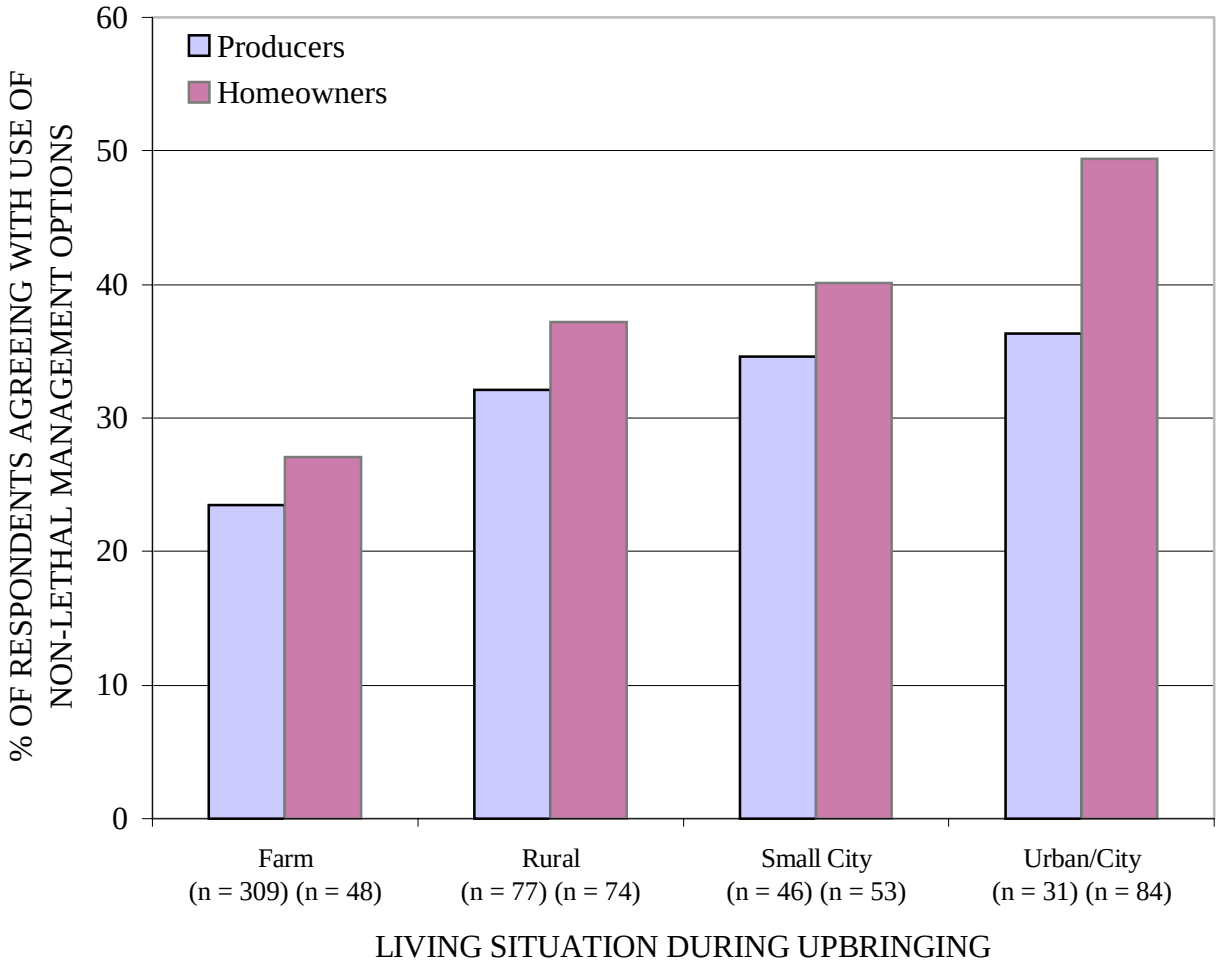

Figure 42. Relationship between the living situation in which a respondent was raised and their opinion on the use of non-lethal options to manage deer populations in Virginia during 1995, as expressed by producers and homeowners (non-lethal options considered were: contraception, trapping and relocating individuals, fencing and repellents to manage conflicts, and allowing nature to take its course; see Q-59 in Appendix A for a description of each living situation).

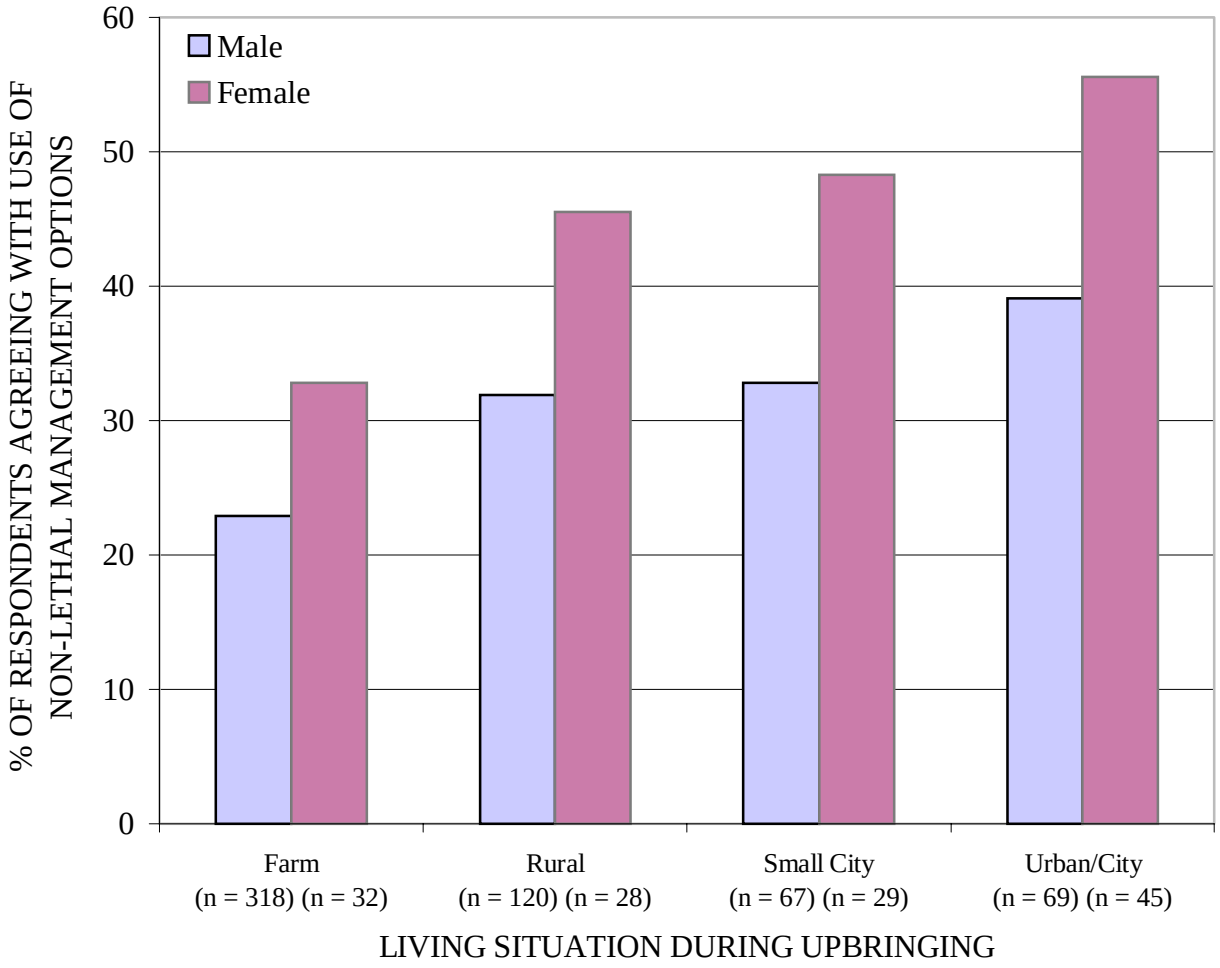

Figure 43. Relationship between the living situation in which a respondent was raised and their opinion on the use of non-lethal options to manage deer populations in Virginia during 1995, as expressed by male and female respondents (non-lethal options considered were: contraception, trapping and relocating individuals, fencing and repellents to manage conflicts, and allowing nature to take its course; see Q-59 in Appendix A for a description of each living situation).

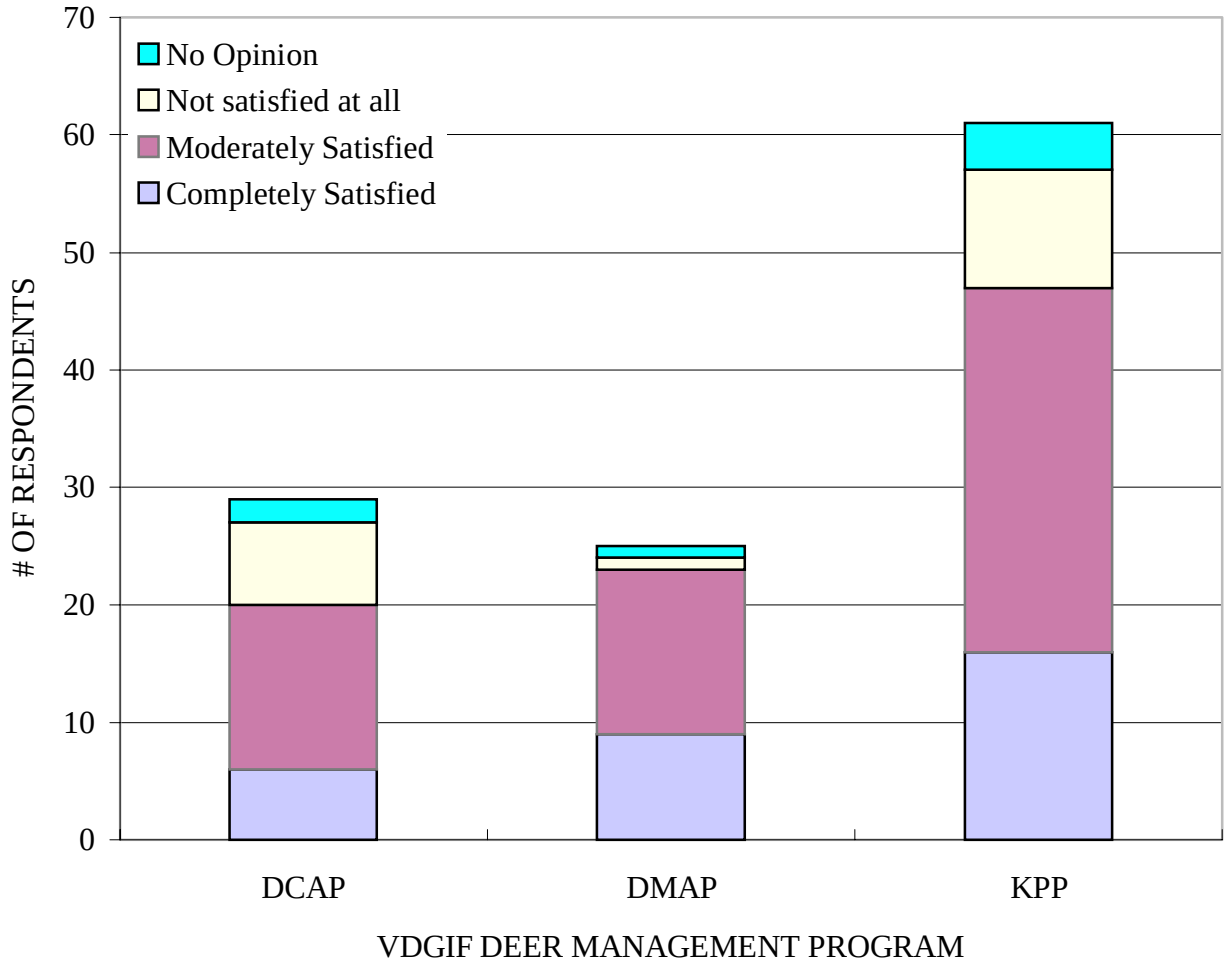

Figure 44. Number of participants in and expressed satisfaction with deer management programs administered by the Virginia Department of Game and Inland Fisheries, as expressed by all respondents in Virginia during 1995 (DCAP = "damage control assistance program", DMAP = "deer management program", and KPP = "kill permit program"; see Appendix E for a description of each program).

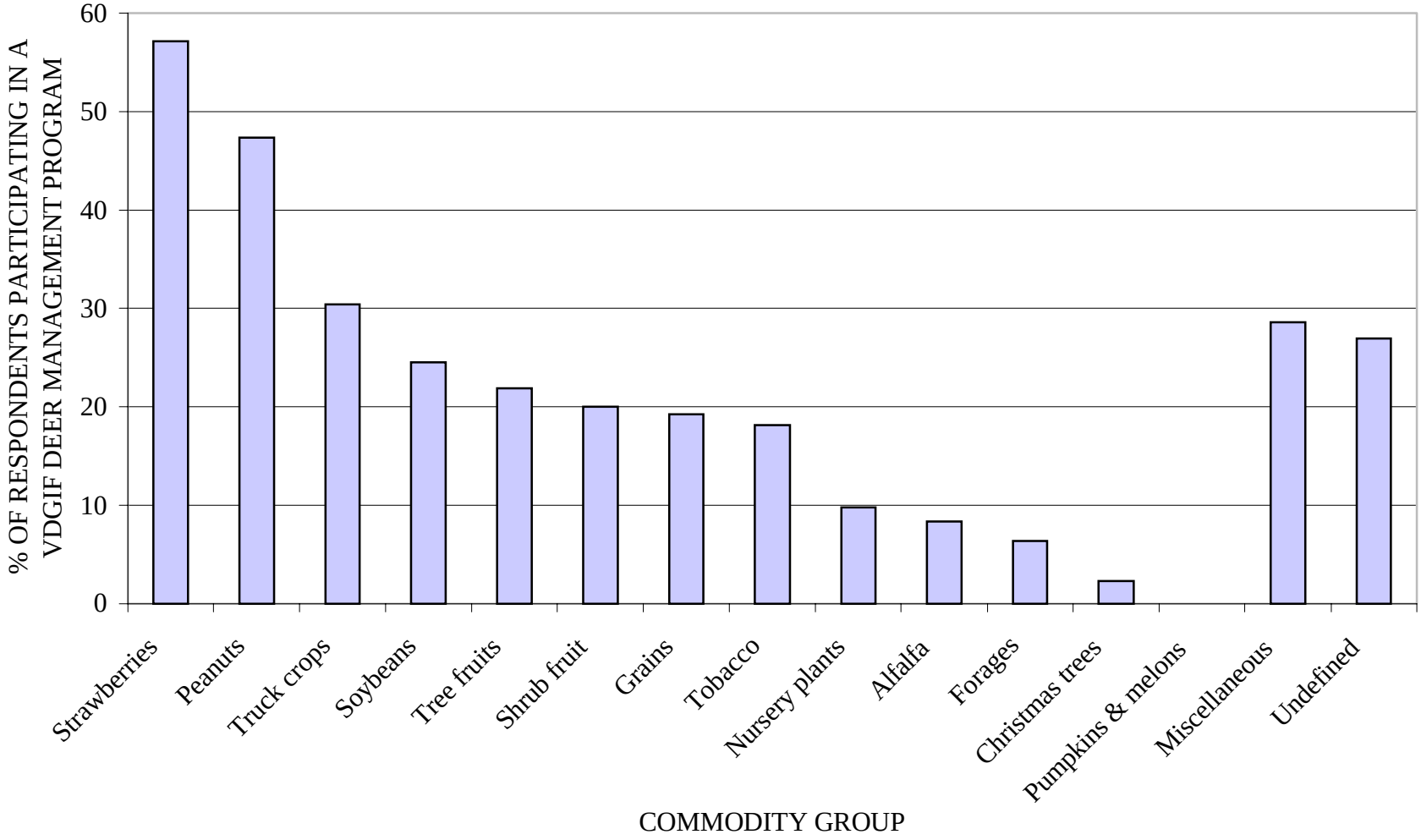

Figure 45. Percentage of individuals within commodity groups who participated in any deer management program administered by Virginia Department of Game and Inland Fisheries during 1995 (see Appendix B for specific crops included within commodity groups).

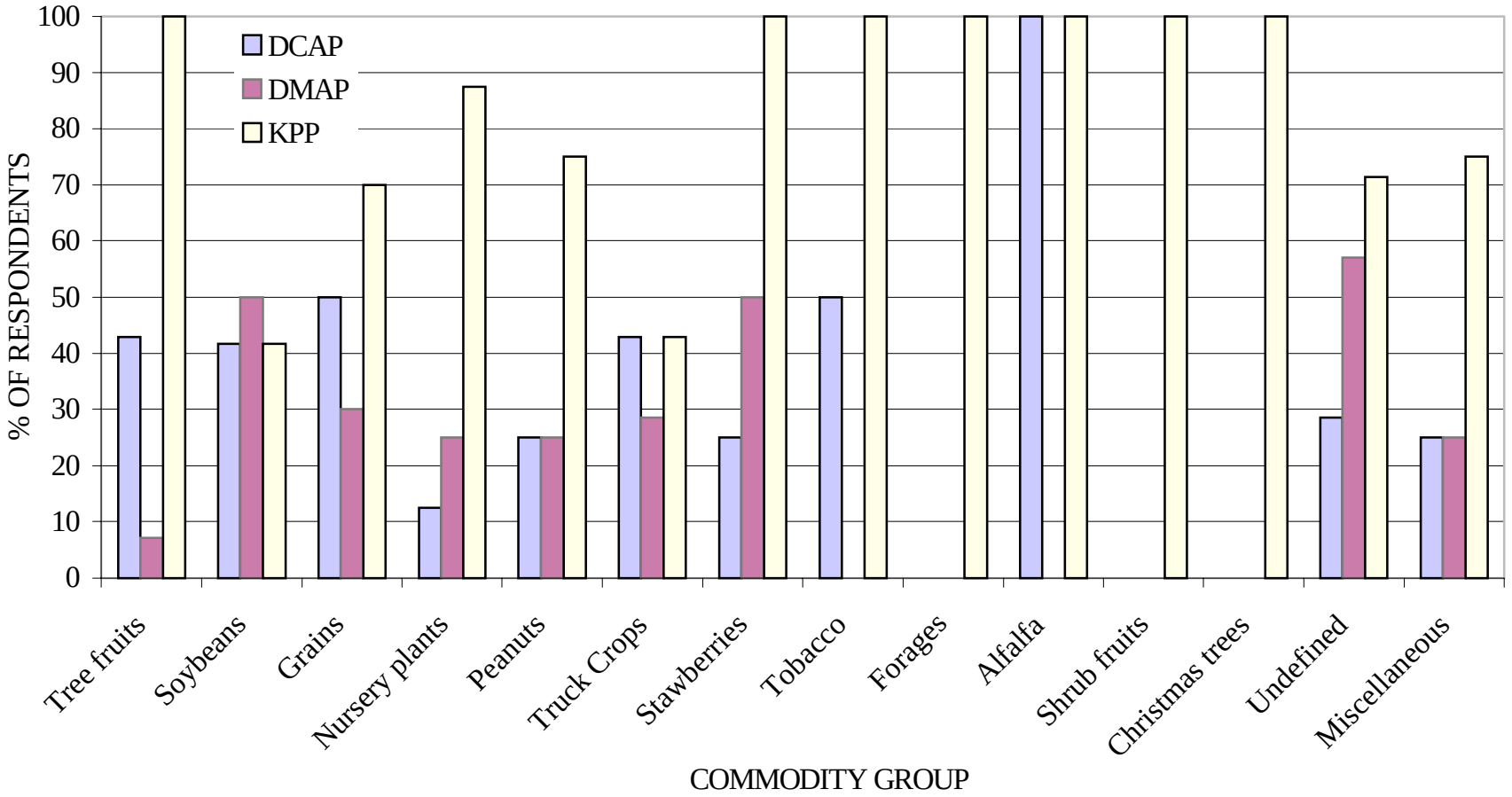

Figure 46. Participation in specific deer management programs administered by the Virginia Department of Game and Inland Fisheries by producers within commodity groups during 1995 (DCAP = "damage control assistance program", DMAP = "deer management program", and KPP = "kill permit program"; see Appendix E for a description of each program; see Appendix B for specific crops included within commodity groups).

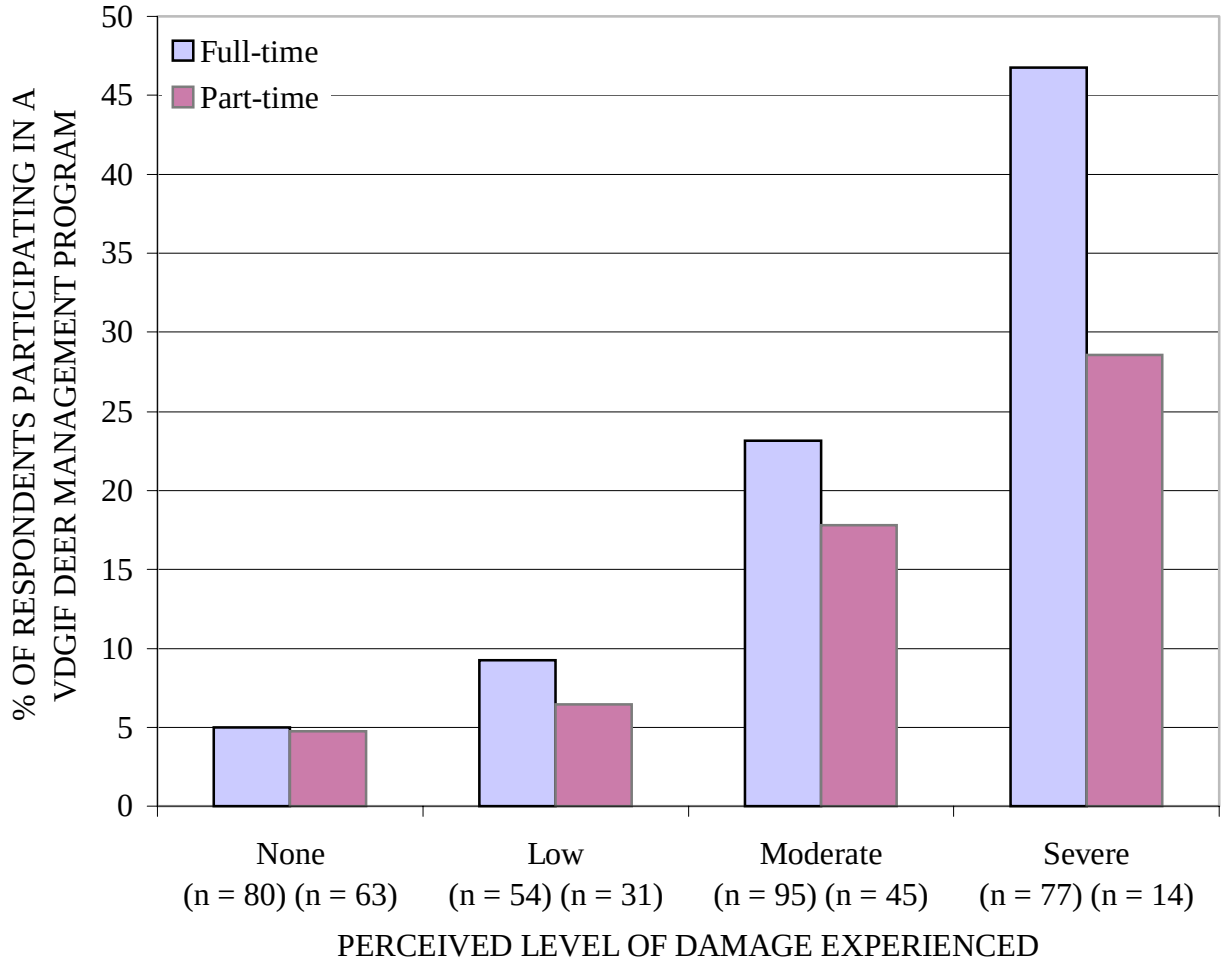

Figure 47. Relationship between a respondent's perception about the severity of damage by deer and participation in any deer management program administered by the Virginia Department of Game and Inland Fisheries during 1995, as reported by part- and full-time producers.

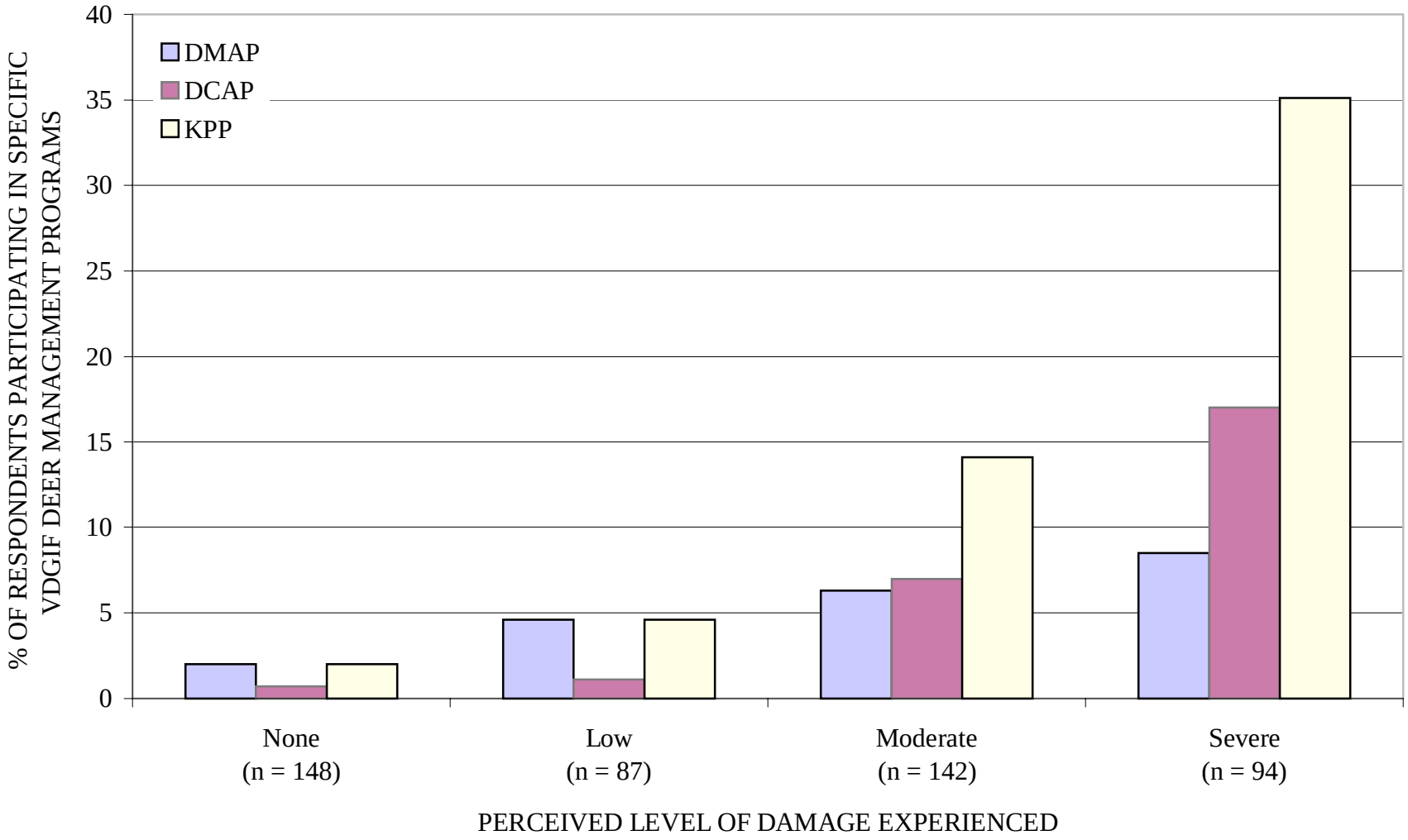

Figure 48. Relationship between a producer's perception about the severity of damage by deer and participation in specific deer management programs administered by the Virginia Department of Game and Inland Fisheries during 1995 (DCAP = "damage control assistance program", DMAP = "deer management program", and KPP = "kill permit program"; see Appendix E for a description of each program).

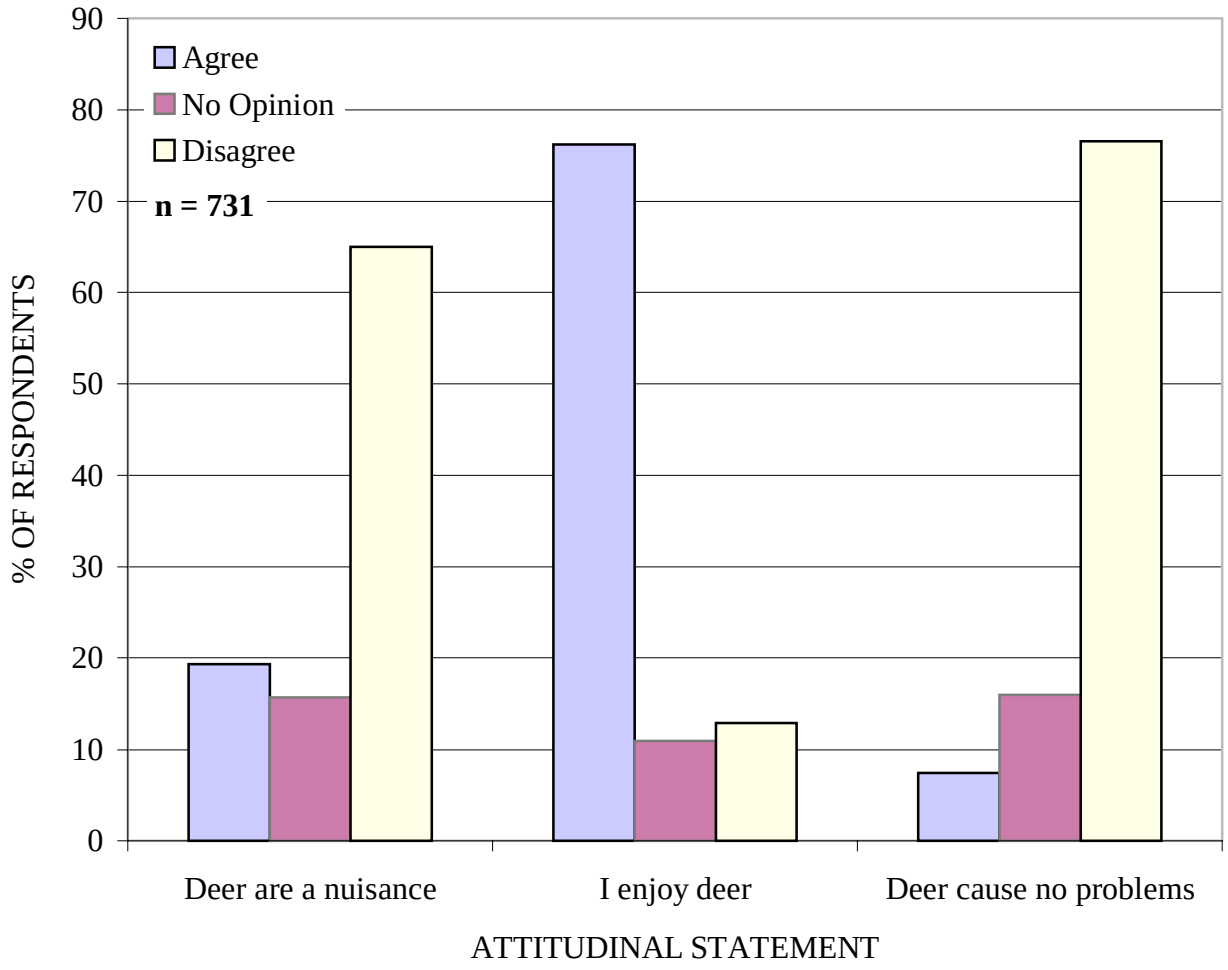

Figure 49. Opinions expressed by respondents during 1995 in Virginia about the statements: "deer are a nuisance and should not be tolerated" (deer are a nuisance), "deer cause some problems but I enjoy having them around" (I enjoy deer), and "deer don't cause any problems" (deer cause no problems).

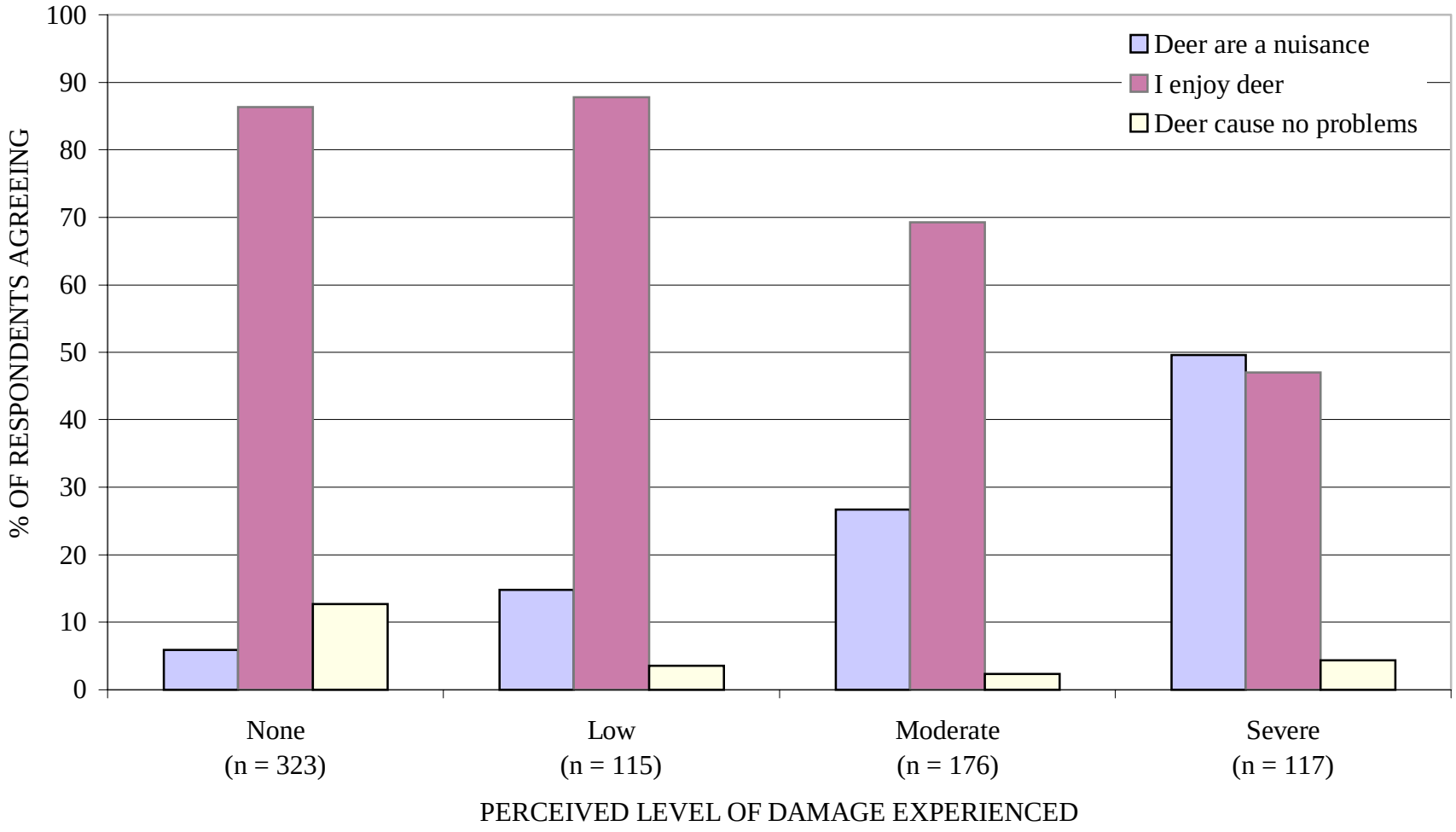

Figure 50. Relationship between a respondent's perceptions about severity of damage by deer and attitude about deer in Virginia during 1995, as embodied by response to the statements: "deer are a nuisance and should not be tolerated" (deer are a nuisance), "deer cause some problems but I enjoy having them around" (I enjoy deer), and "deer don't cause any problems" (deer cause no problems) among those perceiving differing levels of deer damage during 1995.

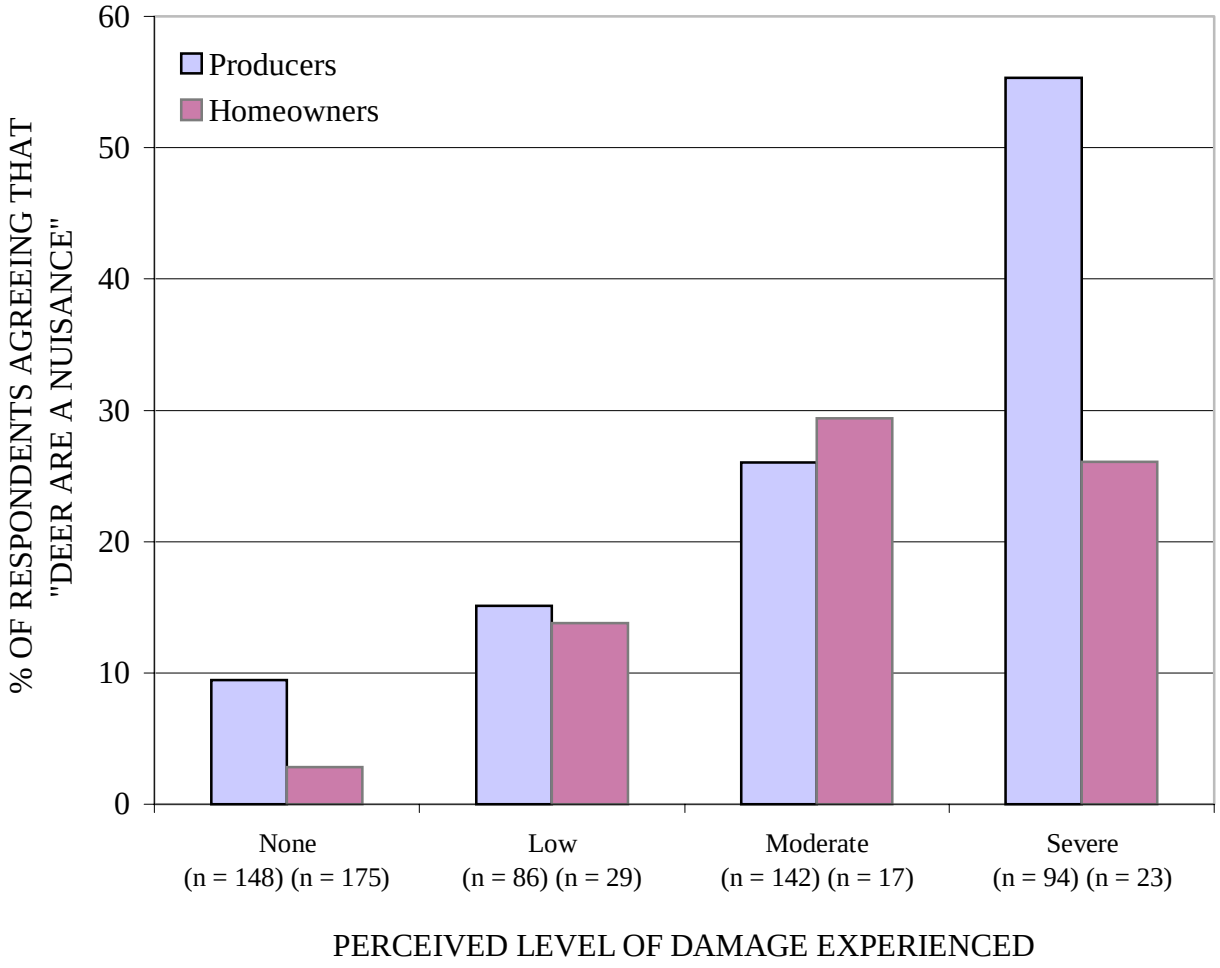

Figure 51. Relationship between a respondent's perception of the severity of damage by deer and opinion on whether "deer are a nuisance and should not be tolerated," as expressed by all respondents in Virginia during 1995.

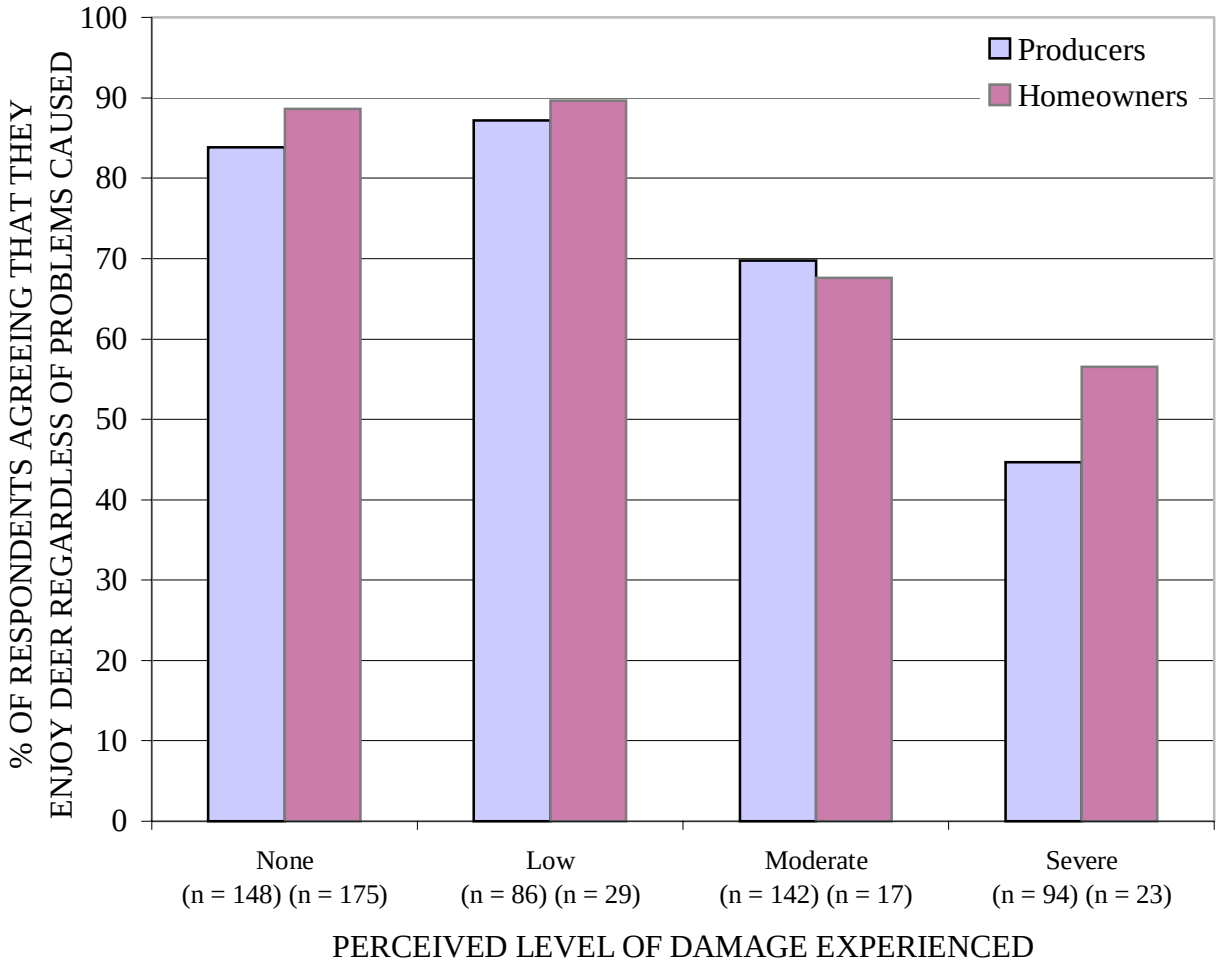

Figure 52. Relationship between a respondent's perception about the severity of damage by deer and opinion about the statement: "deer cause some problems but I enjoy them," as expressed by producers and homeowners in Virginia during 1995.

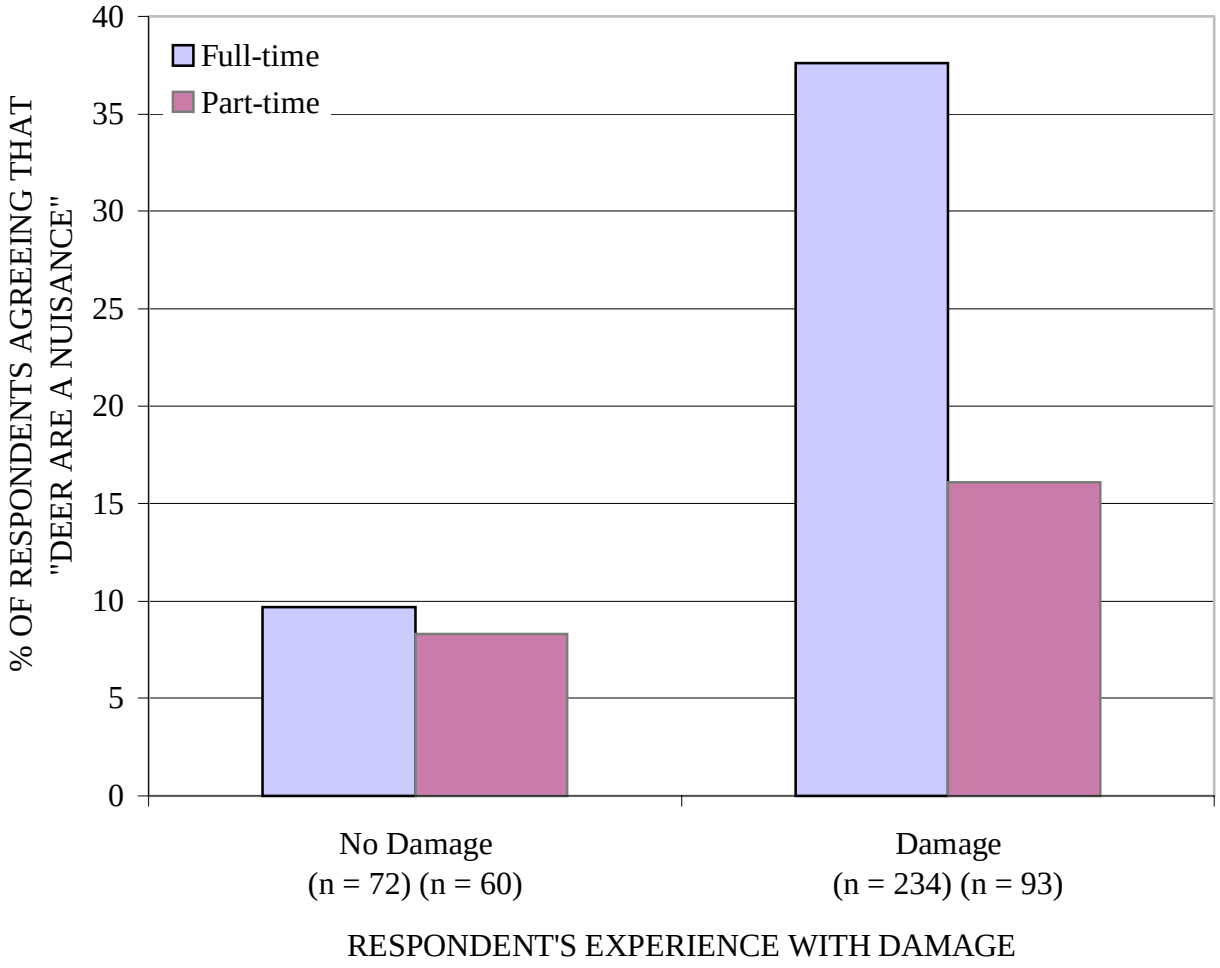

Figure 53. Relationship between a respondent's experience with damage and opinion on whether "deer are a nuisance and should not be tolerated," as expressed by full- and part-time producers in Virginia during 1995.

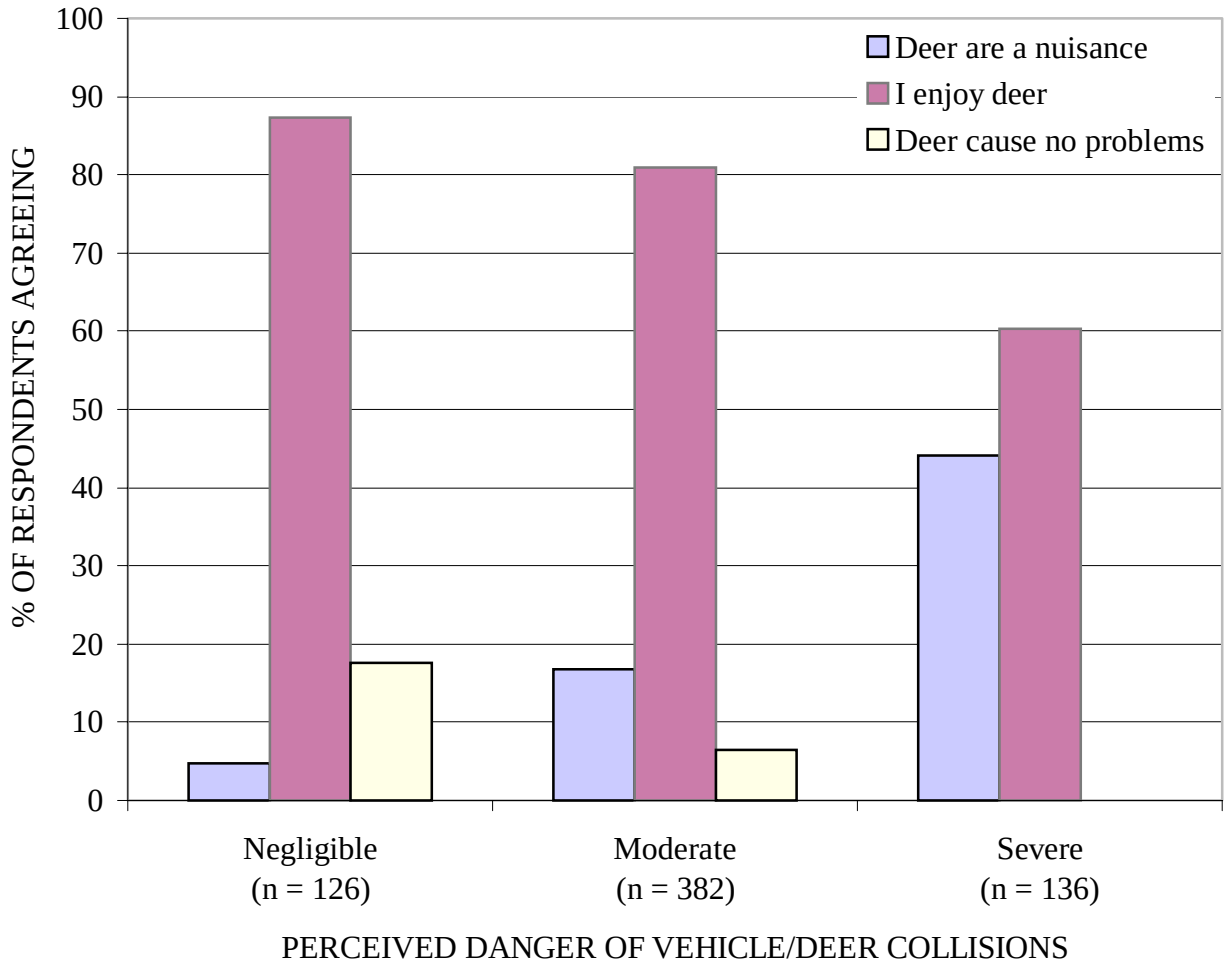

Figure 54. Relationship between a respondent's perception of the danger of having a vehicle/deer collision and attitudes about the statements: "deer are a nuisance and should not be tolerated" (deer are a nuisance), "deer cause some problems but I enjoy having them around" (I enjoy deer), and "deer don't cause any problems" (deer cause no problems), as expressed by respondents in Virginia during 1995.

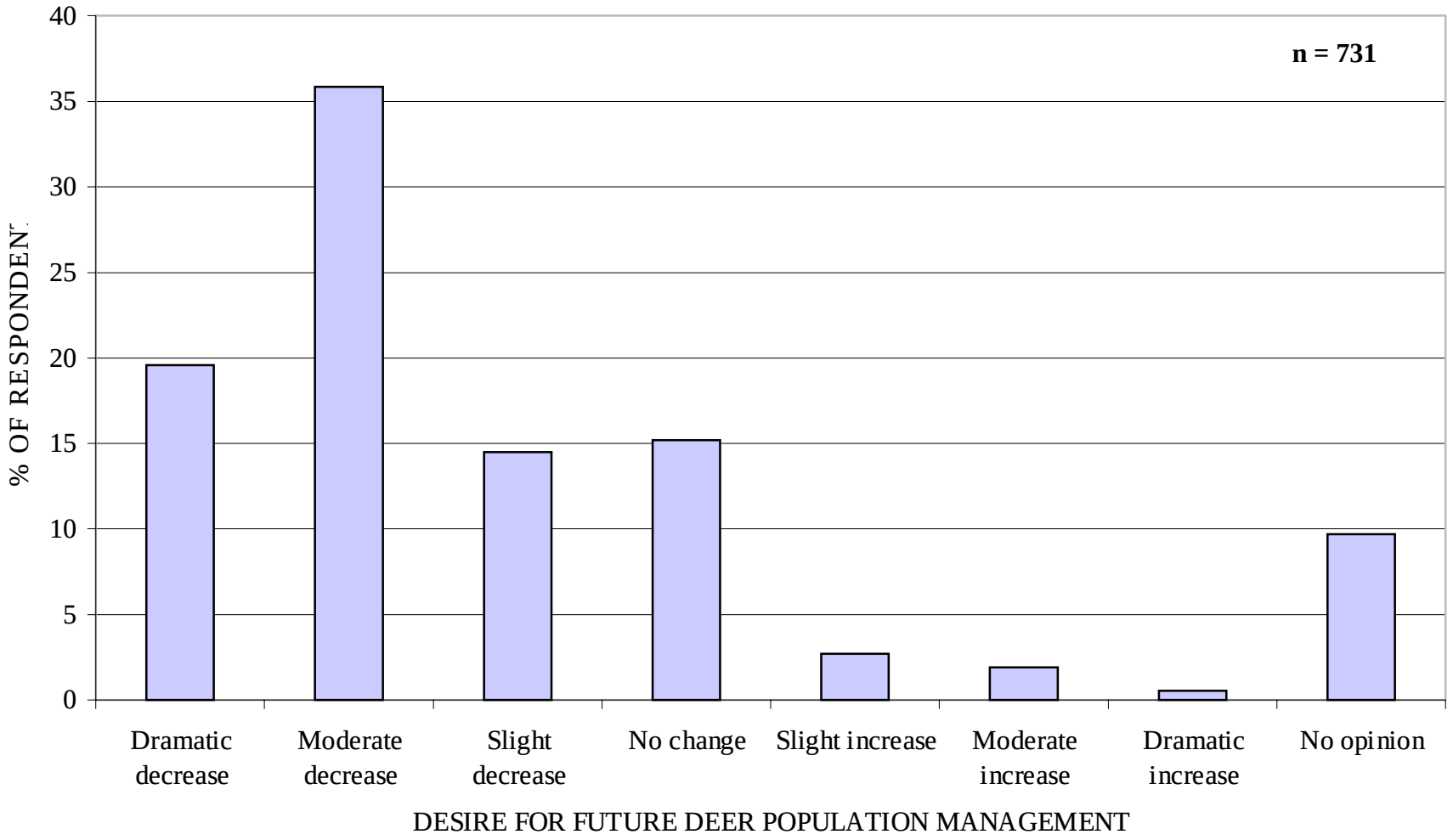

Figure 55. Expressed desires for the future management of deer populations in Virginia among all respondents during 1995.

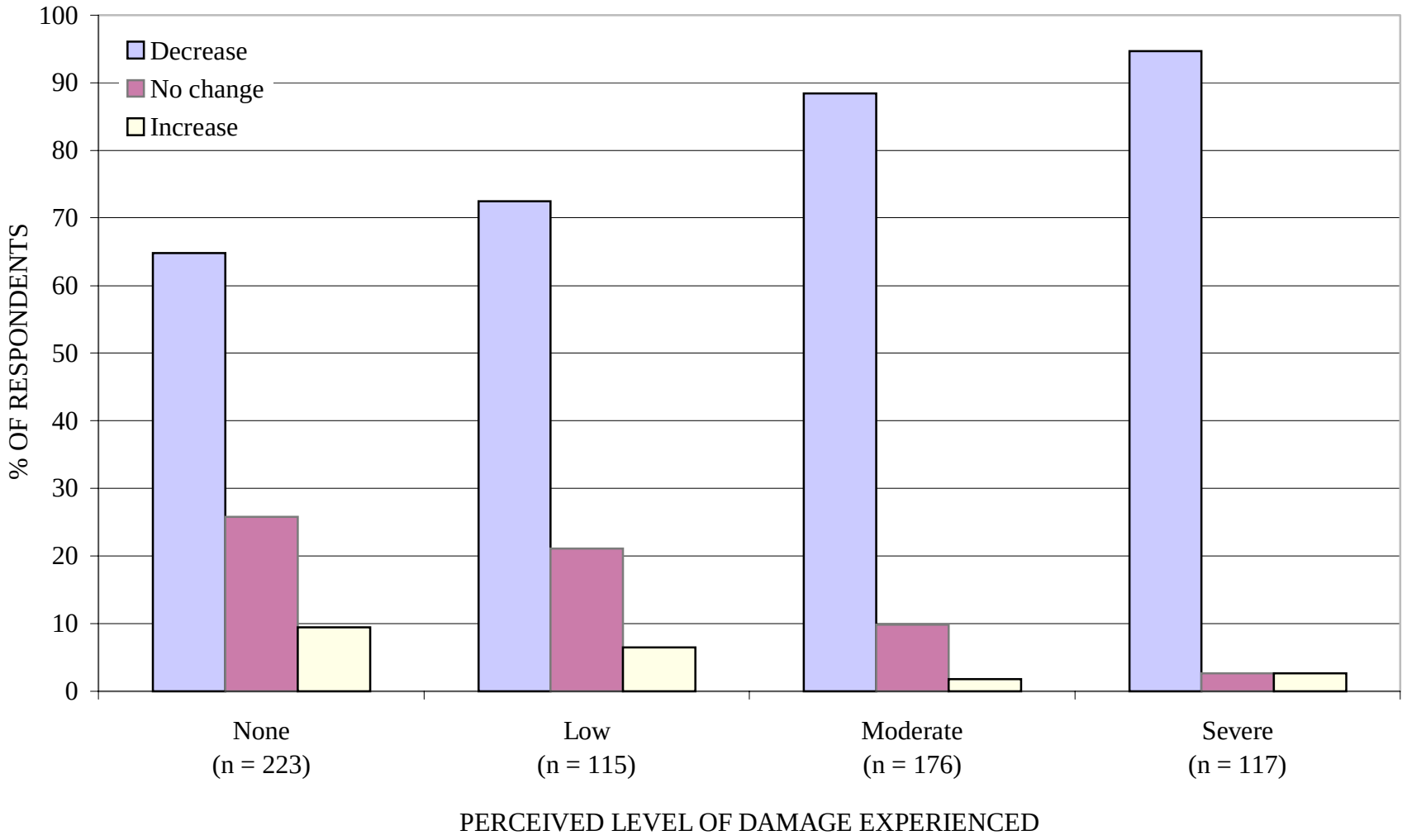

Figure 56. Relationship between a respondent's perception about the severity of damage by deer and desire for future deer population management in Virginia during 1995.

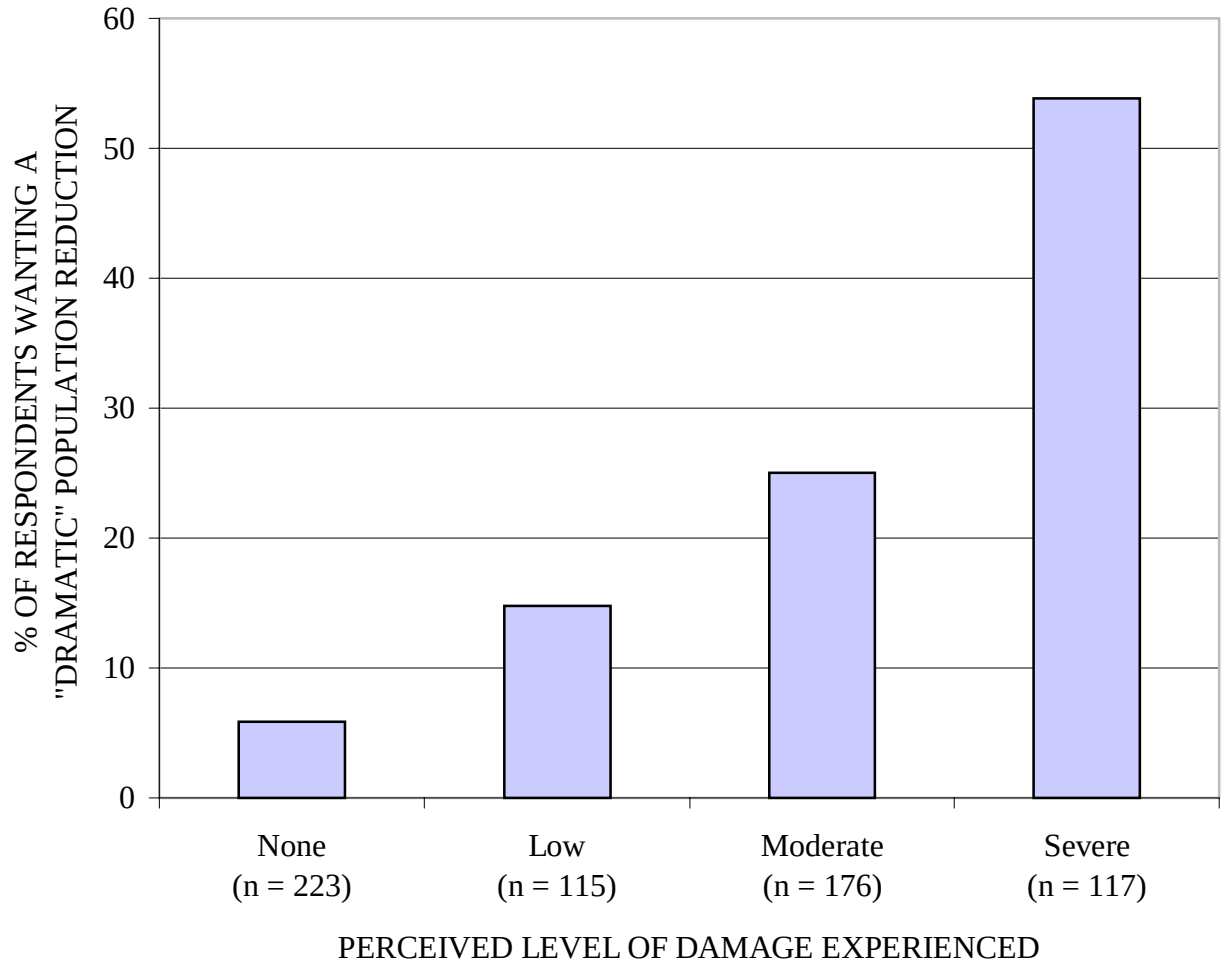

Figure 57. Relationship between a respondent's perception about the severity of damage by deer and desire for a "dramatic" reduction of deer populations in Virginia during 1995.

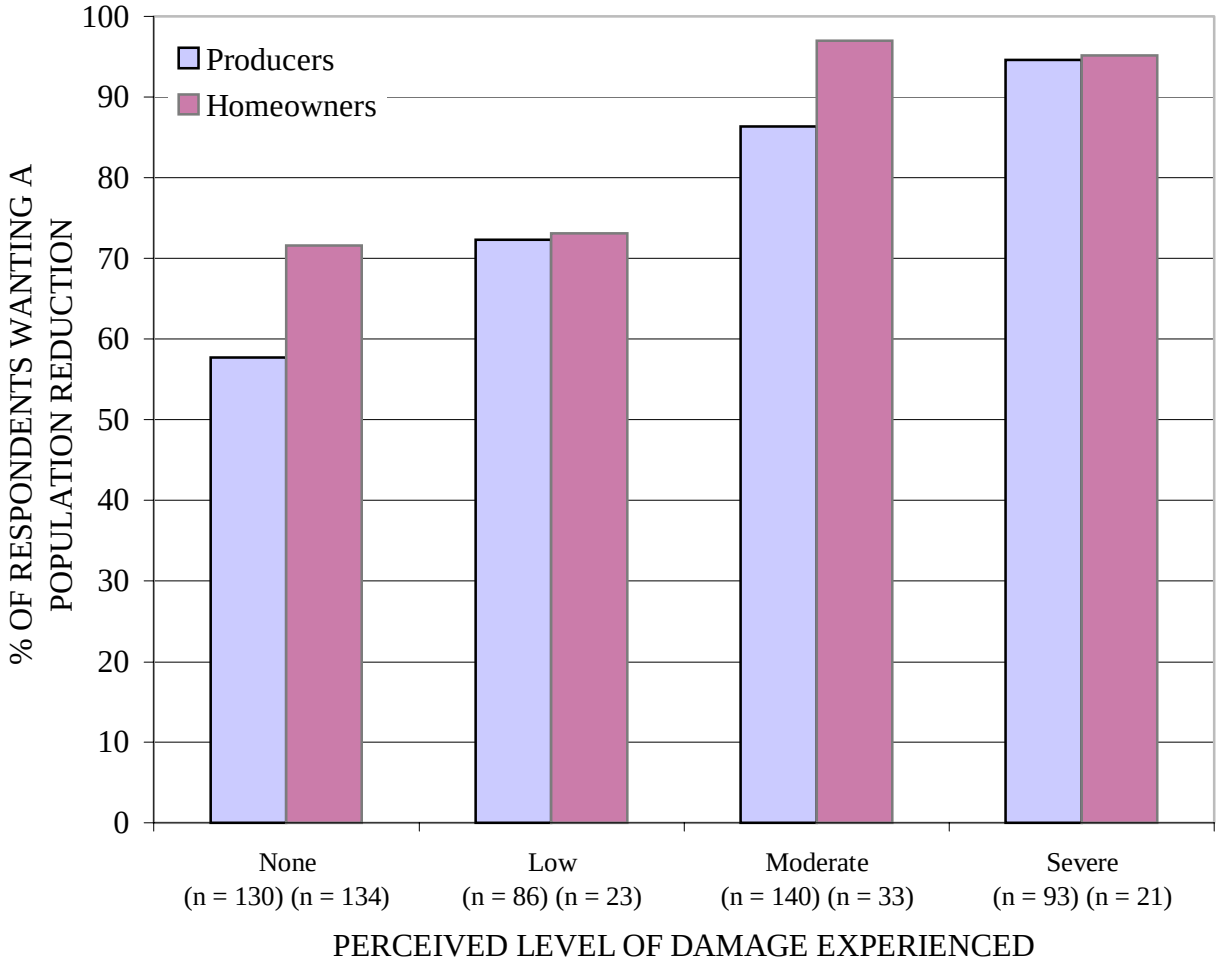

Figure 58. Relationship between a respondent's perception about the severity of damage by deer and desire for future deer population management, as expressed by producers and homeowners in Virginia during 1995.

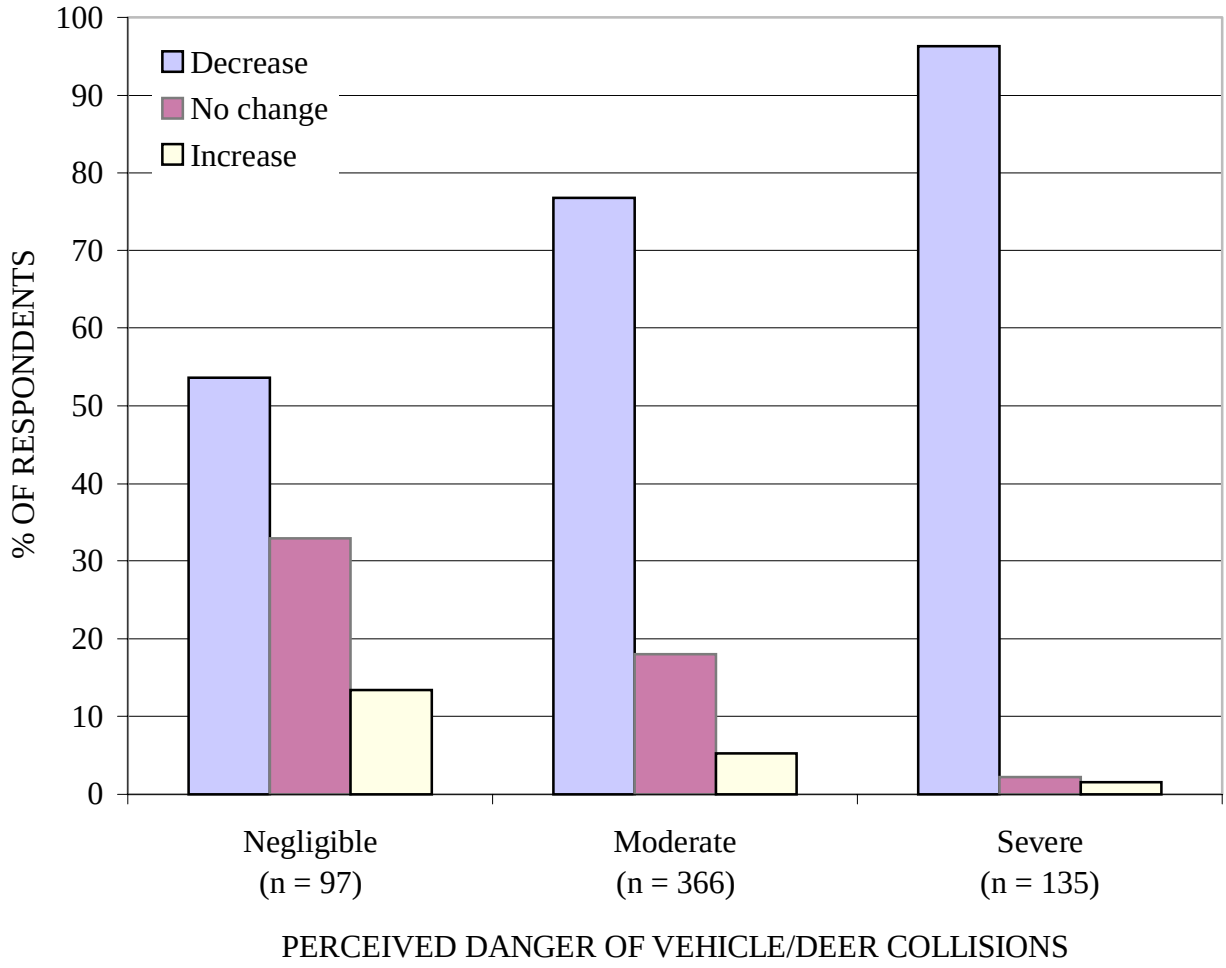

Figure 59. Relationship between a respondent's perception about the danger of having a vehicle/deer collision and desire for future deer population management in Virginia during 1995.

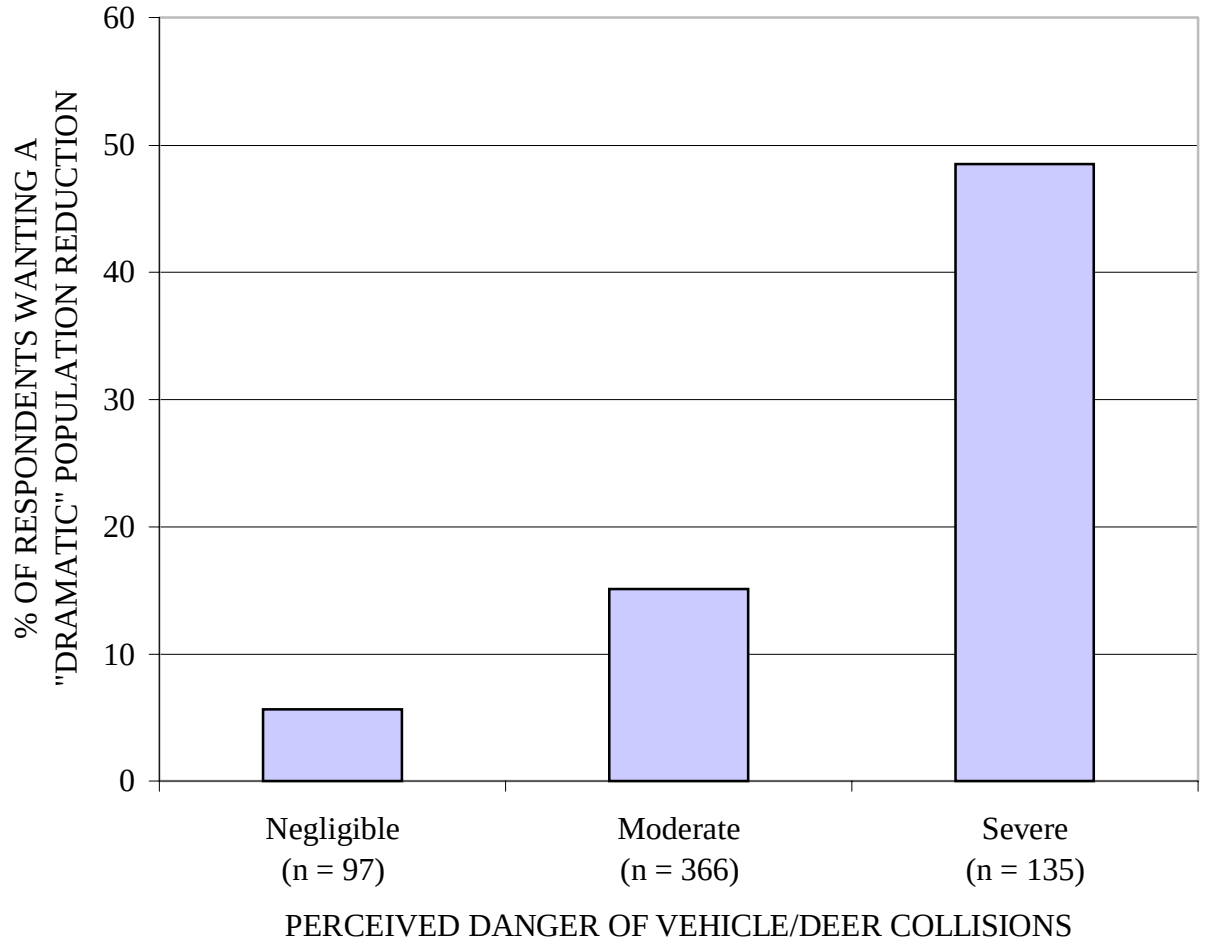

Figure 60. Relationship between a respondent's perception about the danger of having a vehicle/deer collision and desire for future deer population management in Virginia during 1995.

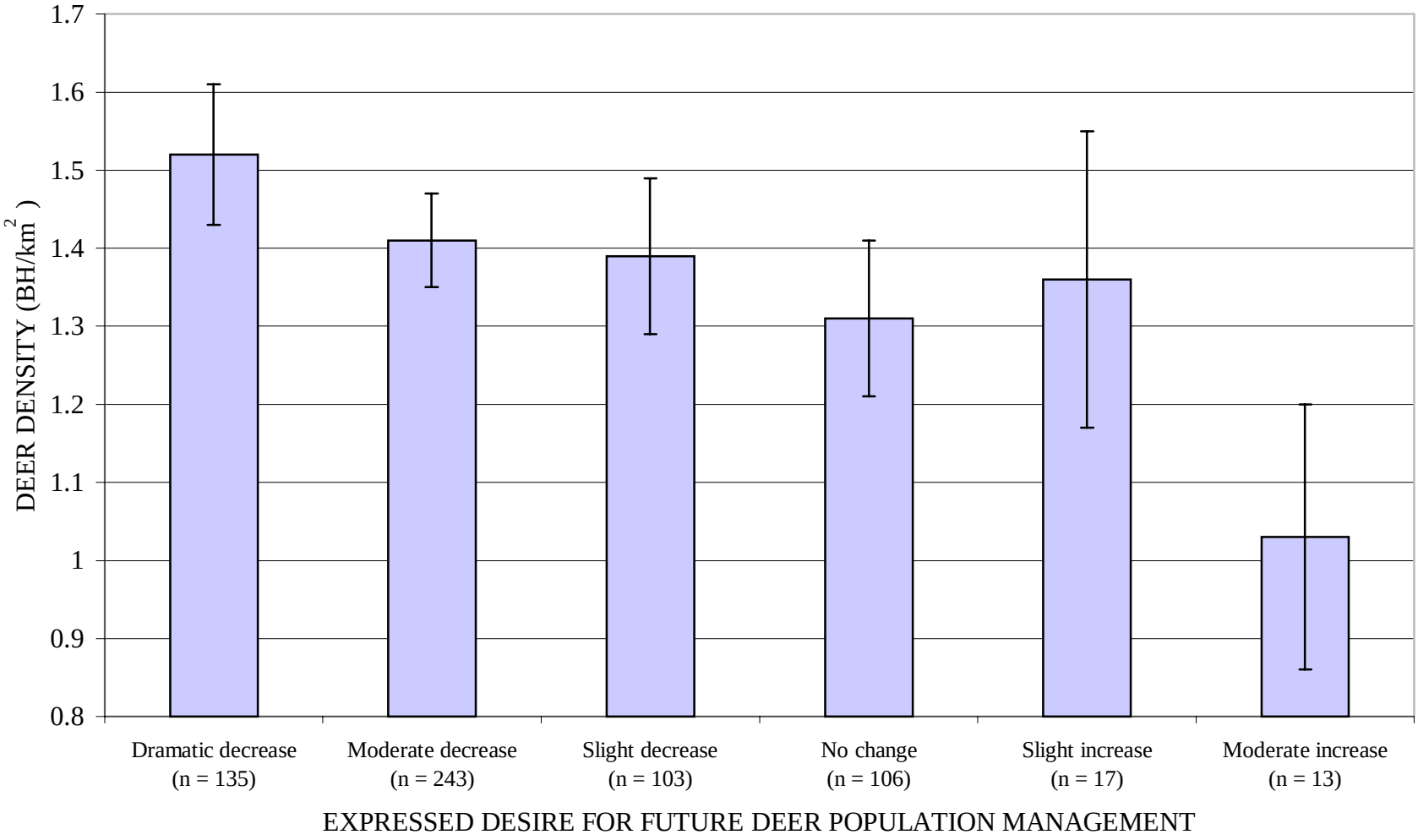

Figure 61. Relationship between deer density in a respondent's county and desire for future deer population management in Virginia during 1995 (error bars represent 95% confidence interval for the mean).

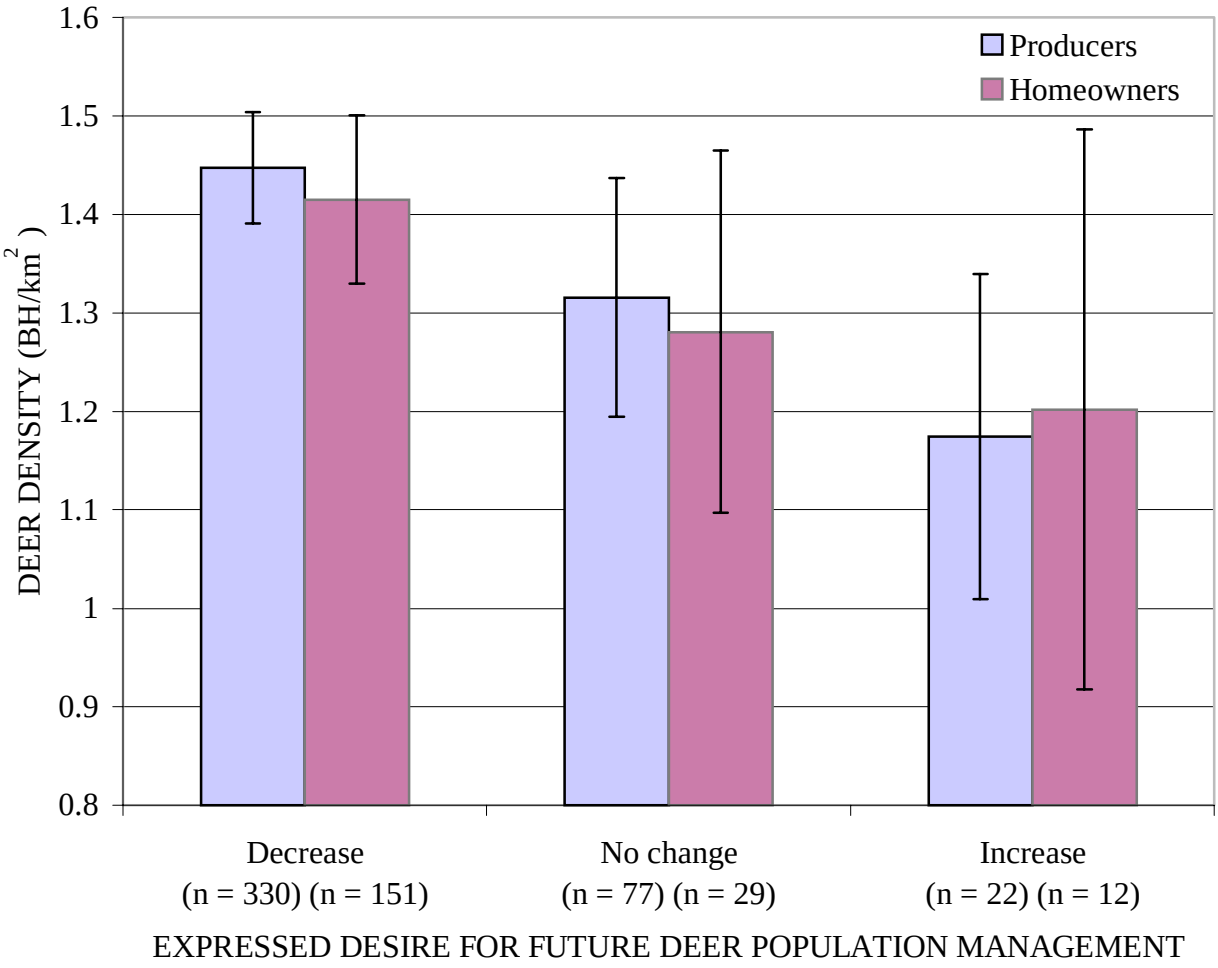

Figure 62. Relationship between deer density in a respondent's county of residence and opinion about future deer population management, as expressed by producers and homeowners in Virginia during 1995 (error bars represent a 95% confidence interval for the mean).

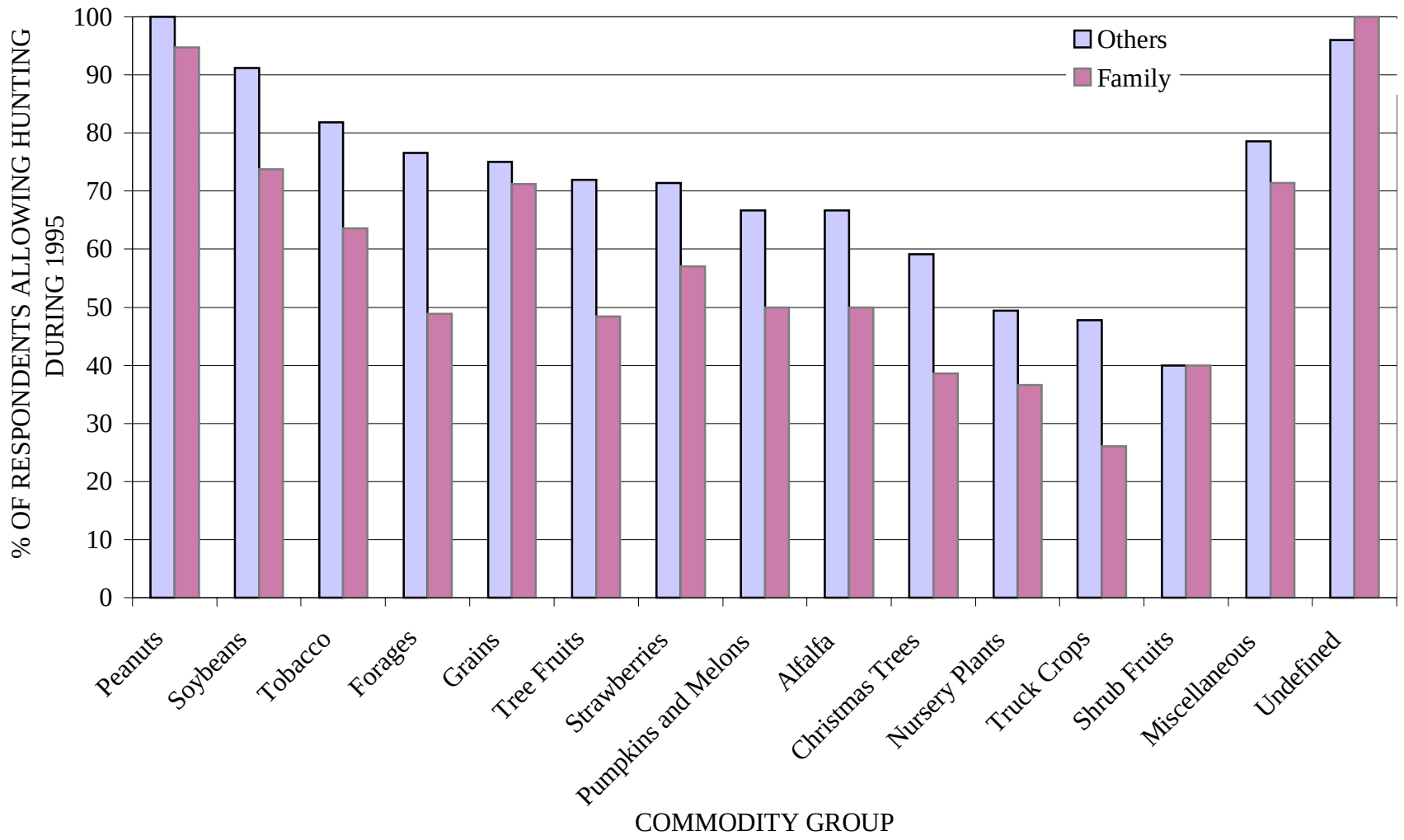

Figure 63. Relationship between type of commodity grown and likelihood to allow family members and other individuals (e.g., non-family) to hunt for deer on a respondent's land, as expressed by producers in Virginia during 1995.

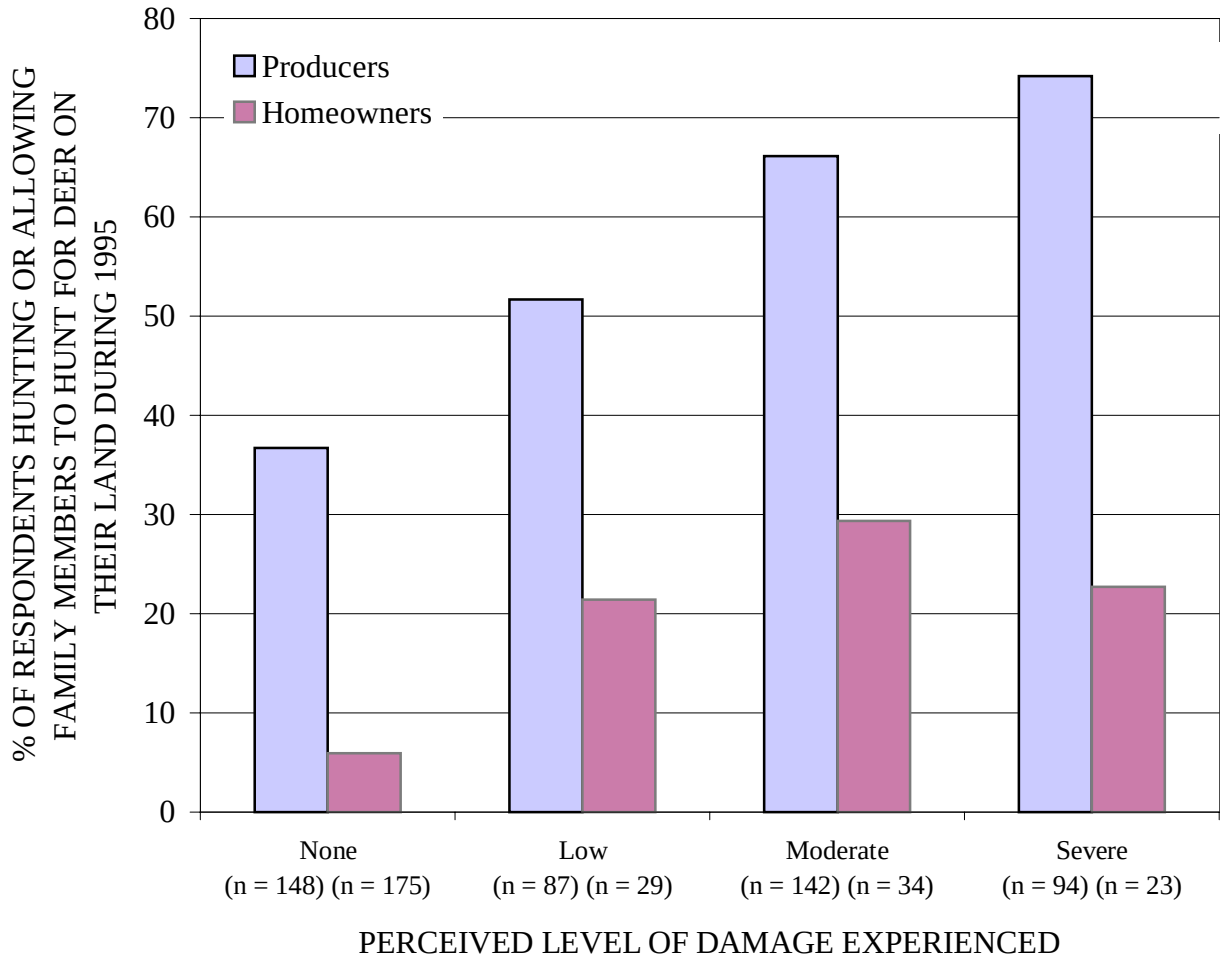

Figure 64. Relationship between respondents' perception of damage and likelihood to hunt or allow family members to hunt for deer on their lands, as expressed by producers and homeowners in Virginia during 1995.

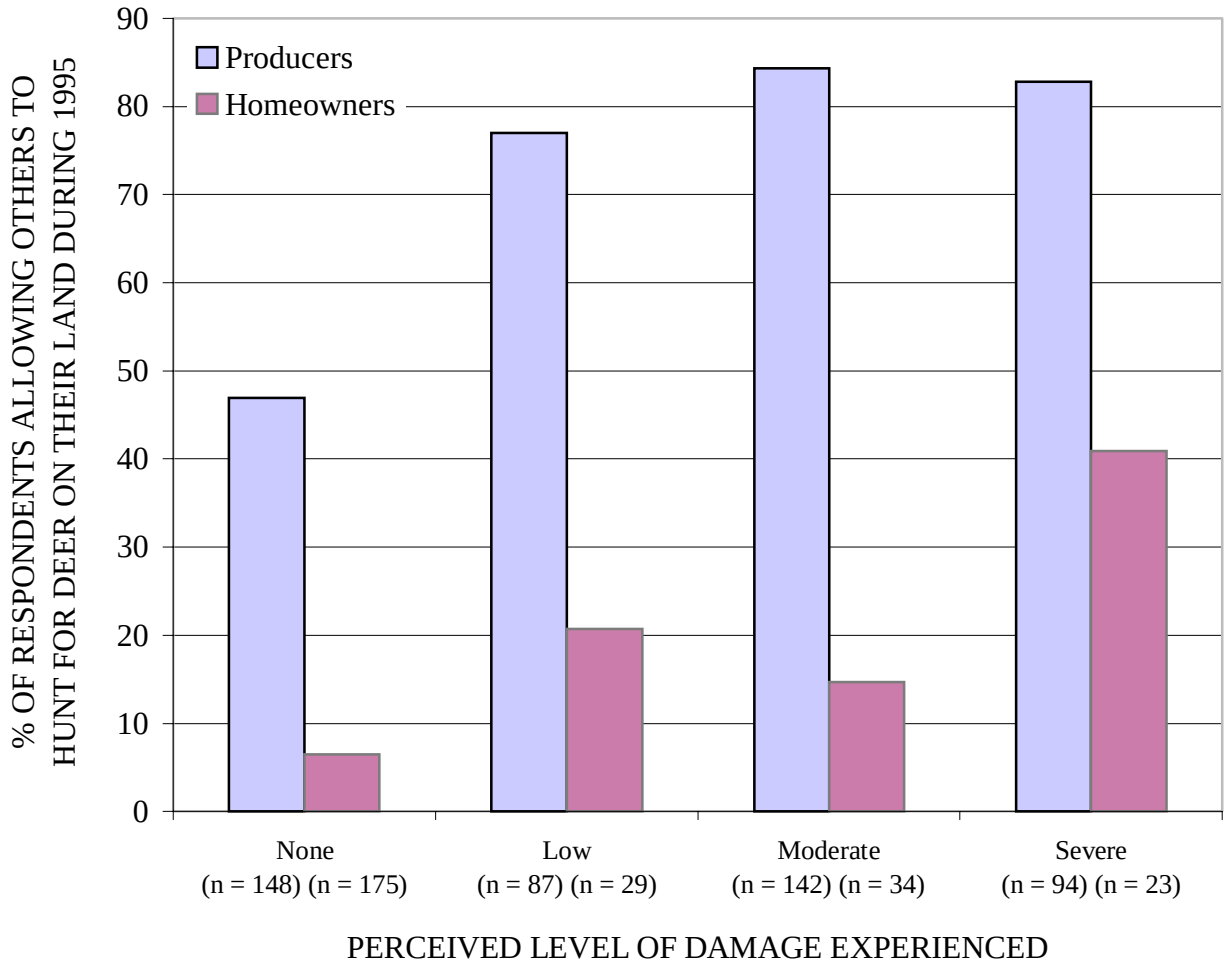

Figure 65. Relationship between respondents' perception of damage and likelihood to allow other individuals (e.g., non-family) to hunt for deer on their lands, as expressed by producers and homeowners in Virginia during 1995.

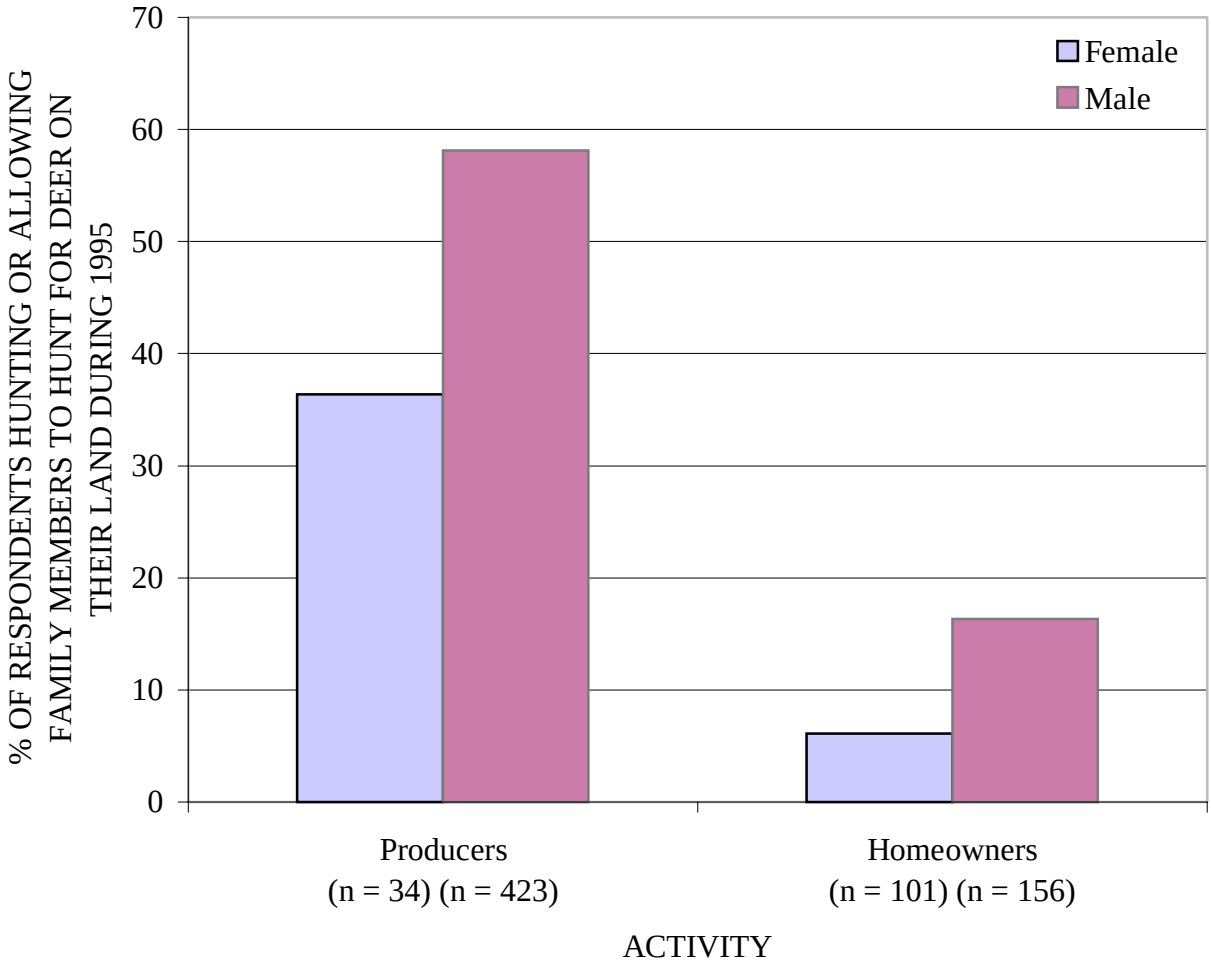

Figure 66. The relationship between respondent's gender and the likelihood to hunt or allow family members to hunt for deer on their land, as expressed by producers and homeowners in Virginia during 1995.

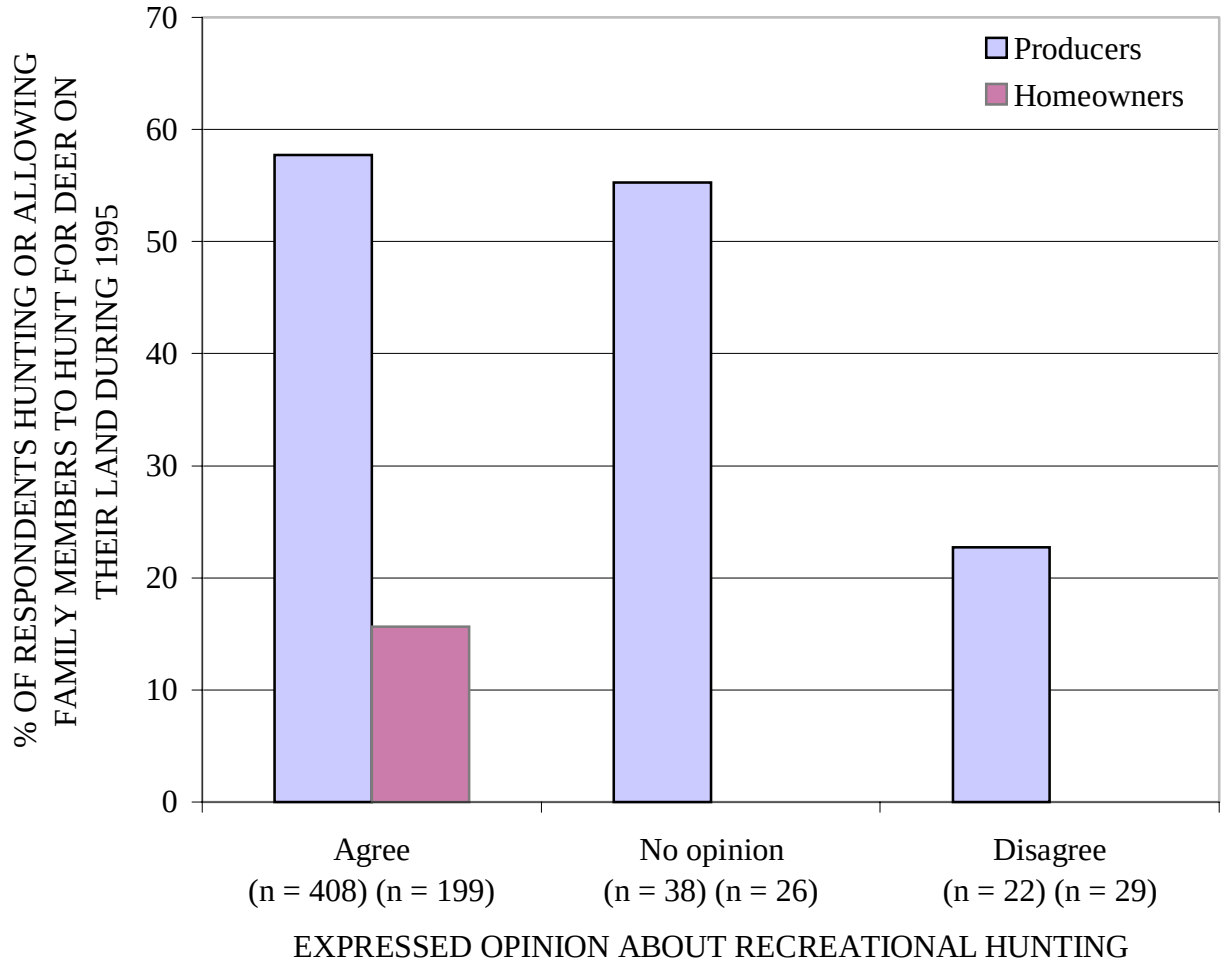

Figure 67. Relationship between a respondent's opinion of using recreational hunting to manage deer populations and the likelihood to hunt or allow family members to hunt for deer on their land, as expressed by producers and homeowners in Virginia during 1995.

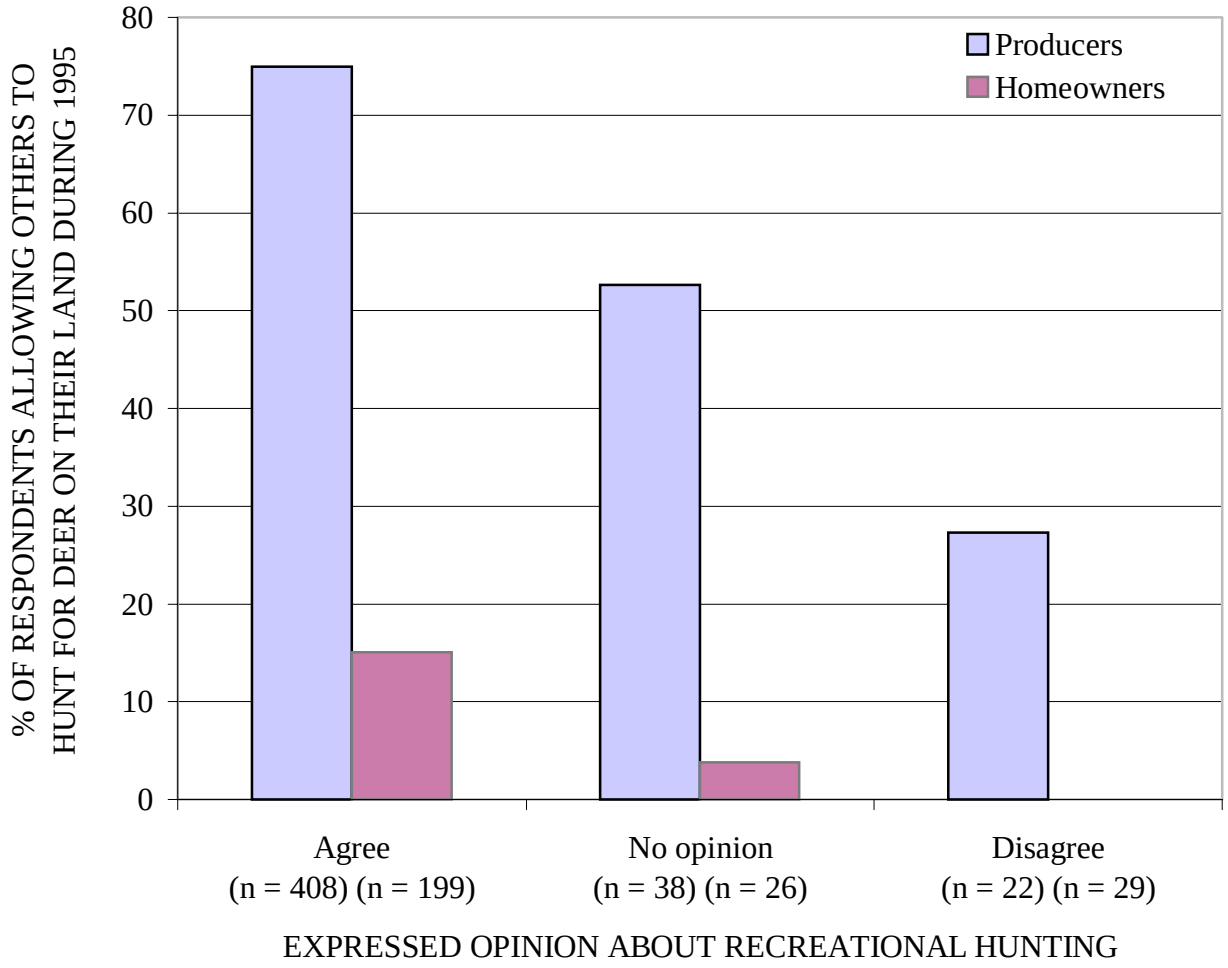

Figure 68 Relationship between a respondent's opinion of using recreational hunting to manage deer populations and the likelihood to allow other individuals (e.g., non-family) to hunt for deer on their land, as expressed by producers and homeowners in Virginia during 1995.

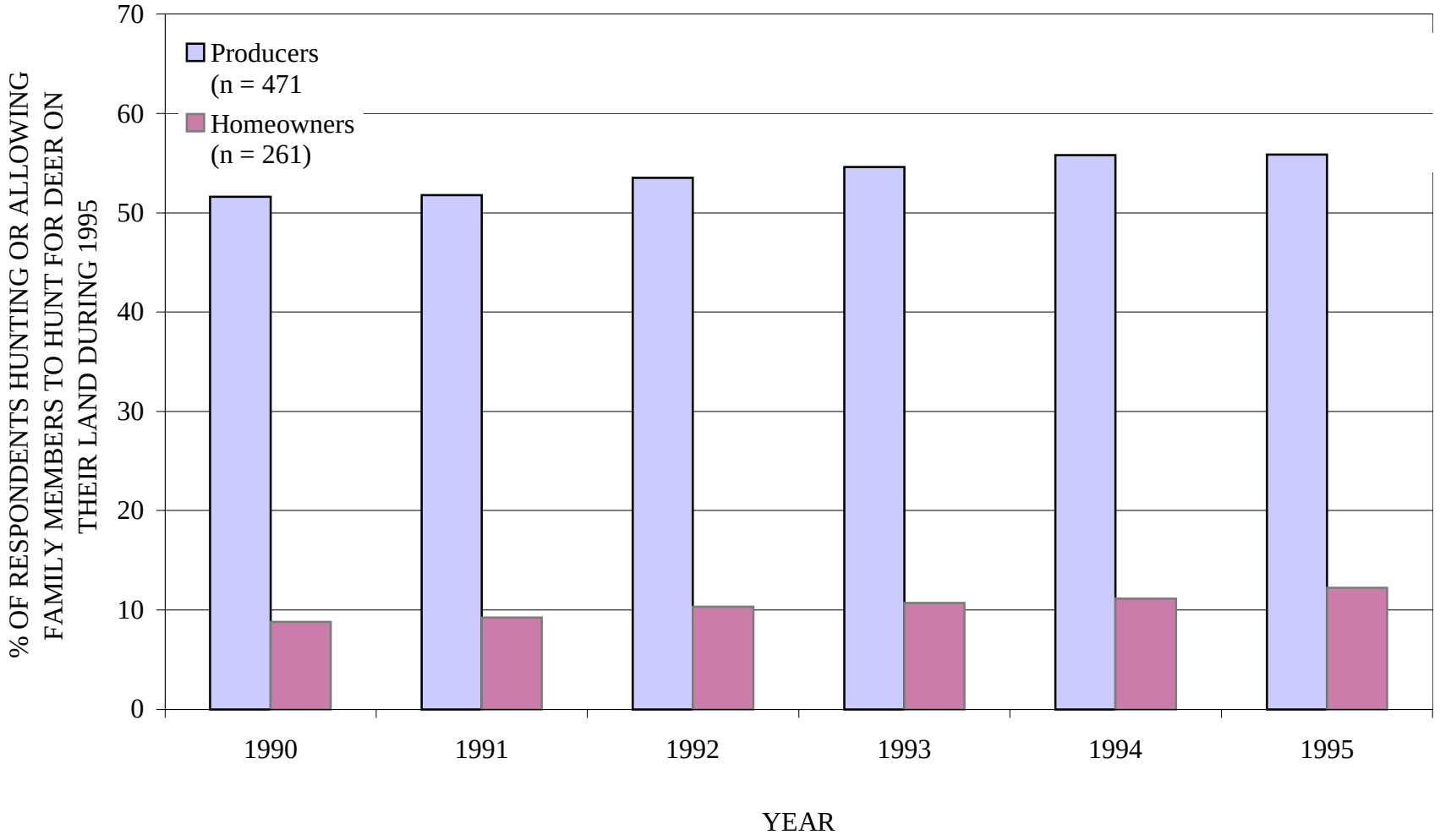

Figure 69. Trend in the percentage of producers and homeowners in Virginia who hunted or allowed family members to hunt for deer on their land each year from 1990 – 1995.

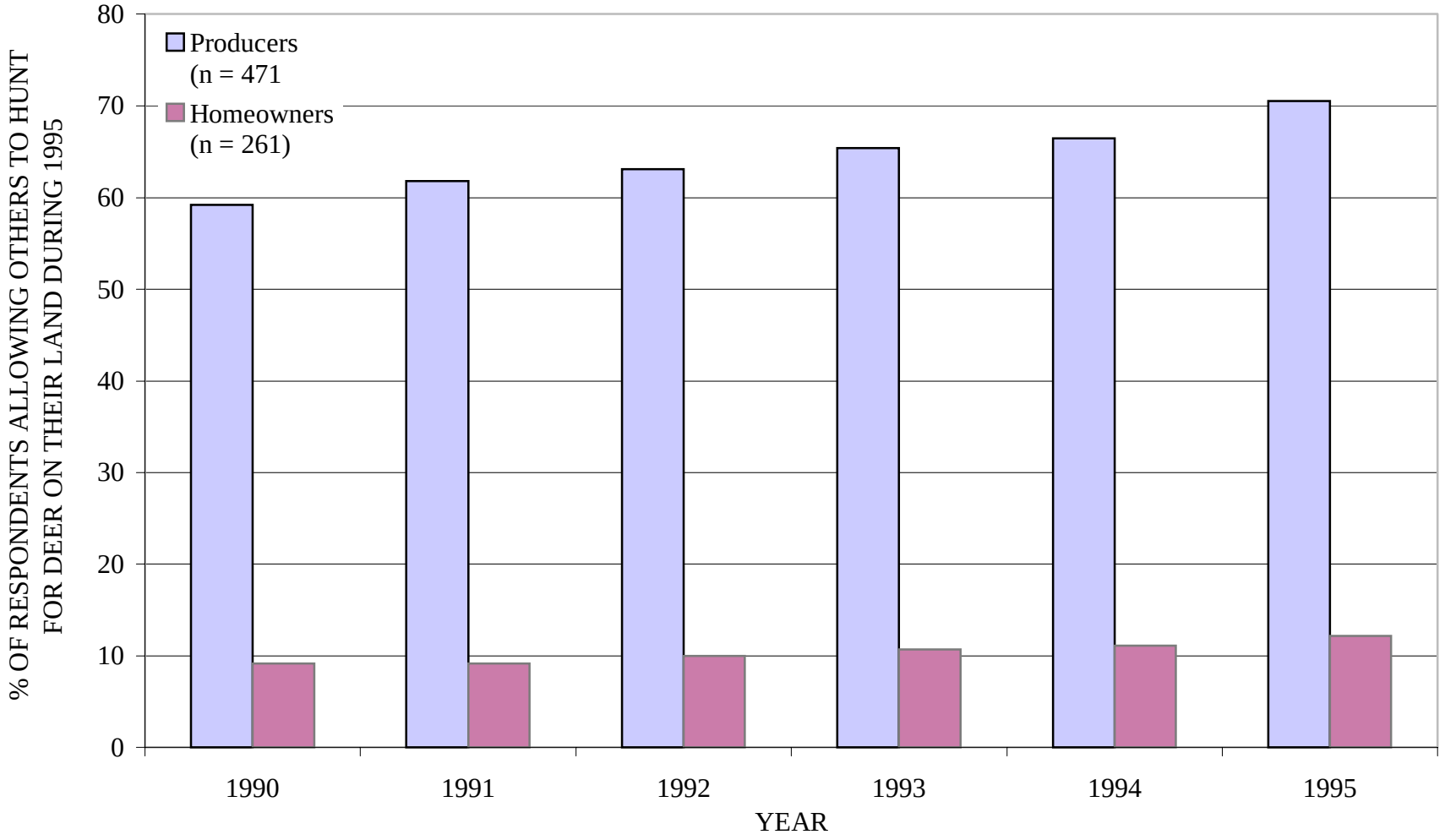

Figure 70. Trend in the percentage of producers and homeowners in Virginia who allowed other individuals (e.g., non-family) to hunt for deer on their land each year from 1990 – 1995.

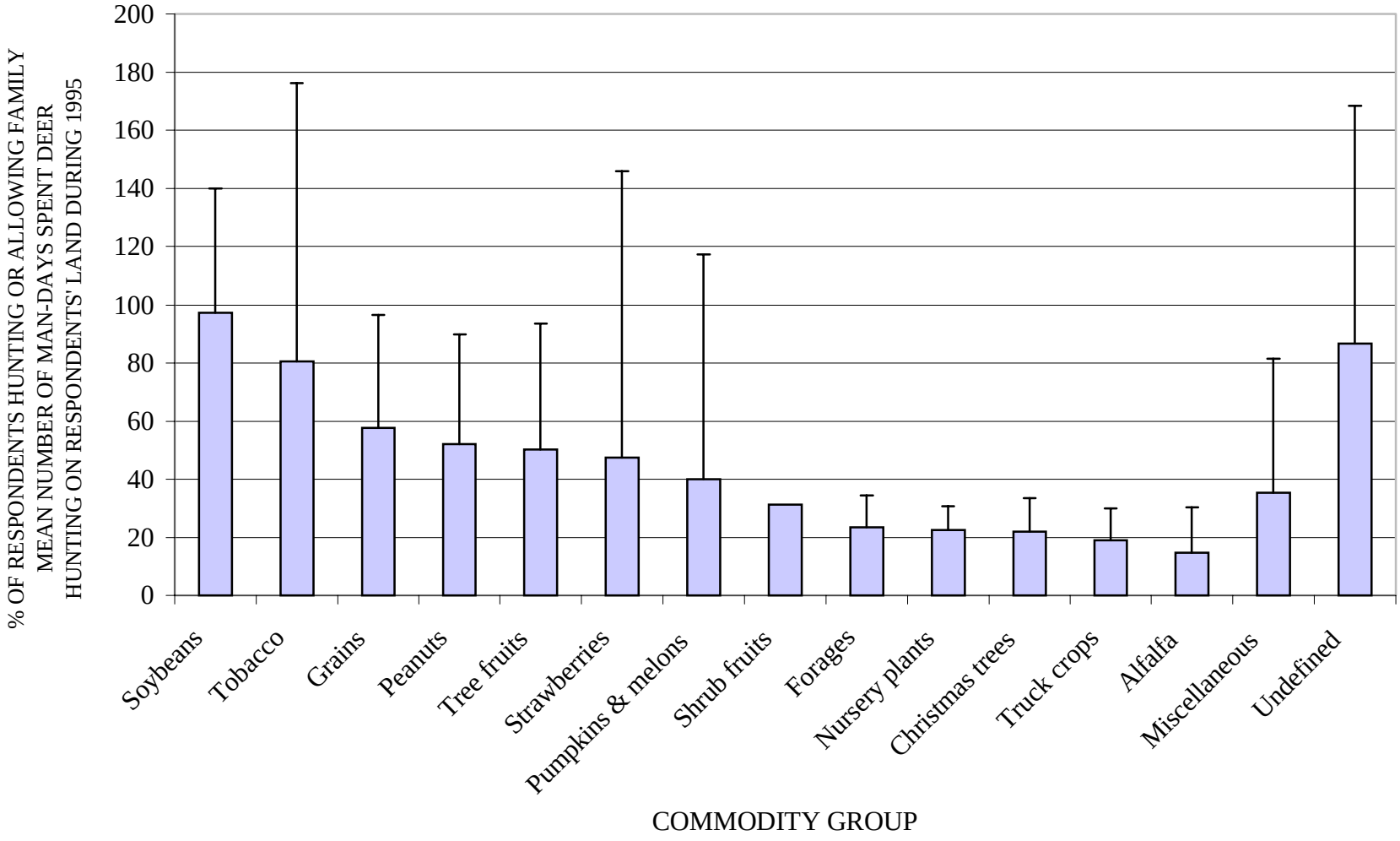

Figure 71. Mean number of man-days (i.e., 1 individual hunting for 8 hours = 1 man-day) reportedly spent hunting on producers land during 1995 in Virginia among those in different commodity groups (error bars represent 95% confidence interval for the mean).

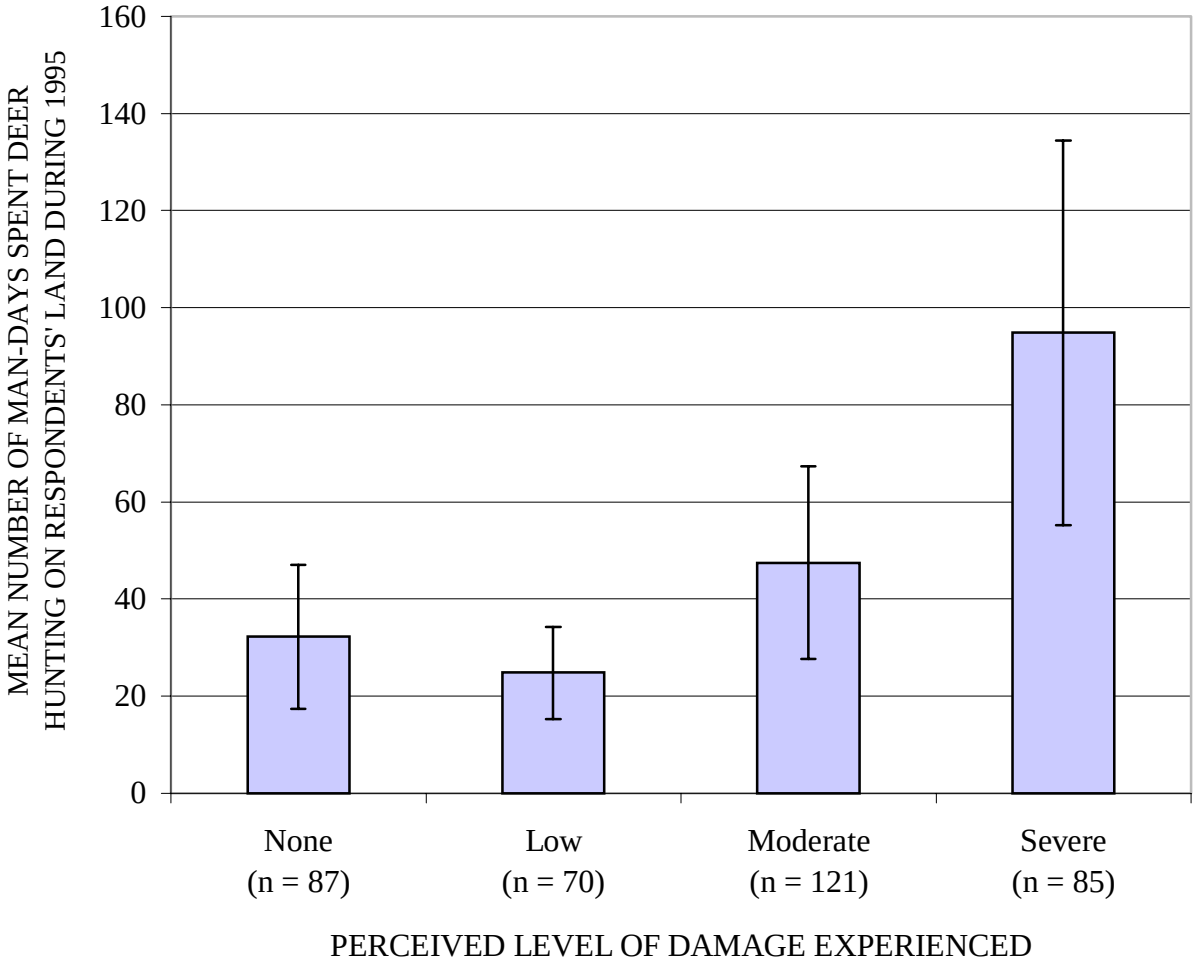

Figure 72. Relationship between respondents' perception about the severity of damage by deer and the mean number of man-days (i.e., 1 individual hunting for 8 hours = 1 man-day) spent hunting for deer on their lands in Virginia during 1995 (error bars represent a 95% confidence interval for the mean).

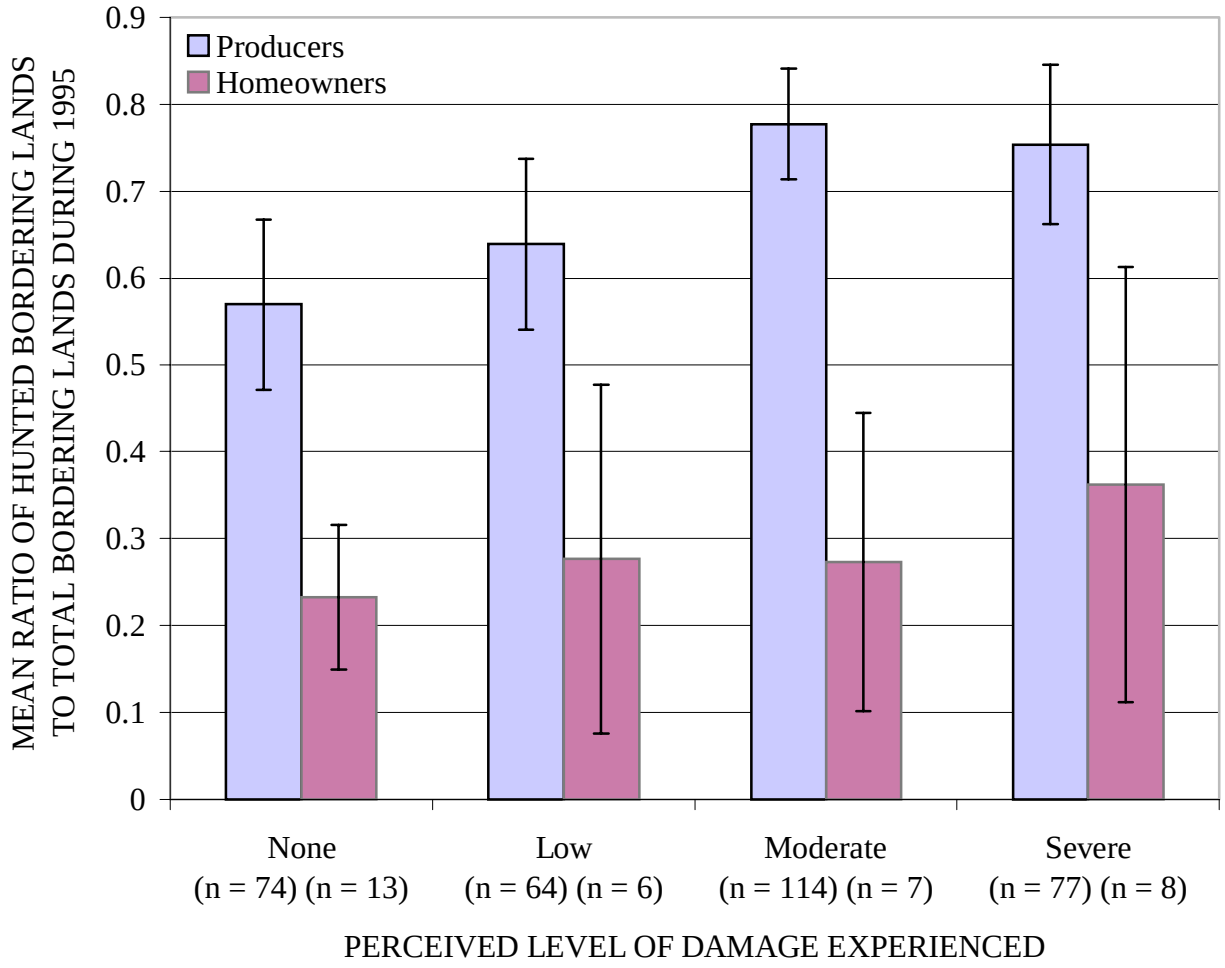

Figure 73. Relationship between respondents' perception about the severity of damage by deer and the mean number of man-days (i.e., 1 individual hunting for 8 hours = 1 man-day) spent hunting for deer on their lands, as reported by producers and homeowners in Virginia during 1995 (error bars represent a 95% confidence interval for the mean).

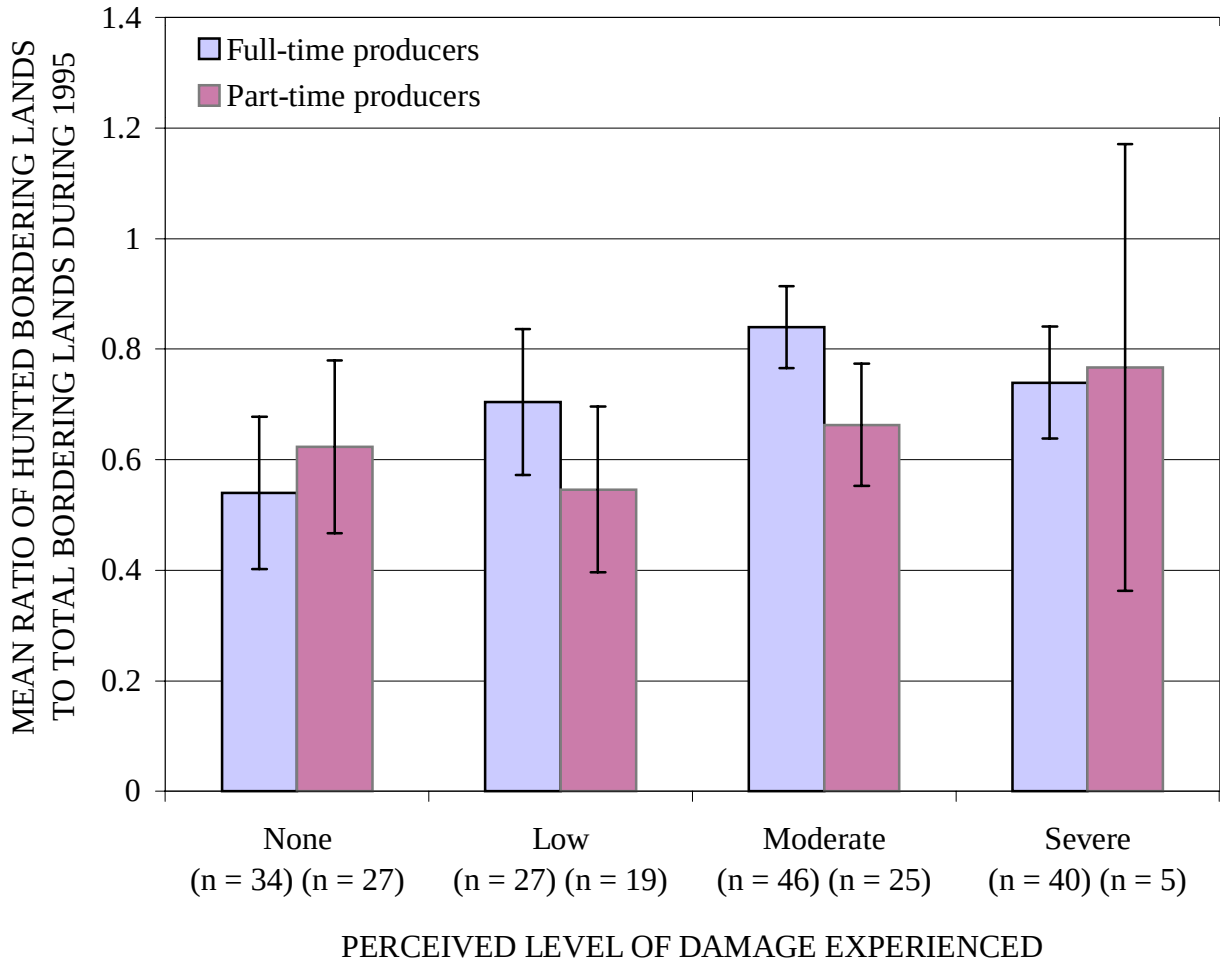

Figure 74. Relationship between respondents' perception about the severity of damage by deer and the mean number of man-days (i.e., 1 individual hunting for 8 hours = 1 man-day) spent hunting for deer on their lands, as reported by full- and part-time producers in Virginia during 1995 (error bars represent a 95% confidence interval for the mean).

Table 1. Response rates from among commodity group mailing lists to a survey used to assess deer damage in Virginia during 1995.

Mailing List	Number of surveys sent	Number returned	Number undeliverable[a]	Number not applicable[b]	Adjusted response rate[c]
Christmas trees	83	58	0	2	71.6
Forages	200	87	25	6	51.5
Master gardeners	310	193	6	7	65.0
Nurseries	197	100	2	5	52.6
Orchards	124	58	0	4	48.3
Peanuts	53	24	1	2	48.0
Small Grains	40	19	0	1	48.7
Soybeans	103	47	2	3	48.0
Vegetables & strawberries	396	140	13	14	37.9
Unknown[d]	-	6	-	-	-
Totals	1506	732	49	44	51.8

[a]Indicates questionnaires that were returned as undeliverable by the U.S. postal service

[b]Indicates questionnaires that were not applicable to respondent (e.g., respondent was deceased, retired from farming)

[c]Calculated by: number returned ÷ (total sent – (number undeliverable + number not applicable))

[d]Indicates questionnaires that had tracking numbers removed by respondents

Table 2. Mean area devoted to production of primary and secondary plantings, as reported by producers of agricultural commodities in Virginia during 1995.

Commodity Group	# of hectares for primary planting			# of hectares for secondary planting		
	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*
Alfalfa	24.8	14.3	12	42.7	27.8	17
Christmas trees	9.4	1.4	43	11.2	4.0	7
Forages	47.8	8.7	45	30.1	4.1	34
Grains	232.7	85.5	49	150.6	24.5	58
Nursery plants	22.6	7.0	77	8.2	2.5	37
Peanuts	108.4	24.5	18	45.9	9.7	3
Pumpkins & melons	41.3	35.3	5	11.5	4.1	12
Shrub fruits	11.8	7.1	4	1.0	0.3	5
Soybeans	296.2	40.0	55	132.6	34.9	30
Strawberries	23.7	16.3	7	1.5	0.3	5
Tobacco	13.1	4.6	8	2.3	1.9	3
Tree fruits	51.5	14.4	55	6.2	1.5	24
Truck crops	53.1	24.2	20	13.4	4.7	24
Miscellaneous[a]	69.6	39.0	13	67.1	22.3	11
Undefined[b]	225.5	64.6	25	52.1	32.1	7

[a]Represents individuals who grew commodities not included in other commodity groups

[b]Represents individuals who did not report growing a specific commodity

Table 3. Areas of Virginia, described as Virginia Department of Game and Inland Fisheries Wildlife Administrative Districts, where agricultural commodities were grown, as reported by producers responding to a survey on deer damage in Virginia during 1995.

Commodity Group	District									
	Region 1 District 1	Region 1 District 2	Region 2 District 1	Region 2 District 2	Region 3 District 1	Region 3 District 2	Region 4 District 1	Region 4 District 2	Region 5 District 1	Region 5 District 2
Alfalfa	0.0 (0)[a]	0.0 (0)	33.3 (4)	16.7 (2)	16.7 (2)	0.0 (0)	25.0 (3)	0.0 (0)	8.3 (1)	0.0 (0)
Christmas trees	0.0 (0)	0.0 (0)	18.2 (8)	2.3 (1)	20.5 (9)	9.1 (4)	0.0 (0)	22.7 (10)	13.6 (6)	13.6 (6)
Forages	2.2 (1)	0.0 (0)	10.9 (5)	13.0 (6)	21.7 (10)	6.5 (3)	10.9 (5)	8.7 (4)	13.0 (6)	13.0 (6)
Grains	17.6 (9)	23.5 (12)	5.9 (3)	7.8 (4)	7.8 (4)	2.0 (1)	3.9 (2)	9.8 (5)	13.7 (7)	7.8 (4)
Nursery plants	7.3 (6)	17.1 (14)	11.0 (9)	6.1 (5)	12.2 (10)	3.7 (3)	1.2 (1)	9.8 (8)	17.1 (14)	14.6 (12)
Peanuts	0.0 (0)	89.5 (17)	0.0 (0)	10.5 (2)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Pumpkins & melons	33.3 (2)	0.0 (0)	16.1 (1)	50.0 (3)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Shrub fruits	40.0 (2)	0.0 (0)	0.0 (0)	20.0 (1)	20.0 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	20.0 (1)
Soybeans	36.2 (21)	27.6 (16)	1.7 (1)	3.5 (2)	1.7 (1)	0.0 (0)	1.7 (1)	1.7 (1)	3.4 (2)	22.4 (13)
Strawberries	0.0 (0)	28.6 (2)	14.3 (1)	0.0 (0)	14.3 (1)	0.0 (0)	14.3 (1)	0.0 (0)	0.0 (0)	28.6 (2)
Tobacco	0.0 (0)	0.0 (0)	45.5 (5)	45.5 (5)	0.0 (0)	9.1 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Tree fruits	1.6 (1)	0.0 (0)	33.3 (21)	1.6 (1)	14.3 (9)	0.0 (0)	1.6 (1)	28.6 (18)	15.9 (10)	3.2 (2)
Truck crops	26.1 (6)	30.4 (7)	13.0 (3)	8.7 (2)	17.4 (4)	0.0 (0)	4.3 (1)	0.0 (0)	0.0 (0)	0.0 (0)
Miscellaneous[b]	0.0 (0)	42.9 (6)	14.3 (2)	0.0 (0)	14.3 (2)	0.0 (0)	7.1 (1)	0.0 (0)	14.3 (2)	7.1 (1)
Undefined[c]	15.4 (4)	30.8 (8)	0.0 (0)	19.2 (5)	0.0 (0)	0.0 (0)	3.8 (1)	7.7 (2)	19.5 (5)	3.8 (1)

[a]First number represents percent of respondents, followed by number of respondents
[b]Represents individuals who grew commodities not included in other commodity groups
[c]Represents individuals who did not report growing a specific commodity

Table 4. Perceptions about the level of damage caused by deer in Virginia during 1995, as reported by producers of agricultural commodities.

	Perceived Damage			
Commodity Group	None	Low	Moderate	Severe
Alfalfa	33.3 (4)[a]	33.3 (4)	25.0 (3)	8.3 (1)
Christmas Trees	31.8 (14)	27.3 (12)	31.8 (14)	9.1 (4)
Forages	70.2 (33)	23.4 (11)	6.4 (3)	0.0 (0)
Grains	25.0 (13)	26.9 (14)	34.6 (18)	13.5 (7)
Nursery Plants	43.9 (36)	17.1 (14)	28.0 (23)	11.0 (9)
Peanuts	10.5 (2)	0.0 (0)	63.2 (12)	26.3 (5)
Pumpkins & Melons	16.7 (6)	16.7 (1)	50.0 (3)	16.7 (1)
Shrub Fruits	20.0 (1)	0.0 (0)	40.0 (2)	40.0 (2)
Soybeans	17.2 (10)	12.1 (7)	43.1 (25)	27.6 (16)
Strawberries	14.3 (1)	14.3 (1)	28.6 (2)	42.9 (3)
Tobacco	63.6 (7)	36.4 (4)	0.0 (0)	0.0 (0)
Tree Fruits	10.9 (7)	17.2 (11)	31.3 (20)	40.6 (26)
Truck Crops	43.5 (10)	8.7 (2)	17.4 (4)	30.4 (7)
Miscellaneous[b]	35.7 (5)	14.3 (2)	35.7 (5)	14.3 (2)
Undefined[c]	11.5 (3)	15.4 (4)	30.8 (8)	42.3 (11)

[a]First number represents percent of respondents, followed by number of respondents

[a]Represents individuals who grew commodities not included in other commodity groups

[b]Represents individuals who did not report growing a specific commodity

Table 5. Reported economic loss ($), economic loss/hectare in production ($), percentage of plants damaged, and yield loss (%) as a result of damage by deer in Virginia during 1995 as provided by producers of agricultural commodities.

Commodity Group	Economic Loss ($)			Economic Loss ($) per Hectare			Plants Damaged (%)			Yield Loss (%)		
	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*
Alfalfa	$2,250.00	$1,750.00	2	$123.46	$74.07	2	-	-	0	15.0	5.0	2
Christmas Trees	$1,955.56	$654.21	18	$286.16	$88.44	18	21.1	9.0	12	8.7	3.2	6
Forages	$666.67	$420.65	3	$37.54	$12.10	3	-	-	0	4.0	1.6	5
Grains	$7,580.77	$2,428.91	13	$34.07	$7.55	11	2.0	1.0	2	10.4	3.7	16
Nursery Plants	$5,132.61	$1,431.92	23	$1,730.30	$606.96	23	17.1	5.6	15	12.8	3.0	13
Peanuts	$4,900.00	$1,228.82	5	$104.64	$64.90	5	2.0	-	1	15.2	4.6	5
Pumpkins & Melons	$3,500.00	$1,500.00	2	$27.43	-	1	4.0	-	1	5	-	1
Shrub Fruit	$25,000.00	-	1	$771.60	-	1	-	-	0	20	-	1
Soybeans	$14,750.24	$3,485.87	21	$50.26	$15.80	20	-	-	0	13.1	2.3	25
Strawberries	$11,283.25	$4,792.64	4	$1,746.87	$904.71	4	-	-	0	50.8	22.3	4
Tobacco	$1,000.00	-	1	$24.69	-	1	-	-	0	1.0	-	1
Tree Fruits	$9,868.57	$7,050.68	21	$400.85	$136.15	19	22.4	6.3	14	31.4	9.0	11
Truck Crops	$4,000.00	$1,000.00	3	$693.06	$539.52	3	-	-	0	26.4	11.1	5
Miscellaneous	$2,924.00	$1,294.52	5	$3,304.80	$2,890.42	5	25.0	5.0	2	13.9	4.8	5
Undefined	$23,314.29	$19, 478.96	7	$26.85	$12.36	7	41.2	17.5	5	30.5	21.7	4

[a]Represents individuals who grew commodities not included in other commodity groups
[b]Represents individuals who did not report growing a specific commodity

Table 6. Time of year during which damage by deer occurred to agricultural commodities in Virginia during 1995, as reported by producers.

Commodity Group	Month During which Damage Occurred											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alfalfa	23.5 (4)[a]	29.4 (5)	29.4 (5)	52.9 (9)	82.4 (14)	70.6 (12)	70.6 (12)	82.4 (14)	**88.2 (15)**[b]	52.9 (9)	23.5 (4)	23.5 (4)
Christmas Trees	37.5 (12)	43.8 (14)	25.0 (8)	28.1 (9)	15.6 (5)	9.4 (3)	9.4 (3)	9.4 (3)	37.5 (12)	**56.3 (18)**	40.6 (13)	25.0 (8)
Forages	6.1 (2)	9.1 (3)	15.2 (5)	27.3 (9)	51.5 (17)	63.6 (21)	63.6 (21)	**75.8 (25)**	63.6 (21)	33.3 (11)	9.1 (3)	3.0 (1)
Grains	9.9 (8)	11.1 (9)	14.8 (12)	17.3 (14)	33.3 (27)	45.7 (37)	61.7 (50)	**64.2 (52)**	59.3 (48)	27.2 (22)	12.3 (10)	7.4 (6)
Nursery Plants	52.9 (36)	51.5 (35)	36.8 (25)	25.0 (17)	25.0 (17)	19.1 (13)	20.6 (14)	25.0 (17)	44.1 (30)	**58.8 (40)**	54.4 (37)	48.5 (33)
Peanuts	0.0 (0)	0.0 (0)	0.0 (0)	5.0 (1)	40.0 (8)	30.0 (6)	60.0 (12)	**95.0 (19)**	90.0 (18)	30.0 (6)	5.0 (1)	0.0 (0)
Pumpkins & Melons	0.0 (0)	0.0 (0)	15.4 (2)	15.4 (2)	30.8 (4)	46.2 (6)	**84.6 (11)**	69.2 (9)	61.5 (8)	23.1 (3)	0.0 (0)	0.0 (0)
Shrub Fruits	0.0 (0)	0.0 (0)	14.3 (1)	42.9 (3)	42.9 (3)	**71.4 (5)**	42.9 (3)	28.6 (2)	28.6 (2)	28.6 (2)	14.3 (1)	14.3 (1)
Soybeans	2.6 (2)	2.6 (2)	3.9 (3)	14.5 (11)	51.3 (39)	68.4 (52)	**85.5 (65)**	81.6 (62)	61.8 (47)	34.2 (26)	17.1 (13)	5.3 (4)
Strawberries	**55.6 (5)**	**55.6 (5)**	44.4 (4)	11.1 (1)	33.3 (3)	11.1 (1)	22.2 (2)	22.2 (2)	11.1 (1)	11.1 (1)	22.2 (2)	**55.6 (5)**
Tobacco	0.0 (0)	0.0 (0)	25.0 (1)	50.0 (2)	**75.0 (3)**	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	25.0 (1)	25.0 (1)
Tree Fruits	21.8 (17)	26.9 (21)	34.6 (27)	56.4 (44)	53.8 (42)	53.8 (42)	53.8 (42)	60.3 (47)	64.1 (50)	**69.2 (54)**	44.9 (35)	20.5 (16)
Truck Crops	6.3 (2)	9.4 (3)	15.6 (5)	18.8 (6)	37.5 (12)	59.4 (19)	65.6 (21)	**68.8 (22)**	50.0 (16)	18.8 (6)	12.5 (4)	9.4 (3)
Miscellaneous[c]	15.4 (2)	15.4 (2)	23.1 (3)	30.8 (4)	53.8 (7)	38.5 (5)	46.2 (6)	61.5 (8)	**76.9 (10)**	53.8 (7)	15.4 (2)	15.4 (2)
Undefined[d]	6.3 (2)	18.8 (6)	18.8 (6)	28.1 (9)	31.3 (10)	46.9 (15)	**65.6 (21)**	50.0 (16)	53.1 (17)	50.0 (16)	31.3 (10)	6.3 (2)

[a]First number represents percent of respondents, followed by number of respondents

[b]**Bold** entries indicate the month during which the greatest occurrence of damage was noted for each commodity group

[c]Represents individuals who grew commodities not included in other commodity groups

[d]Represents individuals who did not report growing a specific commodity

Table 7. Time of year during which damage by deer occurred to plantings in Virginia during 1995, as reported by homeowners.

	Month During which Damage was Reported to Occur											
Planting Group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bedding Fruit	0	0	0	**100.0 (1)**[ab]	**100.0 (1)**	0	0	0	0	0	0	0
Flowers	16.0 (4)	24.6 (6)	36.0 (9)	**68.0 (17)**	**68.0 (17)**	48.0 (12)	40.0 (10)	40.0 (10)	36.0 (9)	28.0 (7)	20.0 (5)	8.0 (2)
General Ornamentals	18.2 (2)	18.2 (2)	45.5 (5)	54.5 (6)	**72.7 (8)**	63.6 (7)	45.5 (5)	54.5 (6)	45.5 (5)	36.4 (4)	36.4 (4)	27.3 (3)
Shrub Fruits	0	**50.0 (1)**	**50.0 (1)**	0	**50.0 (1)**	**50.0 (1)**	**50.0 (1)**	0	0	0	0	0
Tree Fruits	26.7 (4)	20.0 (3)	26.7 (4)	26.7 (4)	**53.3 (8)**	46.7 (7)	**53.3 (8)**	**53.3 (8)**	26.7 (4)	33.3 (5)	20.0 (3)	20.0 (3)
Vegetable Garden	6.1 (2)	6.1 (2)	12.1 (4)	36.4 (12)	60.6 (20)	69.7 (23)	**75.8 (25)**	63.6 (21)	45.5 (15)	12.1 (4)	3.0 (1)	3.0 (1)
Woody Ornamentals	41.7 (15)	**44.4 (16)**	38.9 (14)	38.9 (14)	38.9 (14)	25.0 (9)	27.8 (10)	30.6 (11)	33.3 (12)	41.7 (12)	38.9 (14)	36.1 (13)
Miscellaneous[c]	0	**50.0 (1)**	**50.0 (1)**	**50.0 (1)**	0	0	0	0	0	0	0	50.0 (1)
Undefined[c]	30.0 (3)	30.0 (3)	50.0 (5)	40.0 (4)	30.0 (3)	50.0 (5)	50.0 (5)	**60.0 (6)**	**60.0 (6)**	40.0 (4)	30.0 (3)	10.0 (1)

[a]First number represents percent of respondents, followed by number of respondents

[b]**Bold** entries indicate the month during which the greatest occurrence of damage was noted for each commodity group

[c]Represents individuals who grew plantings not included in other planting groups

[d]Represents individuals who did not report growing a specific planting

Table 8. Opinion of producers within different commodity groups about 3 compensation alternatives (hunter compensation, state general fund compensation, and no compensation) as a means to mitigate damage caused by deer in Virginia during 1996.

	Hunter Compensation[a]			State General Fund Compensation[b]			No Compensation[c]		
Commodity Group	Agree	No Opinion	Disagree	Agree	No Opinion	Disagree	Agree	No Opinion	Disagree
Alfalfa	58.3 (7)[d]	16.7 (2)	25.0 (3)	58.3 (7)	33.3 (4)	8.3 (1)	8.3 (1)	16.7 (2)	75.0 (9)
Christmas Trees	36.4 (16)	15.9 (7)	47.7 (21)	31.8 (14)	11.4 (5)	56.8 (25)	38.6 (17)	11.4 (5)	50.0 (22)
Forages	44.7 (21)	14.9 (7)	40.4 (19)	31.9 (15)	21.3 (10)	46.8 (22)	25.5 (12)	25.5 (12)	48.9 (23)
Grains	28.8 (15)	19.2 (10)	51.9 (27)	50.0 (26)	23.1 (12)	26.9 (14)	19.2 (10)	34.6 (18)	46.2 (24)
Nursery Plants	22.0 (18)	13.4 (11)	64.6 (53)	28.0 (23)	15.9 (13)	56.1 (46)	46.3 (38)	18.3 (15)	35.4 (29)
Peanuts	21.1 (4)	42.1 (8)	36.8 (7)	26.3 (5)	36.8 (7)	36.8 (7)	15.8 (3)	47.4 (9)	36.8 (7)
Pumpkins and Melons	16.7 (1)	0.0 (0)	83.3 (5)	16.7 (1)	16.7 (1)	66.7 (4)	50.0 (3)	33.3 (2)	16.7 (1)
Shrub Fruit	60.0 (3)	0.0 (0)	40.0 (2)	40.0 (2)	40.0 (2)	20.0 (1)	20.0 (1)	20.0 (1)	60.0 (3)
Soybeans	12.1 (7)	25.9 (15)	62.1 (36)	48.3 (28)	19.0 (11)	32.8 (19)	29.3 (17)	22.4 (13)	48.3 (28)
Strawberries	0.0 (0)	28.6 (2)	71.4 (5)	14.3 (1)	42.9 (3)	42.9 (3)	42.9 (3)	28.6 (2)	28.6 (2)
Tobacco	27.3 (3)	9.1 (1)	63.6 (7)	27.3 (3)	27.3 (3)	45.5 (5)	27.3 (3)	27.3 (3)	45.5 (5)
Tree Fruits	31.3 (20)	25.0 (16)	43.8 (28)	50.0 (32)	20.3 (13)	29.7 (19)	23.4 (15)	29.7 (19)	46.9 (30)
Truck Crops	30.4 (7)	21.7 (5)	47.8 (11)	30.4 (7)	21.7 (5)	47.8 (11)	34.8 (8)	26.1 (6)	39.1 (9)
Miscellaneous[e]	14.3 (2)	14.3 (2)	71.4 (10)	42.9 (6)	7.1 (1)	50.0 (7)	14.3 (2)	7.1 (1)	78.6 (11)
Undefined[f]	30.8 (8)	34.6 (9)	34.6 (9)	46.2 (12)	30.8 (8)	23.1 (6)	26.9 (7)	30.8 (8)	42.3 (11)

[a]Opinions of the statement "Hunters should pay a fee to compensate those affected by deer damage"
[b]Opinions of the statement "Those affected by deer damage should be compensated with general state funds"
[c]Opinions of the statement "Those affected by deer damage should not be compensated at all"
[d]First number represents percent of respondents, followed by number of respondents
[e]Represents individuals who grew commodities not included in other commodity groups
[f]Represents individuals who did not report growing a specific commodity

Table 9. Use of preventive measures to deter deer damage, as reported by producers of agricultural commodities in Virginia during 1995.

	Preventive Measure[a]					
Commodity Group	Frightening Devices	Dogs	Fencing	Repellents	Physical Deterrents	Removal by Shooting
Alfalfa	0.0 (0)[b]	0.0 (0)	50.0 (1)	0.0 (0)	0.0 (0)	50.0 (1)
Christmas Trees	9.1 (1)	36.4 (4)	27.3 (3)	27.3 (3)	0.0 (0)	54.5 (6)
Forages	0.0 (0)	0.0 (0)	28.6 (3)	0.0 (0)	0.0 (0)	71.4 (5)
Grains	45.5 (5)	9.1 (1)	9.1 (1)	45.5 (5)	0.0 (0)	63.6 (7)
Nursery Plants	13.8 (4)	24.1 (7)	37.9 (11)	55.2 (16)	3.4 (1)	41.4 (12)
Peanuts	58.3 (7)	16.7 (2)	8.3 (1)	41.7 (5)	0.0 (0)	66.7 (8)
Pumpkins & Melons	100.0 (2)	50.0 (1)	50.0 (1)	100.0 (2)	50.0 (1)	50.0 (1)
Shrub Fruits	66.7 (2)	66.7 (2)	33.3 (1)	100.0 (3)	0.0 (0)	33.3 (1)
Soybeans	50.0 (8)	0.0 (0)	0.0 (0)	43.8 (7)	0.0 (0)	68.8 (11)
Strawberries	20.0 (1)	0.0 (0)	60.0 (3)	20.0 (1)	0.0 (0)	80.0 (4)
Tobacco	33.3 (1)	0.0 (0)	33.3 (1)	66.7 (2)	0.0 (0)	66.7 (2)
Tree Fruits	9.3 (4)	11.6 (5)	25.6 (11)	79.1 (34)	4.7 (2)	53.5 (23)
Truck Crops	40.0 (4)	40.0 (4)	20.0 (2)	50.0 (5)	0.0 (0)	20.0 (2)
Miscellaneous[c]	50.0 (3)	16.7 (2)	16.7 (1)	33.3 (2)	16.7 (1)	50.0 (3)
Undefined[d]	28.6 (4)	14.3 (2)	35.7 (5)	50.0 (7)	7.1 (1)	64.3 (9)

[a]See Q-19 in Appendix A for specific methods included in general preventive measures
[b]First number represents percent of respondents, followed by number of respondents
[c]Represents individuals who grew commodities not included in other commodity groups
[d]Represents individuals who did not report growing a specific commodity

Table 10. Willingness to pay for preventive measures to deter damage by deer, as reported by producers of agricultural commodities in Virginia during 1995.

	What a respondent is willing to pay for damage prevention			
Commodity Group	Nothing	A small amount	A moderate amount	Whatever it takes to control damage
Alfalfa	63.6 (7)[a]	36.4 (4)	0.0 (0)	0.0 (0)
Christmas trees	59.1 (26)	36.4 (16)	4.5 (2)	0.0 (0)
Forages	84.4 (38)	15.6 (7)	0.0 (0)	0.0 (0)
Grains	53.1 (20)	24.5 (12)	18.4 (9)	4.1 (2)
Nursery plants	45.0 (36)	37.5 (30)	15.0 (12)	2.5 (2)
Peanuts	37.5 (6)	43.8 (7)	18.8 (3)	0.0 (0)
Pumpkins & melons	20.0 (1)	60.0 (3)	20.0 (1)	0.0 (0)
Shrub fruits	40.0 (2)	40.0 (2)	20.0 (1)	0.0 (0)
Soybeans	47.1 (24)	29.4 (15)	19.6 (10)	3.9 (2)
Strawberries	57.1 (4)	0.0 (0)	28.6 (2)	14.3 (1)
Tobacco	72.7 (8)	27.3 (3)	0.0 (0)	0.0 (0)
Tree fruits	22.4 (13)	44.8 (26)	20.7 (12)	12.1 (7)
Truck crops	63.2 (12)	26.3 (5)	5.2 (1)	5.2 (1)
Miscellaneous[b]	50.0 (7)	42.9 (6)	7.1 (1)	0.0 (0)
Undefined[c]	50.0 (12)	29.2 (7)	16.7 (4)	4.2 (1)

[a]First number represents percent of respondents, followed by number of respondents
[b]Represents individuals who grew commodities not included in other commodity groups
[c]Represents individuals who did not report growing a specific commodity

Table 11. Perception about the danger of having a vehicle/deer collisions in Virginia during 1995, as reported by respondents living in Virginia Department of Game and Inland Fisheries Wildlife Administrative districts.

	Perceived Danger of Vehicle/Deer Collisions			
VDGIF Administrative District[a]	Negligible	Moderate	Severe	No opinion
Region 1, District 1	25.3 (23)[b]	50.5 (46)	15.4 (14)	8.8 (8)
Region 1, District 2	13.1 (14)	55.1 (59)	19.6 (21)	12.1 (13)
Region 2, District 1	10.9 (10)	52.2 (48)	29.3 (27)	7.6 (7)
Region 2, District 2	8.0 (4)	62.0 (31)	18.0 (9)	12.0 (6)
Region 3, District 1	9.2 (6)	56.9 (37)	20.0 (13)	13.8 (9)
Region 3, District 2	40.0 (6)	40.0 (6)	13.3 (2)	6.7 (1)
Region 4, District 1	29.2 (7)	41.7 (10)	20.8 (5)	8.3 (2)
Region 4, District 2	19.2 (10)	55.8 (29)	7.7 (4)	17.3 (9)
Region 5, District 1	24.6 (32)	46.9 (61)	16.9 (22)	11.5 (15)
Region 5, District 2	13.7 (13)	56.8 (54)	20.0 (19)	9.5 (9)

[a]See Appendix D for a list of counties included in each region and district

[b]First number represents percent of respondents, followed by number of respondents

Table 12. Opinions of producers within different commodity groups about 3 attitudinal statements about deer ("deer are a nuisance," "I enjoy deer," and "deer don't cause problems"), as expressed by respondents in Virginia during 1995.

	Deer are a nuisance[a]			I enjoy deer[b]			No problem[c]		
Commodity Group	Agree	No Opinion	Disagree	Agree	No Opinion	Disagree	Agree	No Opinion	Disagree
Alfalfa	25.0 (3)[d]	33.3 (4)	41.7 (5)	75.0 (9)	16.7 (2)	8.3 (1)	16.7 (2)	16.7 (2)	66.7 (8)
Christmas Trees	11.4 (5)	9.1 (4)	79.5 (35)	84.1 (40)	6.8 (3)	9.1 (4)	6.8 (3)	11.4 (5)	81.8 (36)
Forages	6.4 (3)	17.0 (8)	76.6 (36)	85.1 (40)	8.5 (4)	6.4 (3)	13.0 (6)	15.2 (7)	71.7 (33)
Grains	23.5 (12)	23.5 (12)	52.9 (27)	74.5 (38)	11.8 (6)	13.7 (7)	7.8 (4)	21.6 (11)	70.6 (36)
Nursery Plants	28.0 (23)	8.5 (7)	63.4 (52)	73.2 (60)	8.5 (7)	18.3 (15)	6.1 (5)	13.4 (11)	80.5 (66)
Peanuts	10.5 (2)	36.8 (7)	52.6 (10)	78.9 (15)	10.5 (2)	10.5 (2)	5.3 (1)	26.3 (5)	68.4 (13)
Pumpkins and Melons	33.3 (2)	33.3 (2)	33.3 (2)	66.7 (4)	16.7 (1)	16.7 (1)	16.7 (1)	33.3 (2)	50.0 (3)
Shrub Fruit	60.0 (3)	40.0 (2)	0.0 (0)	60.0 (3)	20.0 (1)	20.0 (1)	0.0 (0)	20.0 (1)	80.0 (4)
Soybeans	25.9 (15)	20.7 (12)	53.4 (31)	70.7 (41)	17.2 (10)	12.1 (7)	8.6 (5)	10.3 (6)	81.0 (47)
Strawberries	42.9 (3)	14.3 (1)	42.9 (3)	57.1 (4)	14.3 (1)	28.6 (2)	14.3 (1)	14.3 (1)	71.4 (5)
Tobacco	9.1 (1)	0.0 (0)	90.9 (10)	90.9 (10)	9.1 (1)	0.0 (0)	0.0 (0)	9.1 (1)	90.9 (10)
Tree Fruits	53.1 (34)	4.7 (3)	42.2 (27)	48.4 (31)	10.9 (7)	40.6 (26)	1.6 (1)	9.4 (6)	89.1 (57)
Truck Crops	17.4 (4)	21.7 (5)	60.9 (14)	60.9 (14)	17.4 (4)	21.7 (5)	17.4 (4)	4.3 (1)	78.3 (18)
Miscellaneous[e]	7.1 (1)	0.0 (0)	92.9 (13)	85.7 (12)	7.1 (1)	7.1 (1)	0.0 (0)	7.1 (1)	92. (13)
Undefined[f]	19.2 (5)	19.2 (5)	61.5 (16)	80.8 (21)	7.7 (2)	11.5 (3)	7.7 (2)	19.2 (5)	73.1 (19)

[a]Opinions of the statement "Deer are a nuisance; they should not be tolerated"
[b]Opinions of the statement "Deer cause some problems but I enjoy having them around"
[c]Opinions of the statement "Deer don't cause any problems"
[d]First number represents percent of respondents, followed by number of respondents
[e]Represents individuals who grew commodities not included in other commodity groups
[f]Represents individuals who did not report growing a specific commodity

Table 13. Desires of producers within different commodity groups for future deer population management, as expressed by respondents in Virginia during 1995.

Commodity Group	Desire for future deer population management							
	Dramatic decrease	Moderate decrease	Slight decrease	No change	Slight increase	Moderate increase	Dramatic increase	No opinion
Alfalfa	16.7 (2)[a]	50.0 (6)	8.3 (1)	8.3 (1)	8.3 (1)	0.0 (0)	8.3 (1)	0.0 (0)
Christmas trees	2.3 (1)	38.6 (17)	22.7 (10)	20.5 (9)	2.3 (1)	4.5 (2)	2.3 (1)	6.8 (3)
Forages	12.8 (6)	21.3 (10)	23.4 (11)	29.8 (14)	4.3 (2)	0.0 (0)	0.0 (0)	8.5 (4)
Grains	21.2 (11)	34.6 (18)	13.5 (7)	26.9 (14)	1.9 (1)	1.9 (1)	0.0 (0)	0.0 (0)
Nursery plants	23.2 (19)	36.6 (30)	15.9 (13)	14.6 (12)	0.0 (0)	2.4 (2)	0.0 (0)	7.3 (6)
Peanuts	15.8 (3)	36.8 (7)	26.3 (5)	15.8 (3)	0.0 (0)	5.3 (1)	0.0 (0)	0.0 (0)
Pumpkins & melons	0.0 (0)	50.0 (3)	33.3 (2)	16.7 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Shrub fruits	40.0 (2)	20.0 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	40.0 (2)
Soybeans	31.6 (18)	36.8 (21)	14.0 (8)	12.3 (7)	1.8 (1)	1.8 (1)	0.0 (0)	1.8 (1)
Strawberries	42.9 (3)	28.6 (2)	0.0 (0)	14.3 (1)	0.0 (0)	0.0 (0)	0.0 (0)	14.3 (1)
Tobacco	9.1 (1)	27.3 (3)	27.3 (3)	18.2 (2)	9.1 (1)	9.1 (1)	0.0 (0)	0.0 (0)
Tree fruits	45.3 (29)	34.4 (22)	10.9 (7)	7.8 (5)	0.0 (0)	0.0 (0)	0.0 (0)	1.6 (1)
Truck crops	26.1 (6)	21.7 (5)	13.0 (3)	8.7 (2)	4.3 (1)	8.7 (2)	0.0 (0)	17.4 (4)
Miscellaneous[b]	7.1 (1)	57.1 (8)	0.0 (0)	28.6 (4)	0.0 (0)	0.0 (0)	0.0 (0)	7.1 (1)
Undefined[c]	15.4 (4)	34.6 (9)	19.2 (5)	19.2 (5)	7.7 (2)	0.0 (0)	0.0 (0)	3.8 (1)

[a]First number represents percent of respondents, followed by number of respondents
[b]Represents individuals who grew commodities not included in other commodity groups
[c]Represents individuals who did not report growing a specific commodity

DISCUSSION

Non-response Bias

Dolsen and Machlis (1991) found that non-response bias negligibly affected the analysis and interpretation of data when a $\geq$ 65% response rate was obtained for a sample population. I obtained a $\geq$ 65% response rate from Virginia Christmas Tree Growers and Virginia Master Gardeners, so I assumed the effects of non-response bias were negligible for these two sample populations. However, because of lower response rates among the remaining sample populations, non-response bias had the potential to greatly affect my analyses and interpretation of data for these groups. Yet, my follow-up telephone interviews suggested that the impact of non-response bias was negligible. Non-respondents participating in the telephone interviews were more likely to be full-time producers than were respondents to the mail survey. This may be a result of full-time producers having limited time to complete the questionnaire during the time of year (fall) the survey was administered. Because differences appeared between part- and full-time respondents to the mail survey, the differences I found between respondents to the mail versus telephone survey are likely an artifact of the proportion of full- and part-time producers that existed in each group.

Drane et al. (1993) suggested that individuals who respond later in the survey process (e.g., individuals who responded after the fourth mailing) are more similar to non-respondents than are individuals who respond early in the survey process (e.g., individuals who responded after the first mailing). Thus, if differences did exist between non-respondents and respondents, it is reasonable to assume that differences would exist among those who responded after each subsequent mailing and that those differences would be directional in nature (e.g., if non-respondents were less likely to report incurring damage than were respondents, one would expect a consistent decrease in the proportion of respondents reporting damage after each mailing). In support of the findings of the telephone survey, I found little evidence of bias when comparing responses received after each of the mailings. Although I found small differences in respondents' experience with deer damage during 1995 and their desires for future deer population trends, these relationships were very weak and, more importantly, were non-directional. These results, in conjunction with the telephone interview data, led me to conclude that non-response bias was negligible.

Perceptions About Deer Damage

One of the primary concerns expressed about using mail surveys designed to evaluate damage caused by white-tailed deer is the accuracy of information provided by respondents (Filion 1980). Flyger and Thoerig (1962) suggested that some farmers may overestimate the severity and extent of deer damage to their crops whereas many other farmers underestimate deer damage. Regardless, few studies have quantitatively compared respondents' perceptions about deer damage with actual measures of damage. Brown et al. (1978) suggested that surveys may not provide a precise estimate of the actual amount of deer damage incurred, yet they do let researchers evaluate the public's perception of deer damage and it is these perceptions that may be most important to managers.

Respondents' perceptions about deer damage varied widely, even among those who grew similar plantings and lived in the same areas. Campa et al. (1997) also found great variation in the severity of deer damage experienced among producers of similar commodities in the same areas and concluded that differences in local deer habitat attributes and crop field characteristics explained much of this variation. Matschke (1984) concluded that crop fields surrounded by woodland are more prone to deer damage than fields situated away from woodlands. It may be reasonable to assume much of the variation in my data can be explained by differences in local habitat characteristics as well. In Chapter 2, I will demonstrate that substantial differences can exist in land-use and predominant vegetation type among landowners within small area (e.g., ~800 ha). Thus, some individuals in an area might report severe deer damage whereas others report none at all.

The Trend of Deer Damage in Virginia

A review of historical literature suggests that deer damage has become increasingly widespread and severe throughout the eastern U.S. since the late 1970s, particularly among producers (Brown et al. 1978, Moore and Folk 1979, Tanner and Dimmick 1984, Sayre et al. 1992). My data represent observations during 1995 only, but conclusions about the historical trend of deer damage in the eastern U.S. can be drawn by comparing my results with those of previous studies. Brown et al. (1978) found that only 32% of farmers in New York experienced deer damage during 1976 and of those, very few (1%) described that damage as being severe. Although conducted in a different area of New York, Decker and Brown's (1982) research noted a substantial increase in the proportion of New York farmers experiencing deer damage (63%), but again, very few producers (6%) characterized their deer damage as being severe. Several years later, Tanner and Dimmick (1984) reported that 59% of farmers in western Tennessee incurred some level of deer damage to their crops, but very few (3%) labeled this damage as being severe. More recently, Sayre et al. (1992) reported that 67% and 61% of nursery producers in southeastern and western New York incurred deer damage during 1989, respectively. In light of these studies, deer damage in Virginia during 1995 appeared more prevalent than has been documented previously. Overall, 71% of producers incurred deer damage during 1995, but this figure is somewhat muted because it includes producers of commodities that generally are not regarded as being highly susceptible to deer damage (e.g., forages, tobacco) (Sayre and Decker 1989). Overall, the percentage of producers reporting damage ranged greatly (low of 30% among forage producers, high of 90% among peanut producers). On the upper-end of the scale, (e.g., producers of highly susceptible crops such as soybeans, peanuts, and tree fruits), one finds a very high proportion reporting damage as compared to that reported elsewhere (Sayre and Decker 1989).

Few studies have examined the extent and severity of deer damage in Virginia and with which I may compare my data. Lyon (1984, Virginia Tech, unpubl. data) found that 76% of soybean producers in eastern Virginia had either no damage (31%) or described their damage as light (45%). Using Lyon's estimates as a baseline for comparison, it appears that Virginia's soybean producers have perceived a dramatic increase in deer damage during the period 1984 – 1995, as only 29% of the soybean producers that responded to my survey reported no or only light damage whereas a relatively high percentage (28%) characterized their damage as being severe.

Additionally, the number of deer kill permits (see Appendix 3) issued by the VDGIF increased consistently from 515 permits in 1989 to about 1,200 in 1995 (VDGIF 1997). Because a kill permit is granted by the local conservation officer only as a direct result of a verified complaint received from a landowner regarding deer damage, the number of complaints regarding deer damage in Virginia clearly has risen dramatically since 1989. However, it is unclear whether this trend is a result of increased conflicts with deer or an increased awareness among the public about the kill permit program. Regardless, this trend shows that public concern about deer damage has increased significantly since 1989. More specifically, this trend suggests an increased demand among producers for damage abatement, because only 1 homeowner in my survey participated in the kill permit program during 1995.

Damage to ornamental plantings grown by homeowners is a relatively new problem facing deer managers (Decker and Gavin 1985). Although problems stemming from urban deer populations in the U.S. have been recognized since the 1960s (Conover 1995), research directed at managing deer damage in residential settings has been concentrated within only the past 10 years. Data documenting damage incurred by homeowners in Virginia prior to 1995 do not exist, thus I am unable to make definitive statements regarding the trend of deer damage to ornamental plantings in the Commonwealth. However, comparisons with findings from other regions of the eastern U.S. may be instructive. A greater percentage of homeowners in Virginia (36%) reported damage than did those in western or southeastern New York (17.0% and 32.0%, respectively; Sayre et al 1992). Given the high percentage of homeowners in my survey that experienced damage during 1995, it appears that deer damage to ornamental plantings in Virginia has increased correspondingly with damage incurred by producers of agricultural crops.

Finally, although the greatest percentage (42%) of respondents indicated that the damage they incurred from deer during 1995 was about the same as that experienced during the previous 5 years (1990-1994), many others (28%) believed damage increased; relatively few (9%) perceived a decrease in damage during that period. However, it is important to note that most (48%) of the respondents who experienced deer damage during 1995 also reported that damage was now more severe than during the previous 5-year period. Conversely, very few (7%) respondents who had damage during 1995 believed that their damage had decreased during the past 5 years. Thus, it seems that once an individual first experiences deer damage, the likelihood of that problem diminishing over time is slight. Most individuals who did not experience deer damage during 1995 believed the situation was about the same as what they experienced during 1990 – 1994, or they voiced no opinion about the trend in damage. Because such a high proportion of respondents who reported having no damage during 1995 also voiced no opinion about the trend of deer damage, these individuals may never have experienced any damage in the past and thus were not motivated to form an opinion. Only 8% of those who reported having no damage during 1995 believed damage had decreased since 1990. These few individuals evidently had experienced damage during 1990 – 1994 but, by 1995, had since noted a cessation of damage. Given the small number of individuals who expressed this opinion, this observation again supports the conclusion that once an individual incurs damage, it is unlikely that damage will cease in the future.

Differences in Stakeholder Groups

My findings (i.e., that producers are more likely than homeowners and that full-time producers are more likely than part-timers to experience deer damage) are consistent with reports from other parts of the eastern U.S. (Sayre et al. 1992). It seems that a respondent's reliance on a planting as a source of income is correlated with the perception of deer damage. Tanner and Dimmick (1984) also noted that producers in western Tennessee who increasingly relied on agricultural crops for income were more likely to report damage. This could be a factor of the respondents' attentiveness to their plantings; those who relied a great deal on their plantings as a source of income were probably more motivated to observe, recognize, and report damage than those who relied on their plantings to a lesser extent. In addition, those who rely on their plantings as a source of income to a great extent may be more inclined to exaggerate the damage to their plantings because of their concern that deer may damage their crops in the future (Flyger and Theorig 1962).

Vogel (1989) found an inverse relationship between the density of homes and deer density, and that deer avoid farmhouses less so than other houses. Homeowners in my survey typically lived in more urban areas than did producers, thus this hypothesis about the response of deer to housing density may explain differences in damage between homeowners and producers. The response of deer to housing density may also explain why homeowners residing in rural areas were more likely to experience damage than those living in urban areas.

Differences in the perceived level of damage between producers of different commodities suggest that each crop may have an inherently different susceptibility to deer damage. Flyger and Thoerig (1962) hypothesized that particular habitat variables associated with different crops might play a role in the susceptibility of a crop to damage by deer. For example, soybeans offer little cover and may cause deer to feed at the periphery of the field. In contrast, trees within an orchard offer increased cover and, as a result, feeding occurs not only along field borders, but throughout the orchard. The palatability and digestibility of different crops also may partially determine that crop's susceptibility to damage by deer. Conover and Kania (1988) noted a large difference in the preference of deer for different ornamental plants. It seems reasonable that deer may have similar preferences regarding agricultural crops, especially when an area provides a variety of foods from which deer may choose.

Producers within different commodity groups possess fundamentally different attitudes and perceptions about deer and the damage they cause (Decker and Brown 1982, Sayre and Decker 1989). Decker and Brown (1982) found that producers of tree fruits were twice as likely as other producers to perceive damage as being "severe." Although my data did not show as strong a disparity between producers of tree fruits and other producers, producers of tree fruits labeled the damage they experienced as severe more than did any other group. Sayre and Decker (1989) summarized previous research and concluded that producers of tree fruits reported damage and displayed negative attitudes toward deer more often than did other producers whereas producers of hay and other forages were the least likely to report damage. Although some producers in Virginia grew commodities (e.g., peanuts) not discussed by Sayre and Decker (1989), their results generally parallel my own.

Estimates of economic loss reported by respondents were not verified through independent field study. Thus, they simply represent respondents' perceptions of the economics of damage caused by deer and should be interpreted only as such. Also, it was not my intent to use respondents' estimates of economic loss to generate a statewide estimate of the economic impact of deer damage. Given the objectives and methods of my study, I believe it would be inappropriate and misleading to do so. Regardless, these estimates do have useful value and should be examined more closely.

Several factors may have affected the estimates of economic loss that respondents provided. The method by which respondents computed their losses likely varied among individuals and contributed to the large variation in reported estimates. Also, most individuals likely had never considered economic loss or did not have the skills necessary to generate estimates (e.g., only 40% of producers and 22% of homeowners could provide an economic estimate). Many individuals who chose not to estimate their losses may have incurred substantial economic loss, but were not confident in their ability to estimate it. Thus, it seems that programs to educate individuals, producers in particular, about methods to estimate the economic impacts of damage by deer would be useful in allowing individuals to accurately assess the impact of deer on their lands.

My results coincide with those of Sayre et al. (1992) in that producers reported greater total economic loss from damage by deer than did homeowners. In contrast, homeowners reported greater economic loss/unit area of production than did producers. The high economic loss/hectare of production as reported by homeowners may be due to numerous factors. Homeowners likely had plantings distributed throughout their property, and thus may have had difficulties in correctly estimating the total area actively used for production. As a result, estimates of economic loss/hectare of production could be underestimated or exaggerated. Additionally, very few homeowners believed they could accurately estimate economic loss caused by deer. Consequently, homeowners may not view deer damage in terms of monetary loss, but see it more as damage to the aesthetics of their property and a loss of time and effort on their part. To account for these intangible factors, homeowners could have inflated their estimates of economic loss in an effort to better reflect their concerns about damage.

It is important to distinguish between economic loss and economic loss/hectare of production when interpreting responses received from producers. Severity of damage incurred notwithstanding, two other important factors contribute to economic loss incurred by producers: (1) the value of the crop or planting produced, and (2) the size of the area on which the crop or planting was grown. For example, producers of nursery plants reported the highest economic loss/hectare, but they also had less area in production than did producers of most other commodities. Despite the high economic loss/hectare reported by producers of nursery plants, their total monetary loss was lower because of the limited amount of land on which damage occurred. In contrast, producers of soybeans reported the lowest economic loss/hectare in production, but, because of the relatively large amount of land in soybean production during 1995, they reported the greatest total economic loss as compared to producers in other commodity groups. Although some authors (Decker and Brown 1982, Rieckenberg and Curtis 1997) have used economic loss/hectare in production to compare economic loss among producers, I propose that it is not an appropriate method of comparing deer damage among

producers in different commodity groups because it does not accurately reflect the total economic impact of deer damage on agricultural operations.

Statistically, mean economic loss estimates appeared to differ substantially among some commodity groups. However, because of low sample sizes among certain commodity groups, extremely high variation existed. Consequently, it was difficult to form meaningful interpretations about true differences among groups based on economic loss alone. However, distinctions between groups that reported very high and very low economic loss seem realistic. For example, the conclusion that producers of tree fruits incur higher economic loss than producers of forages seems reasonable and has been reported elsewhere (Decker and Brown 1982). Yet, small differences in the estimates of economic loss between groups (e.g., tree fruits versus soybeans) offer little evidence to support definitive conclusions regarding differences in economic loss incurred by these producers.

Regardless of the accuracy of these estimates, one would expect a respondent's perceptions about damage severity to coincide with their estimates of economic loss. Although respondents' perceptions about economic loss and damage severity are not independent observations (i.e., they were provided by the same individual), a comparison of these perceptions revealed a positive linear relationship between perceived economic loss and damage among producers. In contrast, I noted no relationship between homeowners' general perception of damage severity and their estimates of economic loss. Although it appears that most homeowners did not evaluate deer damage primarily on economic terms, very low sample sizes and high variance may have prevented me from detecting this trend. Given a larger sample, I suspect that homeowners' perception of damage severity and economic loss would be correlated.

In addition to economic loss, respondents provided estimates of yield loss (reported by producers only) or the percentage of plants damaged by deer (reported by homeowners and some producers). Because producers of tree fruits, nursery plants, and Christmas trees reported the percentage of plants that were damaged by deer slightly more often than yield loss, producers of these commodities seemed to focus on individual plants when evaluating damage. Producers of all other commodities reported yield loss more often than the percentage of plants that were damaged. Statistical differences appeared when comparing yield loss estimates among different commodity groups. Again, high variation made it difficult to develop meaningful interpretations regarding differences between specific commodity groups. For example, though producers of tree fruits reported the highest yield loss estimates, low sample sizes prevented me from concluding that this represents substantially higher loss than that incurred by other commodity groups.

Estimates of yield loss and percentage of plants damaged also correlated with perceptions about the severity of deer damage experienced. Because I noted a positive linear relationship between producers' perception of damage severity and their estimates of yield loss and percentage of plants damaged, producers seem able to connect general levels of damage severity, economic loss, and yield loss. Although homeowners provided confounding estimates of economic loss, they did seem able to quantifiably define deer damage in terms of the percentage of their plants that were damaged by deer. This again suggests that homeowners do not equate deer damage with economic loss; rather, they likely view it as a loss of time and effort and a degradation of the aesthetic value of their property.

Preventive Strategies

Because the likelihood to implement methods to prevent damage by deer increased significantly among respondents' who reported increasingly severe damage, it appears that respondents' perceptions about the level of damage during 1995 was important in motivating them to implement such preventive measures. Producers were more likely than homeowners to report using deterrent strategies, probably because producers also were more likely to incur damage. Perhaps more importantly, the level of damage increased homeowners' likelihood of implementing preventive measures at a faster rate than that among producers. The reason for this discrepancy is likely a result of homeowners' and producers' motivations for growing their plantings. Producers likely weighed the cost of implementing these preventive techniques with the economic advantage that would result from decreased damage; hence the more consistent trend (Purdy et al. 1988). Conversely, homeowners likely judge the value of their plantings in terms of aesthetics and recreation in addition to economic value. Thus, light deer damage appears to be sufficient to influence many homeowners to implement measures to prevent damage by deer.

It appears that a combination of a producer's perception about the level of damage and the true motivation for producing a crop influenced full- and part-time producers' decisions on whether to use preventive measures. Because full-time producers rely on their crops as a vital source of income more so than part-timers do, full-time producers would be expected to rely on economics more when deciding whether to implement preventive measures. In contrast, part-time producers probably engage in production for reasons in addition to monetary ones (e.g., recreational) and may consider economic loss to a lesser degree. Thus, part-time producers may not implement preventive measures when they perceive deer to be causing only light or moderate economic damage.

I also found that differences in the implementation of preventive methods among those in different commodity groups were largely dependent upon whether growers had experienced deer damage during 1995. Producers of tree fruits and peanuts were very likely to use preventive techniques, and they also were among the most likely to have experienced damage during 1995. However, producers of soybeans and grains often reported damage also, but they rarely used preventive methods. Because soybeans and grains are relatively low in value/unit area in production and typically are grown over large acreages and in isolated fields, it is possible producers of these commodities may not perceive preventive measures to be cost-effective (Hygnstrom and Craven 1988).

Little previous research has examined the use of preventive measures among commodity groups. However, use of preventive methods by producers in Virginia during 1995 was lower than that noted among nursery producers in New York during 1989 (Sayre et al. 1992). These seem to be confounding results because a relatively high proportion of producers experienced damage during 1995. However, Sayre et al. (1992) considered recreational hunting a means of damage prevention; although most producers (70.9%) in Virginia reported allowing others to hunt on their land during 1995, few (20%) reported using removal by shooting as a preventive tool. If I considered recreational hunting a means of damage control, then producers in Virginia actually were much more likely to use preventive measures than respondents to the Sayre et al. (1992) survey. Additionally, producers in my survey were more likely to use frightening devices, kill

permits, and repellents than were respondents to Scott and Townsend's (1985) survey. Similarly, homeowners in my survey used preventive methods more than homeowners in New York (Decker and Gavin 1985). Again, this difference is likely the result of Virginia homeowners (36%) being more likely than respondents to Decker and Gavin's (1985) survey (25%) to report experiencing damage.

A respondent's willingness to pay for damage prevention is an expression of the motivation to protect a planting. Because I asked only for relative payment amounts (e.g., nothing, a little, a moderate amount, whatever it takes; see Q-18 in Appendix 1), it is difficult to interpret differences between individuals in different groups. Given that producers seem to evaluate damage primarily on an economic basis, they likely responded with the income of their operation as a basis for their response. In contrast, because homeowners did not produce plantings for economic gain, it is difficult to interpret their willingness to pay; their responses most likely reflect monetary values that are related to their annual income. Thus, although homeowners and producers shared a similar willingness to pay for preventive measures, their interpretation of what that actual monetary value would be probably differed. Similarly, because full-time producers appeared to evaluate deer damage on economic terms more than part-time producers did, their stated willingness to pay likely represented differing monetary values. Finally, I did not specify how effective any preventive method would be in my hypothetical example. Because preventive methods rarely eliminate all deer damage, the effectiveness of a particular preventive method likely would influence a respondent's willingness to pay; respondents likely would be less willing to pay for ineffective techniques versus effective ones.

A respondent's use and perception about the effectiveness of preventive measures should be important factors in future planning for educational programs. Because many respondents expressed dissatisfaction with methods they used to deter damage by deer, one could assume that most methods failed to meet expectations. Respondents' expectations of these methods prior to implementation could have been unrealistic. Also, it is unclear whether respondents had an understanding of how each preventive method should be properly implemented or applied. If a respondent was not knowledgeable about the correct use of a preventive method, incorrect implementation probably resulted in decreased effectiveness. Clearly, preferences for and satisfaction with different specific methods may be important in defining and focusing educational needs

Repellents

Repellents are receiving increased attention because of their ease of use and negligible aesthetic impacts. In my survey, repellents were more popular among both homeowners and producers than any other method. Given that some repellents are applied similarly to chemical pesticides, experienced homeowners and producers probably would be more confident in their ability to use deer repellents. Though generally popular among producers, producers growing different commodities used repellents disproportionately. Because the price and effort required for repellent application would increase with the amount of land area treated, producers with a large amount of acreage likely were hesitant to use them because of the high investment required per treatment. In fact, producers of soybeans, peanuts, and grains were among the least likely to report using repellents during 1995. In contrast, producers of tree fruits were very likely to use repellents during 1995.

Although repellents were popular among both producers and homeowners, they were given some of the poorest effectiveness ratings. Reasons for the discrepancy between high use and low effectiveness are several-fold. First, some respondents may have first used a repellent during 1995 and did so with unrealistically high expectations of being able to deter deer from damaging a planting. When this expectation was not realized, ratings of effectiveness suffered. Secondly, research (Ellingwood and Caturano 1988) has shown that the effectiveness of repellents decreases as deer density increases. Deer density has increased significantly during the past decade throughout much of Virginia. Therefore, respondents who had used repellents prior to 1995 with some degree of success may have been experiencing the negative effects of increased deer density on repellent effectiveness.

Fencing

Fencing often requires a high initial investment/unit area protected. For homeowners, the total cost required to install fencing would be much less than that required for most producers. As a result of this lower initial investment, homeowners in this study used fencing more often than producers did. However, producers of highly valuable commodities grown on smaller acreages would have the potential of gaining the most economic benefits from the installation of fencing given the increased potential for economic loss/unit area (Matschke et al. 1984). Perhaps recognizing this benefit, producers of nursery plants and Christmas trees used fencing as a damage abatement technique more often than other producers in Virginia. Although producers of alfalfa and other forages also used fencing, these crops often are used for grazing by cattle and may have been fenced simply to contain livestock rather than to deter deer. Given that tree fruit producers reported relatively high economic loss/unit area, one would expect the cost required to install fencing would be favorable given the opportunity for loss (Matschke et al. 1984). However, Ellingwood and Caturano (1988) pointed out that fencing (especially high tensile) typically requires a good soil depth and moderate terrain for installation. Because many producers of tree fruits reported living in mountainous areas of Virginia, these conditions may not have been met and may have discouraged them from installing fencing. Perhaps more importantly, many tree fruit producers operate “pick-your-own” operations and concerns about aesthetic impacts may have discouraged some producers of tree fruits from installing fencing. Likewise, many homeowners may have been skeptical of fencing, given its negative aesthetic impact, or may have been constrained by local ordinances.

Fencing generally was regarded as being effective in controlling damage by deer, yet it seldom was used, particularly by producers. Many producers may have been skeptical about fencing because of its perceived high initial investment. However, Ellingwood and Caturano (1988) noted that, when prorated over a 10-year period, an 8-foot woven-wire fence was cheaper than repellents. Given the opportunity for loss among producers of highly valuable crops, they should be made aware of the economic advantage offered by fencing (Purdy et al. 1988).

Frightening Devices

Frightening devices were used by about a quarter of both homeowners and producers. Many respondents used frightening devices, possibly because some specific methods (e.g., playing radio, scarecrow) require a minimal investment of time and money. Yet, other more costly methods (e.g., propane exploders) often are used by producers of grains, primarily to deter bird

damage. Given that producers of grains already may have purchased such frightening devices to manage bird damage, their use in attempting to prevent deer damage would represent a minimal expenditure of resources. In support of this hypothesis, I found that producers of soybeans, peanuts, and grains (commodities more often affected by birds) used frightening devices to control deer damage more often than producers of other commodities did. Homeowners may have been discouraged from using loud frightening devices (e.g., propane exploders, shooting blanks) because of community ordinances or concerns about noise.

In general, frightening devices were rated as being ineffective. I did not ask respondents when preventive methods were implemented and was unable to determine the time of the year during which respondents used frightening devices. Because deer typically acclimate rapidly to frightening devices, their effectiveness may be influenced by the time of year and duration of their use (Matschke et al. 1984). In instances where frightening devices were used for short periods of time (e.g., periods during which damage was most severe), they have been shown to be partially successful in reducing damage to field crops (Flyger and Thoerig 1962). However, given the low effectiveness ratings of frightening devices by respondents to my survey, they did not appear successful in meeting expectations of damage reduction. Although it is unclear whether the devices were ineffective due to deer-related factors (e.g., deer acclimated to the devices) or improper use, individuals who are inclined to use such devices should be made aware of how best to use them and the extent of damage reduction that realistically can be expected.

Other Preventive Methods

Although a number of other methods were used by respondents, low sample sizes prevented me from conducting meaningful statistical tests. The use of dogs specifically to reduce damage is a relatively new method, but it was used by some Virginia respondents. Rieckenberg and Curtis (1997) reported that dogs enclosed via an “invisible” fence or similar product significantly reduced deer damage to fruit orchards in New York. Dogs can effectively control deer damage on smaller areas, and most respondents who used dogs during 1995 did so to protect plantings grown on relatively small acreages (e.g., nursery plants, truck crops). Rieckenberg and Curtis (1997) reported that selection and proper training of dogs are essential for successful damage abatement. I did not ask respondents if they owned their dogs specifically to prevent damage; many respondents probably owned dogs for other reasons (e.g., recreation). Consequently, reported effectiveness of using dogs to prevent damage may not be indicative of the success that could be achieved through a rigorous damage prevention program. Because this method is significantly cheaper than traditional deer proof fencing, it likely will gain increased acceptance as individuals become more aware of the technique.

Finally, other physical deterrents (e.g., leader protectors and tree tubes) were used by very few homeowners and producers. Although these devices effectively can reduce damage to woody plants, the high cost and intense labor that is required for implementation may discourage growers from using them. Because most physical deterrents are designed to protect individual or small groups of plants, it’s not surprising that homeowners or producers of commodities grown on small acreages (e.g., tree fruits, nursery plants, ornamental plants) used physical deterrents more so than other growers. Of the few individuals who used physical deterrents during 1995, most appeared satisfied with their effectiveness. However, physical deterrents are not designed

to protect field crops (e.g., soybeans, grains, peanuts) and are not an option for producers of such commodities.

Removal by Shooting

The use of shooting as a means to remove deer is not equivalent to recreational hunting. Although recreational hunting may be used as part of a deer management strategy focused on controlling damage, the mechanisms and goals of recreational hunting are substantially different from attempts to remove deer using lethal methods (Horton and Craven 1997). Recreational hunting implies that goals other than the removal of deer are taken into consideration (e.g., recreation); a lethal deer removal program has only the goal of removing enough animals to reduce damage to an acceptable level.

Producers were much more likely than homeowners to control damage by shooting deer. Homeowners who lived in urban areas did not view shooting as a viable alternative, probably because of safety concerns or local ordinances. Many homeowners who lived in rural areas also appeared hesitant about shooting deer to control damage, even though they probably were not constrained by local ordinances preventing such harvest. Rather, many probably were concerned about safety issues given the small size of the average landholding. The results do not suggest that homeowners avoided shooting deer because of an anti-hunting sentiment; most homeowners agreed with the use of recreational hunting. Although full-time producers were more likely to shoot deer to prevent damage than were part-timers, this difference was slight and probably can be explained by their living situation (i.e., part-timers typically lived in more urban areas) and the amount of land owned by each (i.e., full-time producers probably owned more land than did part-timers).

Removal of deer by shooting generally was regarded as one of the most effective damage control methods by both producers and homeowners. Although few homeowners actually used the method, those that did appeared quite satisfied. In my survey, many producers (71%) allowed others to hunt their property during 1995, but only 20% used a lethal (non-recreational) deer removal strategy. This finding parallels the conclusions of Horton and Craven (1997), who found that 62% of farmers who had implemented a lethal removal strategy believed that recreational deer hunting should be considered a damage abatement technique. Although lethal deer removal programs generally were rated as being effective among producers in my survey, the success of such programs are determined by the initiative of the landowner (Beringer 1994). This may explain why some individuals believed their efforts to control damage by lethally removing deer were ineffective.

VDGIF Deer Management Programs

The VDGIF administers programs designed to assist landowners in achieving deer management objectives on their land, which may include the control of damage as an objective. The kill permit program (KPP) and damage control assistance program (DCAP) are designed specifically to assist landowners in controlling deer damage (see Appendix 3). In addition, though designed to meet broader deer management objectives, the deer management assistance program (DMAP) allows landowners to specify multiple objectives for deer management and receive technical support from VDGIF biologists to facilitate meeting their objectives (see Appendix 3).

Because so few (n = 2) homeowners participated in any VDGIF program during 1995, I was unable to identify factors that may have contributed to their decision to do so. Most homeowners in my survey owned small landholdings, so these deer management programs likely were not applicable to most of them. Also, because each of these programs involves lethal harvesting of deer, homeowners in more urban areas typically would be unable to participate because of safety reasons and local ordinances. Where conditions permit, homeowners with larger landholdings in rural areas could have benefited from these programs, but probably were not aware of their existence.

Full-time producers were more likely to participate in these programs than were part-timers; thus, these programs may be more appealing to those who own relatively large landholdings. Perceptions among producers regarding the level of deer damage incurred greatly affected their decision to participate in $\geq$ 1 VDGIF deer management program(s) during 1995. However, this effect was not consistent for each of the 3 programs. The decision to participate in DMAP was least affected by one's perception about the level of damage incurred. Given the objectives and mechanisms of DMAP (see Appendix E), many landowners probably chose to participate because of interests in general deer management. Conversely, producers' decisions to participate in DCAP and KPP strongly were affected by their perceptions about the level of damage experienced. As perceptions about damage severity increased, producers increasingly were likely to participate in KPP rather than DCAP. KPP allows landowners to harvest deer at any time of the year under special conditions set forth by the local conservation officer that would not be allowed under "fair-chase" regulations (e.g., shooting deer at night). Therefore, KPP was preferred by producers who incurred severe damage. Also, given that participants in DCAP are only allowed to harvest deer during the hunting season, producers who experienced damage outside the regular hunting season may have chosen KPP so that they could harvest deer when damage actually occurred.

Satisfaction with each of the VDGIF deer management programs varied greatly. Because one's decision to participate in a deer management program probably was due to different motivational factors, the satisfaction expressed by a participant must be interpreted in light of each program's specific objectives. Although producers expressed satisfaction with DMAP, this does not imply that it was the most effective program in controlling deer damage. The satisfaction of producers with DMAP likely reflects the flexibility of the program in allowing producers to determine their own deer management objectives and adjust their management plan accordingly. Additionally, DMAP participants are offered extensive technical support from VDGIF personnel. This interaction between VDGIF biologists and landowners undoubtedly fostered improved relationships between the landowner and the agency and increased satisfaction among participants.

Producers also were satisfied with the KPP. Although KPP does not provide participants the follow-up support that DMAP does, KPP may be the most effective program where the primary objective is to control deer damage through lethal means. Because the number of kill permits issued to participants is variable and dependent upon the needs of the landowner, KPP is somewhat flexible in offering increased permits to those more in need of assistance. Secondly, at the discretion of the local conservation officers, regulations concerning "fair-chase" restrictions may be suspended for permits granted under KPP. However, because the issuance of kill permits is at the discretion of the local conservation officer, complaints received by

landowners in different counties may not receive equal privileges regarding the use of kill permits; this apparently has created distrust among some landowners toward VDGIF (M. Knox, VDGIF, pers. commun.).

In contrast, participants in DCAP are issued "bonus" tags that allow them to harvest additional antlerless deer during the regular hunting season. Although DCAP is designed specifically to assist landowners control deer damage via recreational hunting, "fair-chase" restrictions imposed on DCAP tags may account for the general dissatisfaction with this program. Also, because DCAP tags can be used only during the regular hunting season, DCAP tags would be of little value to producers who incurred damage outside the normal hunting season.

The Role of Recreational Hunting on Respondents' Lands

Two primary factors seemed to influence a respondent's decision to allow family members or other individuals to hunt for deer on their land during 1995: (1) the activity of the respondent during 1995 (e.g., homeowner, part-time producer, full-time producer), and (2) their opinion on whether to use recreational hunting as a deer management tool.

Recreational hunting during 1995 was more predominant on producers' than on homeowners' lands. Although few homeowners actually allowed either a family member or another individual to hunt for deer on their land during 1995, this did not reflect a negative attitude toward hunting. In fact, most homeowners favored using recreational hunting as a management tool. Also, full-time producers allowed family members and other individuals to hunt for deer on their land more so than did part-timers. Because these differences were very slight, this disparity was likely driven by the fact that full-time producers lived in more rural areas and owned more land than did part-timers. Also, I did not ask respondents to indicate whether their land was opened for hunting among the general public or was hunted on by a hunting club. Given that full-time producers probably owned more land than did part-timers, their landholdings were likely more suitable for operating a hunting club and may have accounted for the increased occurrence of hunting on their land.

Respondents' opinions about recreational hunting clearly influenced their decision of whether to allow deer hunting on their land during 1995. However, respondents' decision of whether to allow hunting did not always parallel their opinion about recreational hunting. For example, not all producers who agreed with recreational hunting allowed individuals to hunt deer on their land during 1995. In contrast, nearly 30% of producers who disagreed with recreational hunting allowed others to hunt for deer on their land during 1995. Exact reasons for this disparity are unknown, but behavior probably was shaped by specific experiences of these individuals. Producers who agreed with recreational hunting, but did not allow hunting on their land, may have been concerned about liability, property damage, or bad behavior by hunters (Scott and Townsend 1985). Conversely, a small percentage of producers who disagreed with recreational hunting may have allowed individuals to hunt deer on their land in response to damage by deer, despite their negative perceptions about hunting.

The reported number of hunter-days spent hunting for deer allowed me to quantitatively compare the intensity of deer hunting that occurred on each respondent's lands; however, it is important to note that hunter-days may not necessarily correlate with the number of deer harvested on

respondents' landholdings. As expected, I found that lands owned by producers supported more man-days of deer hunting than did those owned by homeowners. Similarly, full-time producers reported a greater mean number of man-days spent deer hunting on their land than did part-timers. Because full-timers probably owned more land than did part-time producers and homeowners, their lands were increasingly more able to support recreational hunting activities. Because I did not ask respondents' to provide the total amount of land they owned during 1995 (i.e., I asked them to provide the amount of land used to produce their plantings), I was unable to evaluate hunting pressure on the basis of hunter-days/unit area.

Given that recreational hunting often is used as a means of reducing deer damage, it is not surprising that respondents' perceptions regarding damage severity were related to their allowance of deer hunting on their land; this positive relationship suggests that many individuals responded to increasing damage by allowing or increasing hunter access to their lands. Though this trend was more predominant among producers, this is likely a reflection of restrictions on recreational hunting that homeowners face. Perhaps more importantly, there was a direct relationship between the mean number of hunter-days on a respondent's lands and perceptions about the level of damage experienced. Though one might expect a decline in damage as a result of increased hunting pressure, it is difficult to determine what effects hunting may have had on the severity of deer damage without information regarding respondents' prior experience with damage. Apparently, respondents increased the hunting presence or effort on their land in response to increasingly severe deer damage.

In addition to the effects that hunting activities on respondents' lands had on the local deer population and deer damage, hunting activities (or lack thereof) on adjacent lands also may have had an impact. Among producers in particular, perceptions about the level of damage incurred coincided with an increasing presence of hunting on adjacent lands. Adkins and Irby (1994) reported the opposite relationship and noted that complaints about damage were greatest among producers who allowed hunting on their land, but had adjoining neighbors who didn't allow hunting. Although Adkins and Irby's (1994) conclusions suggest that hunting restrictions contributed to damage on farmer's lands, they failed to discuss similarities in perceptions about damage among adjoining landowners. It is possible that landowners adjacent to respondents in my survey experienced similar deer-related problems as the respondent, and thus also were more likely to make their land available for deer hunting. However, to determine true causation regarding the effects that activities on surrounding lands may have on an individuals success in controlling deer damage, an experimental study must be developed that evaluates the effects of land-use and hunting restrictions on deer management.

Demand for Compensation Programs

The preventive methods discussed above focus on two techniques of wildlife damage management: manage the offending animal or its habitat. In addition to this approach, Wagner et al. (1997) suggested two additional techniques: modify human activities and increase tolerance for wildlife damage. An often-suggested method to increase tolerance for wildlife damage is to implement compensation programs. Through these programs, those individuals who incur damage from wildlife receive monetary compensation from an administrative agency (most often from the state wildlife agency) to reimburse them for any economic loss caused by wildlife. In Virginia, counties currently have the option of requiring hunters to purchase a "damage stamp,"

which would provide a source of funds to compensate producers who incur deer damage. However, the program is seldom used and only 4 counties required hunters to purchase a damage stamp during the 1994 – 1995 hunting season (Wagner et al. 1997)

Overall, there was little consensus among respondents about the 3 hypothetical compensation options (e.g., no compensation, state compensation, hunter compensation). Although the greatest percentage of respondents believed that those who incur deer damage should not be compensated at all, major differences appeared when I evaluated these preferences based on a respondent's activity and the perception about the level of damage they incurred. Because monetary gain was a primary motivational factor for producers to grow their commodities, many seemingly viewed monetary compensation as a reasonable trade-off for any damage incurred. In contrast, homeowners' motivation for growing plantings likely involve aesthetic reasons more so than economic ones; hence, monetary compensation for deer damage was not an acceptable exchange with them.

A state-funded compensation program elicited more favorable responses overall than did a hunter-funded program. Although I did not ask respondents to qualify their opinions of these programs, I did receive many negative comments regarding a hunter-funded program. "Hunters already pay enough to hunt," and "hunters didn't create the deer problem; why should they pay more than other Virginians" typify comments that were received and seem to echo the sentiments of many respondents. In light of respondents' perceptions about a hunter-funded program, it appears that many respondents recognized the importance of hunting in deer management and were hesitant about placing increased financial demands on hunters.

One's perception about the level of damage experienced also affected the opinion about compensation programs, particularly among producers. I previously noted a relationship between perceived damage severity and economic loss; thus, this increased demand for monetary compensation probably is reflective of greater economic loss among producers. Although benefits obtained from Virginia's deer population may be enjoyed by all of the public, producers who reported increasingly severe damage evidently believe they are incurring a disproportionate amount of the cost associated with maintaining the deer population and should be compensated as a result. Similarly, homeowners with increasingly severe damage were slightly more likely to favor a compensation program. Although economic loss was not the primary motivational factor for homeowners, those incurring severe damage may have viewed monetary compensation as a "better-than-nothing" alternative.

Much of the variation noted in opinions among producers about compensation programs could be traced to reported levels of deer damage and economic loss. For example, producers of tree fruits and soybeans reported high estimates of economic loss and preferred a state-funded compensation program. However, other factors also must have influenced producers' opinions about compensation programs because producers of nursery plants reported relatively high estimates of economic loss, but seemed to prefer having no compensation program. Wagner et al. (1997) suggested that traditional agriculturists (e.g., producers of grain, soybeans, tree fruits) historically have been served by compensation programs. Thus, producers of nursery plants may have had little prior exposure or knowledge of these programs and reacted with skepticism. Additionally, producers of traditional field crops (e.g., soybeans, grains, peanuts) were especially negative about a hunter-funded compensation program. Given that these producers often lease

their lands to hunting clubs (M. Knox, VDGIF, pers. commun.), they possibly disagreed with a hunter-funded program because of the monetary compensation already provided them by the hunting lease and because of personal relationships with hunters.

Finally, it is important to note that I did not provide respondents with any details on how such funds would be disbursed in any hypothetical compensation program. Because it would be impossible to implement a program that reimbursed 100% of the cost of all losses incurred, some lesser payment likely would be offered if a program actually was created in Virginia. Wagner et al. (1997) suggested that, as the amount of reimbursement decreases relative to an individual's loss, that individual's likelihood of being satisfied with the program dwindles. To fully evaluate the demand for a compensation program in Virginia, limits on monetary compensation would need to be explained to stakeholder groups to more realistically determine their preferences for compensation programs.

Deer/Vehicle Collisions in Virginia

Unfortunately, comprehensive statewide data on the extent and distribution of deer/vehicle collisions in Virginia are not readily available. Although the Virginia Department of Transportation (VDOT) collects dead deer from roadways and often records such roadkills, this effort is inconsistent and is not standardized. Thus, these data are not a reliable indicator of the number of vehicle/deer collisions that occur annually. Based on my survey, a very high proportion of respondents reportedly experienced $\geq$ 1 vehicle/deer collisions during 1995 when compared to other studies (e.g., Stout et al. 1993). Given the extremely high incidence of collisions, it seems possible that respondents misrepresented their experiences with deer/vehicle collisions during 1995. Respondents who had experienced a collision prior to 1995 may have been motivated to report experiencing a collision during 1995 to emphasize their concern about vehicle/deer collisions given the strong emotional response elicited by a collision (Stout et al. 1993). Also, because I found that those in more rural areas are more likely to have experienced a collision, the data probably are skewed because most of the respondents lived in rural areas. Hence, these data should not be used to predict the total number of collisions or economic impact of vehicle/deer collisions in Virginia during 1995.

Most respondents who experienced a collision also provided an estimate of the cost to repair the vehicle. Estimated costs were similar to that reported by Romin and Bissonette (1996). Thus, the estimates provided appear reflective of actual costs. Given the high incidence of collisions and potential for substantial damage, vehicle/deer collisions clearly have a substantial economic impact in Virginia annually. Continued research will be important in quantitatively assessing this economic impact and facilitating the development of management strategies.

Although human injury often receives much attention from the news media, participants in my survey rarely (n = 2) reported injuries because of a collision. Although most respondents did not report having sustained any injury from a vehicle/deer collision, the threat of that possibility elicits a strong emotional response from individuals involved. This perceived threat actually may be more important in determining a respondent's perceptions about deer than economic loss (Stout et al. 1993). Perceptions regarding the danger of vehicle/deer collisions varied widely among respondents to my survey. Overall, most (53%) individuals believed the danger of having a vehicle/deer collision was moderate whereas an additional 18% viewed that danger as severe.

In comparison, Stout et al. (1993) found that 20% of New York residents believed the chance of experiencing a deer/vehicle collision was severe. Further, whether a respondent previously had an accident strongly affected the view regarding the danger of collisions. Not surprisingly, those who experienced a collision believed the threat of a collision was much greater than among those who had not been involved in a collision. Because a respondent's perception about the level of damage incurred to plantings was positively correlated to perception about the danger of vehicle deer collisions, it appears that respondents' experiences with other deer-related conflicts (e.g., damage to planting) influenced their perceptions regarding the danger of collisions.

As noted earlier, vehicle/deer collisions occurred most often during October, and 42% of all reported collisions occurred during the autumn season (September, October, November). Scanlon (1995) found a similar concentration of collisions in Lynchburg, Virginia. This time of the year corresponds with the rutting period of deer in Virginia, so the primary factor influencing this trend probably is increased movement by deer (particularly bucks). Therefore, educational and deterrent programs to reduce the occurrence of vehicle/deer collisions should be concentrated immediately prior to and during the autumn season.

In addition to deer-related factors (e.g., deer density, deer movements), characteristics of respondents also may affect the likelihood of experiencing a collision. Factors such as driving experience, eyesight, age, and potential to experience a collision (i.e., amount of time spent driving) affect a respondent's ability to detect and avoid hitting a deer while driving. Respondents to my survey were upper-middle aged. Thus, many factors associated with aging (e.g., poorer eyesight, slower reflexes) may have increased the likelihood of having a collision among respondents. Further research is needed to assess the influence of these factors on the occurrence of vehicle/deer collisions to ensure that educational programs target demographic groups most susceptible to vehicle/deer collisions.

Tolerance for deer in Virginia

As has been shown in other studies (e.g., Brown et al. 1978, Decker and Brown 1982, Sayre and Decker 1989, Minnis and Peyton 1995), the public's tolerance of deer is a result of many factors. Damage to plantings, the occurrence of vehicle/deer collisions, and the threat of Lyme disease have been shown to greatly impact public opinion toward deer. In addition to these negative aspects, deer offer many positive benefits to individuals and to local and state economies. Although I did not specifically evaluate positive factors that may increase one's tolerance of deer, an individual's tolerance reflects some personal evaluation of positive benefits derived minus negative costs incurred.

Responses to the 3 attitudinal questions regarding deer (see Q-51 – 53 in Appendix 1) suggest that most producers and homeowners are intolerant of deer populations at current levels in Virginia. However, it is heartening that most respondents did not perceive deer to be a nuisance species; rather, producers and homeowners both valued deer and the positive benefits they provide, but were unwilling to sustain severe damage or face the danger of vehicle/deer collisions in return. Equally as encouraging, most individuals acknowledged that deer cause problems for certain people, regardless of that individual's prior experience with deer damage.

Wildlife managers must understand factors that lead to public intolerance of deer so that proactive management strategies can be developed (Minnis and Peyton 1995). I found that one's perceptions about the severity of damage and the danger of vehicle/deer collisions were primary motivational factors in the expression of intolerance. The threat of Lyme disease was a primary factor influencing the opinions of New York residents (Decker and Gavin 1987), but, because of low incidence in Virginia, I did not assess perceptions about Lyme disease and assumed that the effects of this concern among Virginia residents were low.

Differences in attitudes about deer between homeowners and producers were due primarily to each group's likelihood of experiencing damage during 1995. Perceptions about the severity of damage influenced producers' opinions more so than homeowners', but this difference was relatively minor. Similarly, differences in the level of intolerance between full- and part-time producers also were determined by each group's likelihood of experiencing damage. Damage severity affected full-time producers' opinions more so than those expressed by part-time producers, but again, this effect was minor. Clearly, perceptions regarding the level of damage incurred greatly affected all respondents' opinions about deer.

The degree to which damage severity affected respondents' attitudes likely can be attributed to respondents' reliance on their plantings as a source of income; those relying to a large extent on their plantings as a source of income would be expected to react to increased damage more strongly than those deriving aesthetic or recreational benefits from their plantings. In fact, Tanner and Dimmick (1984) stated that those who received higher levels of income from their plantings expressed greater intolerance of deer. Although a cursory examination of my data appears to support this hypothesis, I disagree with Tanner and Dimmick's (1984) interpretation. Producers and homeowners who reported similar levels of deer damage also displayed similar attitudes regarding intolerance. Considering the increased potential for economic loss among producers, it seems that producers clearly were willing to incur much greater economic loss than homeowners who expressed a similar attitude about deer. Hence, although producers generally may display more negative attitudes toward deer, they also are incurring much greater economic losses. What would homeowners' response be to an increased potential for economic loss caused by deer? Given my results, homeowners appear more sensitive to deer damage than producers and would respond to increased damage with extreme intolerance.

Cultural Carrying Capacity

Many papers (e.g., Brown et al. 1978, Brown and Decker 1979, Decker and Brown 1982, Decker and Gavin 1985, Sayre and Decker 1989) have discussed using respondents' desires for future deer population trends as the primary measurement for tolerance of deer. These desires inherently refer to population levels rather than the species as a whole. For example, many respondents in my study expressed the desire to lower Virginia's deer population, but they also indicated a general enjoyment of deer regardless of the problems they caused. In light of these interactions, respondents clearly valued the deer resource in Virginia, but still wanted to reduce Virginia's deer population and, due to their expressed desires, would likely react negatively to any increase in the deer population in the future.

Minnis and Peyton (1995:20) defined cultural carrying capacity (CCC) as "the wildlife population level in a defined area that produces the most manageable amount of issue activity at

a particular time." In other words, CCC could be defined as the wildlife population level that creates the least amount of societal conflict. Unlike other measures (e.g., Wildlife Acceptance Capacity [WAC]) devised to measure the amount of intolerance for wildlife damage (Decker and Purdy 1988), CCC incorporates both positive and negative values associated with a wildlife population and defines both upper and lower limit goals for the population. In order for CCC to be derived and used as a basis for decision-making, there must be quantifiable and functional relationships between the management parameter (i.e., deer density) and attitudinal response (i.e., desire for future deer populations). Heretofore, research has presented confounding evidence of such a relationship (Decker et al. 1983). Although some research (Sayre and Decker 1989) has shown differences in perceptions between those living in areas with "high" deer density as opposed to those living in areas with "low" deer density, these "all-or-nothing" comparisons are limited in their ability to quantitatively determine CCC and predict public response to changing deer population levels. To facilitate such predictions, linear relationships between deer density and public perceptions must be evaluated.

Although great variation existed, I detected a linear trend between deer density and respondents' desires for future deer population trends. Minnis and Peyton (1995) emphasized that attitudinal response to deer density may not be a direct effect. In actuality, a respondent's experience with damage to plantings and opinion about the danger of vehicle/deer collisions appear to be factors that directly influence an individual's preference for future deer management; deer density appears to indirectly affect a respondent's desire for future deer population trends by contributing to deer-related conflicts. Upon initial observation, both producers' and homeowners' desires for future deer populations appeared to correlate with BH/km^2 in their county, but this trend was not statistically significant when considering only homeowners. Because of the high variation in BH/km^2 estimates among those with differing desires, the relatively low number of homeowners in the sample did not allow me to detect this trend; a larger sample may have yielded a significant trend.

Caution should be taken when interpreting these relationships. Instead of being viewed as clear definitions of CCC among homeowners and producers in Virginia, these relationships should only be the starting point to objectively and quantitatively determine CCC for deer in Virginia. Clearly, before these relationships can be used to form management decisions, much more research is needed. Though considerations of other stakeholder groups (e.g., hunters) must be accounted for, my findings do suggest limits for the deer population above which homeowners and producers are likely to react negatively. Both homeowners and producers expressed acceptance of the deer population when BH/km^2 estimates approximated 1.3 (about 3.4 BH/mile^2). More importantly, respondents appeared increasingly intolerant of deer when BH/km^2 exceeded 1.4 (about 3.6 BH/mile^2). In fact, those expressing the strongest desire for a population reduction (e.g., respondents who desired a dramatic population reduction) lived in counties with a mean BH/km^2 of 1.52 (about 4.0 BH/mile^2). Finally, as BH/km^2 approached 1.2 (about 3.1 BH/mile^2), respondents became more likely to desire an increase in the deer population. Though highly variable, these data suggest that maintaining a deer density that produces an annual BH/km^2 of 1.3 most likely would satisfy homeowners and producers in Virginia. More importantly, I believe these data establish an observable linear relationship between population density and attitudinal response.

In theory, societal conflict will decrease to its lowest point when deer density and CCC fall within the same range of values (Minnis and Peyton 1995). One method of reaching this consensus is by managing the deer population to equate to CCC. Conversely, because deer density appears to indirectly affect attitudinal response, management of factors directly affecting those perceptions could be used to increase CCC for a stakeholder group. For example, providing technical and/or financial support to facilitate the implementation of preventive measures may increase tolerance for deer among producers. Similarly, implementing strategies to reduce the number of vehicle/deer collisions may increase the CCC for deer among motorists. Though these strategies may not produce results as quickly or with the same assurance as reducing the deer population would, they may be necessary due to diametrically opposing CCC desires expressed by $\geq$ 2 stakeholder groups (Minnis and Peyton 1995).

As Minnis and Peyton (1995) emphasized, a true definition of CCC would need to incorporate the perceptions of a wide variety of stakeholder groups; the data presented from my study represent the views of only a few stakeholder groups in Virginia. To properly define the CCC for deer in Virginia, more research would have to be conducted to evaluate the perceptions of other groups (e.g., hunters). Additionally, the range of BH/km^2 among those desiring differing population trends is relatively narrow and deer managers may not be able to realistically manage for such specific population goals. However, my sampling method was not designed to select participants based upon the deer density in their county of residence or production. Because many areas of Virginia that characteristically maintain low deer densities also are basically devoid of agricultural operations, my sampling scheme inherently selected against individuals in these areas and may have contributed to this narrow range. Additional research with a sampling method designed specifically to sample those living in areas with differing deer densities likely would yield a more meaningful relationship between deer density and stakeholder attitudes. Also, an increased sampling effort may allow the researcher to differentiate specific preferences among different stakeholder groups.

Management Paradigms

When interpreting respondents' opinions about the use of deer management options in Virginia, it is important to note that I neither provided respondents with information about each management option (see Q-33 -- 40 in Appendix 1) nor attempted to evaluate their knowledge about each. Thus, many of the respondents may have provided opinions regarding management options about which they knew little. Increased knowledge about these management options may have allowed respondents' to provide more informed opinions, but my objective was to evaluate unbiased perceptions and attitudes so management strategies may be formulated.

Differences in demographic factors appeared to be primary factors influencing a respondent's preferences for deer management options. Given that producers more often were male and raised in more rural areas than were homeowners, differences of opinion about deer management options appeared to be driven by demographic differences between each group. The characteristic that appeared most influential in determining respondents' opinions was gender. Kellert (1996) suggested that many of the differences that exist between males and females are due to basic value distinctions between the sexes. Specifically, males and females held differing views of recreational hunting. Although a clear explanation for these discrepancies has not been offered, cultural differences are hypothesized to be a primary contributor. Traditionally, hunting

has been viewed primarily as a masculine activity; these perceptions historically may have excluded females from participating in hunting. In response, many states have implemented programs (e.g., "Becoming an Outdoors Woman") to encourage female participation in activities such as hunting and fishing. Although the cumulative effects of these programs are not yet known, preliminary observations suggest that hunting is becoming more popular among females (U.S. Department of the Interior 1996). Perhaps more importantly, regardless of the disparity that was observed between males and females with regard to recreational hunting, a majority of all demographic groups agreed with the use of recreational hunting as a management tool.

In addition to recreational hunting, respondents provided their opinion of other "non-lethal" management options as well. The use of contraception, possibly the most controversial of these options, was favored by 30% of respondents. This represents a small proportion of all respondents, but the growth in interest among the public concerning contraception should encourage wildlife managers to evaluate factors that may affect the public's opinions about it. Although some differences appeared between homeowners' and producers' attitudes toward contraception, I found this largely a result of the proportion of males and females that made up each group. Regardless of whether they were a homeowner or a producer during 1995, males expressed negative views about contraception. Many logistical factors currently restrict the broad application of contraception (Ellingwood and Caturano 1988). Thus, given the propensity of males to rely on logic in decision-making, the negative views held by males about these non-lethal methods may reflect their consideration of these factors (Kellert 1996). In contrast, female homeowners were much more favorable toward contraception than female producers. Females have been shown to rely heavily on subjective values in decision-making (Kellert 1996); thus, those living in different cultures likely based their decision upon different value systems.

More comprehensively, homeowners expressed more favorable opinions about 4 non-lethal management options (i.e., fencing and repellents, contraception, allow nature to take its course, and trapping and relocating individuals) than producers did. Despite these differences, the primary factors in determining a respondent's attitudes about deer management options appeared to be gender and situation in which they were raised. Differences in the opinion of these non-lethal management options between females and males are likely a result of their decision-making processes (Kellert 1996). Because each of these methods encounter substantial logistical problems in implementation and are often ineffective (Ellingwood and Caturano 1988), males likely used these facts to form an opinion about each. Females probably viewed these methods as most humane and formed opinions on this basis. For males, their knowledge of these methods may have greatly influenced their opinions; for females, factual information was likely of lesser value.

Although Kellert (1996) found that one's dependence on the land influenced the view of nature much more so than did the size of one's hometown, respondents' activity and living situation during their upbringing both influenced opinions about these deer management options. However, Kellert (1996) did point out a clear relationship between the amount of land owned and one's opinion of hunting (i.e., utilitarian values). Although I was unable to determine the amount of land owned by each respondent, it might be reasonable to assume that producers and those living in rural areas owned more land than homeowners and those living in urban areas. Regardless of the variable used as a measure, one's living situation (e.g., urban versus rural) influences the culture in which one lives. Those not dependent upon the land for income or those

living in urban areas typically view the lethal harvest of animals as unappealing (Kellert 1996). In contrast, farmers or those who were brought up in rural areas generally are more accepting of lethal harvest because they likely have been exposed to recreational hunting or trapping.

Finally, Kellert (1996) found age and education to be strong motivators in one's attitudes about nature, particularly with respect to utilitarian and moralistic values. However, many of the differences Kellert (1996) found occurred at the periphery of education and age categories. For example, those who were very young (e.g., $\leq$ 17 years old) displayed very moralistic values whereas those who had less education (e.g., < high school diploma) expressed strong utilitarian values. I was unable to either detect or interpret the effects of these demographic factors because the respondents to my survey were relatively homogenous with regard to age and education,

The importance of these demographic factors (e.g., gender, living situation, education) in determining one's attitudes concerning deer management alternatives should be of primary importance to wildlife managers. Because historical funding has been provided primarily by hunting and fishing expenditures, state wildlife agencies traditionally have viewed sportsmen as being their key constituents. Therefore, most state game agencies have targeted educational outreach programs at males living in rural environments. As the U.S. becomes more urbanized and females gain an increasing voice in state and local governments, the support for recreational hunting likely will continue to decline and other non-lethal options may begin to be viewed as preferable alternatives. In the short-term, the apparent widespread preference for recreational hunting supports current management efforts of the VDGIF.

Conclusions

Clearly, damage caused by deer is a concern for many producers and homeowners in Virginia. As noted above, the ability to accurately predict public attitudes toward deer in the future will be paramount to successful deer management. Unfortunately, relationships between attitudes and factors that affect those attitudes often are complex. Although the nature of my data did not allow me to conduct multivariate analyses to predict public attitudes, conclusions can be drawn from several relationships. A comprehensive model displaying these relationships can be shown with a path model (Figure 75).

The path model (Figure 75) is limited in its ability to predict public response to management actions. The model was generalized to clearly communicate direct relationships among a number of factors relating to an individual's tolerance for deer. Among certain stakeholder groups, certain relationships displayed in the model may actually have little significance. For example, compensation programs have been shown to increase an individual's tolerance for deer (Wagner et al. 1997), but my data suggests that this trend is much stronger among producers than among homeowners. Similarly, perceptions about Lyme disease were of little importance in Virginia, but may be crucial to the model among individuals living in other regions of the US. To make appropriate use of this model, managers must consider such other factors when interpreting it.

The primary factors that influenced a respondent's tolerance for deer were perceptions of damage severity and danger of vehicle/deer collisions. Additionally, deer density appeared to influence one's tolerance for deer; however, this likely is an indirect relationship. Rather, deer

density appeared to influence a respondent's perceptions about the level of damage incurred and the danger of vehicle/deer collisions.

Clearly, manipulating deer density would have the most direct effect on public tolerance for deer because manipulation of that factor would affect the remaining factors in the model (Figure 75). However, desires of other stakeholder groups (e.g., hunters) may not allow a drastic reduction in deer populations in some areas of Virginia (Peyton and Minnis 1995). In this situation, the model suggests other options that may increase tolerance for deer. For example, in areas where lethal removal of deer is not viable or desirable, educational prgrams that address damage to plantings and danger of vehicle/deer collisions likely would most effectively increase tolerance for deer.

In conclusion, the path model allows a comprehensive view of factors that may affect an individual's tolerance for deer (Figure 75). Although other factors (e.g., region of country, influenced stakeholders) must be considered when interpreting the model, these factors easily could be included in the model by the manager. The subsequent application of this model to situations where deer-related conflicts occur will allow managers to collectively consider the primary factors that relate to tolerance and formulate management strategies accordingly.

Recommendations

Based on the analysis and interpretation of information supplied by producers and homeowners in Virginia, I recommend:

1. similar research be conducted at regular intervals (e.g., every 5 years) to assess temporal changes in attitudes regarding deer and deer damage;

2. implementation of an educational program designed to disseminate information to homeowners and producers regarding preventive measures that may be used to control deer damage;

3. an expansion of the deer management assistance program (DMAP) and the kill permit program (KPP);

4. the development of a protocol to be used to manage urban deer populations;

5. the implementation of a standardized data collection program designed to assess vehicle/deer accidents in Virginia;

6. increased emphasis regarding the danger of vehicle/deer collisions in driver training programs;

7. research designed to quantitatively determine CCC by management unit in Virginia;

    7a. until such time that CCC is better determined, the VDGIF should endeavor to stabilize or slightly decrease deer populations in counties where annual BH/km^2 is greater than 1.4, particularly in areas predominated by agricultural operations; and

8. focus educational efforts about the advantages and disadvantages of deer management options on females and those living in urban environments.

Recommendation #1

Given that my data only reflect the attitudes and perceptions of homeowners and producers during 1995, I was limited in my ability to assess temporal changes in public attitudes about deer and deer damage. The lack of baseline data against which my results could be compared also hampered my ability to make predictions regarding future trends of public attitudes and perceptions. As the public gains an increasingly important voice in decision-making within state agencies, the ability to predict public response to changing deer populations will become increasingly important as well (Knuth et al. 1992).

Clearly, the objectives of this study were to provide a broad overview and evaluation of deer damage and related factors among key stakeholder groups in Virginia. This comprehensive approach was important given that little work previously had been conducted in Virginia. However, in the future, a more focused survey likely would be more logistically feasible but also could provide information needed to formulate management decisions. More specifically, the abbreviated questionnaire should include key questions from the "deer damage to your primary and secondary plantings" section (see Appendix A) to allow researchers to assess temporal changes in the perceptions about the occurrence and severity of deer damage. Also, the inclusion of questions from the section "participant opinions about deer" (see Appendix A) would be important in assessing whether perceptions about deer continue to correspond with perceptions about damage, as I demonstrated with this study. Because the VDGIF is the state agency mandated to "manage Virginia's wildlife and inland fisheries to maintain optimum populations of all species to serve the needs of the Commonwealth" (VDGIF 1997:1), they should clearly be the leading organization in such future efforts. Certainly, cooperation with other groups (e.g., Virginia Tech Department of Fisheries and Wildlife) would strengthen and enhance the agency's ability to conduct such research. Finally, given that the VDGIF has a stated goal of maintaining consistent harvest regulations for $\geq$ 4 years before reevaluations (VDGIF 1997), information obtained from such surveys would be most useful immediately prior to harvest regulation changes.

Recommendation #2

Because damage severity was a primary contributor to a respondent's level of intolerance regarding deer, effective use of preventive methods may lead to more tolerance of deer among homeowners and producers. Although many respondents used preventive measures to deter deer from damaging their plantings during 1995, most appeared dissatisfied with them. Additionally,

many methods that appeared most popular (e.g., repellents) also were given some of the poorest effectiveness ratings. An educational program to address these concerns should (1) ensure that participants have an adequate understanding of how each preventive method should be implemented, and (2) foster realistic expectations on the part of participants regarding the effectiveness of different methods. My results suggest that both producers and homeowners are willing to implement preventive measures, especially as the level of damage becomes increasingly severe. Thus, although historical programs have been targeted toward producers, a program addressing the concerns of both groups likely will be met with acceptance. Such a program would allow participants to chose a preventive method that would come closest to achieving their objectives and facilitate the proper implementation of such. Additionally, programs to educate producers about the potential economic rate-of-return offered by different preventive measures would allow them to objectively decide which method to implement. Integral to the success of this program, producers must be able to accurately assess the economic impacts of deer on their operation to judge whether preventive methods would be cost-effective; thus, this knowledge also must be addressed with such educational efforts.

Clearly, both the VDGIF and the Virginia Cooperative Extension Service have responsibilities in education regarding wildlife conflicts. However, it is questionable whether either agency would be willing to dedicate the resources needed to facilitate an effective program. More likely, a cooperative effort between the two would be most feasible and effective. An effective program would consist of several facets and, of course, would be dependent upon a consistent funding source. Educational pamphlets and brochures may be useful, but more personalized and intensive technical advice and support likely would be necessary for the success of such a program.

Recommendation #3

Both the deer management assistance program (DMAP) and the kill permit program (KPP) elicited favorable responses from producers. Although each program was designed to meet different objectives, respondents apparently were satisfied with their success in meeting these objectives. Due to its objectives and mechanisms (see Appendix E), DMAP seems most useful to landowners who have multiple objectives regarding deer management on their lands. Given the flexibility of DMAP and the satisfaction among its participants, it is likely to become increasingly popular among landowners, particularly producers. In contrast, KPP is designed specifically to control deer damage and seems to become increasingly important to producers who incur severe damage. However, because individual conservation officers vary in their willingness to issue kill permits and in the restrictions (e.g., time of year during which deer can be harvested, removal techniques) they place on participants, landowners may become dissatisfied with the program if they believe inequities exist. These inconsistencies certainly should be resolved by the VDGIF. Also, many participants in KPP commented that they had insufficient time to remove deer from their lands. Granting landowners permission to allow other individuals to harvest deer on their land may alleviate the concern regarding limited available time expressed by participants.

Because few producers participated in DMAP (5%) or KPP (13%) during 1995, many may not have been familiar with these programs or were skeptical about them. Given the high satisfaction with these programs among participants, an effort to disseminate information about

the existence and mechanisms of these programs could recruit new participants and foster more cooperative relationships between the VDGIF and private landowners. Because the VDGIF is the agency that administers these programs, it is reasonable to assume that the agency should also be responsible for such an effort. However, cooperation with other organizations (e.g., Virginia Cooperative Extension, Virginia Farm Bureau) would certainly aid the VDGIF in disseminating this information

In one sense, DCAP is a synthesis between DMAP and KPP -- it is targeted specifically toward individuals who incur damage, but it uses recreational hunting as a means of control. Given respondents' low satisfaction with DCAP, it appears that the program is neither addressing damage problems nor providing adequate support to landowners interested in general deer management. Given that participants in DMAP and KPP were relatively satisfied with each program and that these programs address demands for general deer management assistance (DMAP) and specific complaints about deer damage (KPP), the VDGIF should thoroughly reevaluate DCAP to determine whether the program is meeting a unique need not addressed by DMAP or KPP. Although I briefly evaluated perceptions about each program, the data was limited in allowing me to identify specific reasons for the poor satisfaction attributed to DCAP. A more intensive effort by the VDGIF to solicit input from previous program participants and the hunting community would allow a more comprehensive assessment regarding the value of this program.

Recommendation #4

DCAP, DMAP, and KPP probably are not viable alternatives for many homeowners who are incurring deer damage in Virginia. Given that each of these programs involves lethal harvest of deer, homeowners may be precluded from these programs due to restrictive ordinances in their community or the size of their landholdings. Although community-wide deer removal programs can be successful in reducing deer-related conflicts in urban areas (Scanlon et al. 1995), many communities are unwilling to implement such a program due to safety concerns. Because many homeowners incurred deer damage during 1995 and displayed attitudes of intolerance as a result, there is a demand for a program targeted toward homeowners who incur damage and live in residential settings. Many homeowners may have to rely on site-specific, non-lethal options (e.g., fencing, repellents) to control deer damage; thus, an educational program such as that described under Objective #2 may be useful. Additionally, in situations where community-wide management efforts are desired, the VDGIF should develop a standardized protocol to be used in developing management alternatives for each community. Attitudes and perceptions may differ among communities, so any such protocol should incorporate public input in the decision-making process (Stout et al. 1992, Stout et al. 1996). Administratively, it is unclear who should develop and execute this program. Again, both the VDGIF and Virginia Cooperative Extension have responsibilities regarding education, but neither organization appears willing to provide the resources to accomplish this recommendation alone. Most likely, a cooperative venture between the 2 agencies would provide the most effective program.

Recommendation #5

In addition to a continuing process of evaluating public perceptions and attitudes toward deer damage as described under Objective #1, there clearly is a need for a data collection program to

assess the occurrence of vehicle/deer collisions. Because I found perceptions regarding vehicle/deer collisions to be a primary motivator influencing respondents' opinions about deer, such a program would allow VDGIF to annually monitor collisions and develop management recommendations accordingly. Also, such a program would allow VDGIF to identify areas in which collisions are most likely to occur and focus specifically on these areas when deciding where to allocate resources (e.g., deer crossing signs, wildlife crossings, fencing) to deter collisions.

Other states (e.g., Pennsylvania) rely heavily on information (i.e., number of deer carcasses observed on roadways) provided by the state Department of Transportation to monitor the occurrence of vehicle/deer collisions. However, given that the VDOT is primarily responsible for interstates and major highways, this method would overlook many collisions that occur on secondary roads, but may be sufficient to identify "hotspots" in the state. Also, some states use reports of collisions received by state wildlife and law enforcement agencies to assess the occurrence of vehicle/deer collisions. Given that few respondents in my survey who had experienced an accident during 1995 reported it to a law enforcement agency, this would be an inaccurate method. However, such a method may provide sufficient information to assess the prevalence of vehicle/deer collisions relative to previous years.

Recommendation #6

The threat of vehicle/deer collisions currently is given little attention in driver training and educational programs (P. Scanlon, Virginia Tech, unpubl. data). VDOT includes information on the danger of vehicle/deer collisions in the Virginia driver's training manual, but educational programs that target older drivers generally are lacking. Because other non-deer-related factors may affect one's likelihood of experiencing a vehicle/deer collision (e.g., driver experience, eyesight, age), incorporation of information about the danger of vehicle/deer collisions and avoidance strategies into educational programs may foster an increased awareness on the part of Virginia motorists and result in lowered incidences of collisions. A data collection program as described under Recommendation #5 would allow deer managers to evaluate the success of this strategy in reducing the incidence of vehicle/deer collisions.

Recommendation #7

Heretofore, clear evidence documenting a linear relationship between deer density and attitudinal responses has been lacking. I found a clear linear relationship between deer density in a respondent's county and attitudes regarding future deer management (i.e., increase, decrease, stabilize deer population). Clearly, the next logical step would be to design and implement a survey to assess CCC for a variety of stakeholder groups (e.g., producers, homeowners, hunters, outdoor enthusiasts) in Virginia. As discussed under Recommendation #1, the VDGIF is clearly the agency responsible for wildlife-conflict management in Virginia and should take the lead with such an effort. In fact, the department has stated a goal to "determine CCC by management unit by January 1, 2004" (VDGIF 1997:45). Again, however, cooperation with other organizations (e.g., Virginia Tech Department of Fisheries and Wildlife) would certainly enhance this research. Unfortunately, similar work has not been accomplished elsewhere, so there is little supporting evidence to suggest how such information should be best obtained. Most likely, a variety of methods (e.g., surveys, focus groups) would produce the most

dependable results. Additionally, as outlined by Minnis and Peyton (1995), perceptions about deer damage (as I evaluated) are not the only concerns that should be used to produce such an estimate. Clearly, a comprehensive CCC estimate would incorporate not only concerns about deer-related conflicts, but also benefits derived from deer.

Once accomplished, this research would provide managers with quantitative estimates of CCC by management unit. After harvest strategies were implemented and deer densities adjusted to correspond with CCC, a follow-up survey should be completed to assess perceptions about deer and determine whether those perceptions corresponded with deer density manipulation. Until such time that this research is completed, it appears that producers and homeowners alike are most tolerant of deer population densities around 1.3 BH/km^2 annually. Consequently, the VDGIF should identify counties with densities $\geq$ 1.4 BH/ km^2 and consider implementing regulations to reduce the population in that county, particularly in areas predominated by agriculture. Perhaps more importantly, these counties should be targeted first to determine CCC quantitatively. In so doing, the VDGIF not only will be responding to stakeholder concerns in areas of greatest deer density, but will also be able to evaluate the methodology used prior to initiating a statewide effort.

Recommendation #8

It is encouraging that a vast majority of all demographic groups viewed recreational hunting as a favorable deer management option in Virginia. To ensure continued support of recreational hunting, wildlife management agencies (VDGIF) must initiate educational programs targeted toward those individuals found most likely to oppose management actions, particularly hunting. Also, many private organizations (e.g., Virginia Deer Hunters Association) have a vested interest in this concern and likely would be willing to support and assist in such an effort.

Clearly, females who were raised in urban environments are least likely to support the use of recreational hunting. Caution must be taken when interpreting these results because I did not ask respondents whether they would actively oppose recreational hunting in the future -- disagreement with recreational hunting does not necessarily imply they will actively oppose its use. However, given that urban females were much more likely than others to disagree with recreational hunting, one would expect that they also would be more likely to actively oppose it. Hence, state agencies and other organizations wishing to ensure the continuation of recreational hunting as a management tool should design and implement educational programs that target many demographic groups, but particularly females who live in urban environments. Clearly, the influence of such educational efforts will be dependent upon the level of funding and support provided by participating agencies and organizations; increased support will theoretically result in a greater impact. Following the implementation of this recommendation, follow-up evaluations should be conducted to assess the influence of this program in determining group's perceptions about deer management.

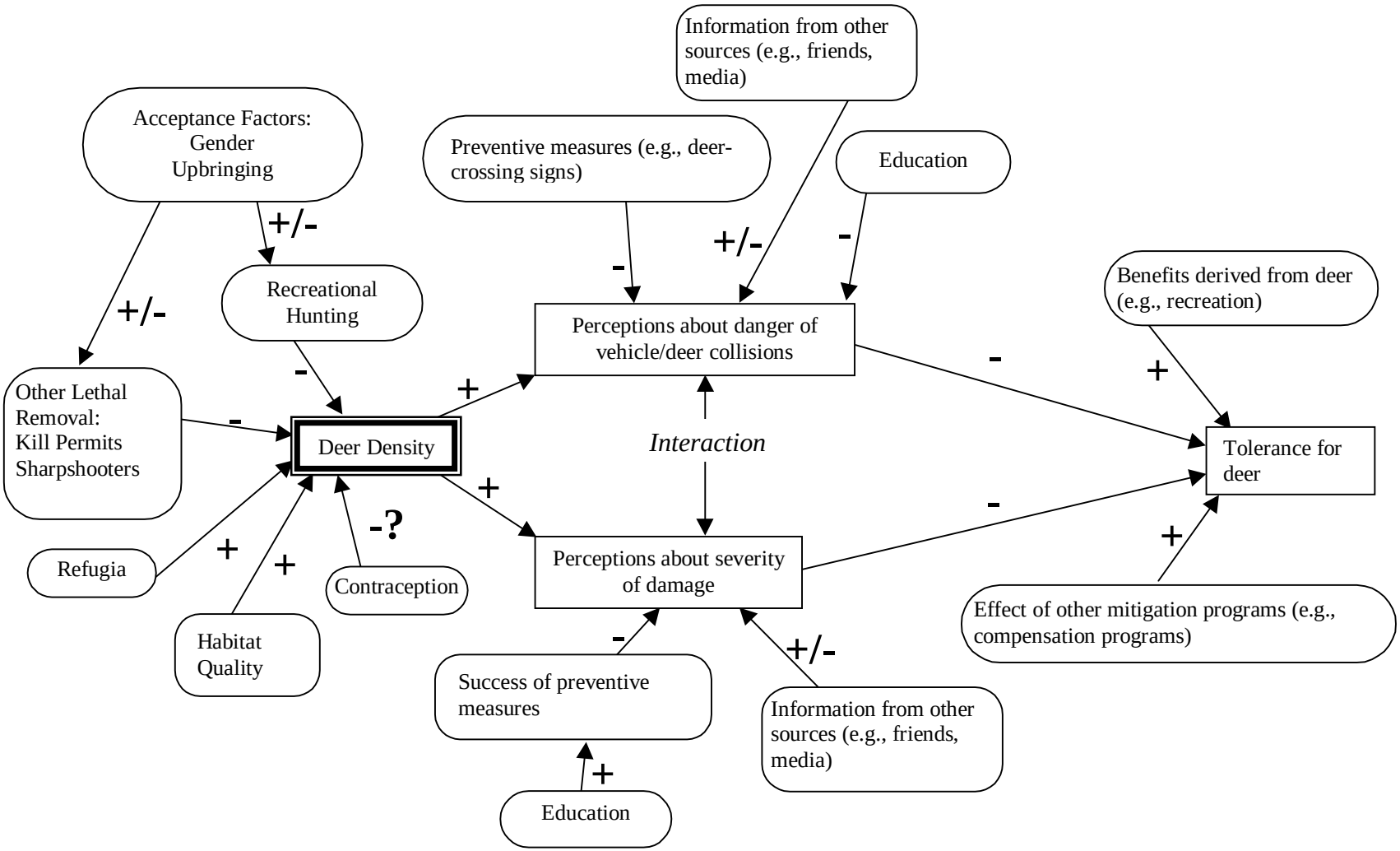

Figure 75. Path model displaying factors affecting an individual's tolerance for deer and relationships among those factors, based on respondents to a survey assessing deer damage in Virginia during 1995 (the sign of arrows [+/-] indicates a positive or negative correlation between factors).

CHAPTER 2

Potential Impacts of Refugia on Traditional Deer Management – A Pilot Study

INTRODUCTION

The vast majority of agricultural producers and homeowners in Virginia want a general reduction of the deer population in Virginia (see Chapter 1). Though educational programs focused on informing people about preventive measures may increase the public's tolerance for deer (Minnis and Peyton 1995), deer populations in many areas of Virginia are approaching intolerable levels. Programs designed to limit the growth of deer populations are certain to be an integral part of deer management in coming decades.

Traditionally, wildlife managers have used recreational hunting as the primary tool to manage deer populations on a statewide basis (Ellingwood and Caturano 1988). However, the effectiveness of this management strategy may be dwindling in response to a smaller population of hunters and an increasing prevalence of lands restricted to hunting. As the U.S. has become more urbanized, private organizations and governmental agencies have prohibited hunting on many areas for safety concerns. Although these suburban areas and parks do not qualify as refugia according to Leopold's (1947:195) definition, which classifies a refuge as "an area closed to hunting in order that its excess population may flow out and restock surrounding areas," numerous studies have shown that deer can and will use these areas as viable habitat (Zagata and Haugen 1973, Vogel 1989, Witham and Jones 1990, Swihart et al. 1995). Also, although the results of my previous survey (see Chapter 1) suggest that agricultural producers and homeowners in Virginia have increasingly allowed hunting on their lands since 1990, these results represent a select group of private landowners (e.g., landowners who were known to produce crops or engage in landscaping and gardening) and probably are not representative of all landowners in Virginia. Wright and Kaiser (1986) concluded that prohibition of hunting on private land (i.e., "posting") is increasing throughout most of the U.S. This trend, in conjunction with increasing urbanization, strongly suggests that the total amount of land in Virginia open to hunting for deer annually probably has declined during the last few years. Additionally, the number of individuals hunting for deer annually has been decreasing steadily since the mid-1970s (VDGIF 1997). Thus, the amount of land in Virginia on which deer are hunted likely has become increasingly smaller during the past decade.

McCullough (1984) was one of the first to suggest that refugia may prevent deer populations from ever being reduced below some point, despite intense hunting pressure. However, research has yet to offer substantive evidence to support or refute this hypothesis. Deer movement onto a refuge with the onset of the hunting season can increase the survival of deer locally (Root et al. 1988) and therefore has substantial negative implications on the occurrence and severity of deer damage. For example, if a farmer allows hunting on the farm, but, with the onset of the hunting season, a significant percentage of deer on that farm emigrate to surrounding refuge areas until the end of hunting season and then disperse, efforts made to reduce the local deer population would be nullified. Similarly, if a landholding is hunted and deer do not emigrate off-site during the hunting season, but the site is surrounded by refugia, that area could function as a "sink" (i.e., the local population experienced significant mortality during the hunting season, but subsequently was replenished by immigration from surrounding "sources"). In either case, population reduction by sport hunting theoretically would be nullified and would not have the anticipated effect of minimizing deer damage.

Kammermeyer and Marchinton (1976) found that deer in Georgia moved into a refuge with the onset of hunting pressure and then dispersed after that activity subsided. In contrast, Nixon et al. (1991) found no relationship between hunting and deer emigration to refuge areas, but noted that considerable dispersal out of the refuge occurred during April through June. Root et al. (1988) found that deer movements and behavior were affected by intensity of hunting pressure; female deer with home ranges within a refuge were protected from intensive hunting pressure. In contrast, Vercauteren and Hygnstrom (1998) found that deer shifted home range centers in response to hunting, but they typically were available for harvest on lands where damage was observed, despite the presence of bordering refugia.

Although this previous research offers conflicting results, sufficient evidence exists to suggest that, in some situations, the local presence of refugia can protect some proportion of a deer population from hunting mortality. Thus, the presence of locally abundant refugia potentially could increase the severity and incidence of deer damage despite a landowner's efforts to limit deer damage via hunting. The key issue in this observation is the identification of areas that may effectively serve as refugia. McCullough (1984) suggested that the designation of an area as a refuge is rarely absolute. Rather, the characterization of area as a "refuge" is more like that of a sliding scale; most areas are neither an absolute refuge nor completely exploited, but somewhere in-between. McCullough (1984) also suggested that intensity of hunting pressure, geographical isolation, and vegetation or habitat type may influence whether an area is a functional refuge. Unfortunately, no work has yet evaluated these factors quantitatively. In speculation, it seems certain that the size of a refuge influences its effectiveness in protecting deer. Certainly, the impact of one very small refuge on the local dynamics of a deer population would be limited, but research has failed to define exactly how large an area must be to act as a functional refuge. Similarly, habitat type likely influences the role of refugia in an area. For example, 2 areas of equal size, but different habitat types (e.g., woodland versus pasture), would differ in their ability to protect deer from harvest because of the amount of cover available in each area (McCullough 1984). Also, the size of a refuge could determine its ability to "protect" deer from harvest.

Finally, Root et al. (1988) found that hunting pressure (i.e., hours of human activity/hectare/day) greatly influenced deer movements. An area on which hunting is prohibited certainly would be classified as a refuge assuming other criteria were met (e.g., sufficient cover), but what about an area that is hunted only sporadically? Clearly, these are distinctions that must be made by wildlife managers in light of burgeoning deer populations and increased intolerance for deer among some stakeholder groups.

METHODS

Study Area Selection

To begin to evaluate the potential effects of refugia on deer management, I selected 2 areas in Virginia to survey, 1 each in Bedford and Frederick Counties, Virginia. Each county contains similar topology, has similar land-use patterns, and supported similar deer densities during 1995 (VDGIF, unpubl. data). I selected specific areas within each county subjectively, based on topology and land-use. Additionally, I used information from my previous survey (see Chapter 1) to identify areas within which respondents had incurred damage by deer during 1995. Once a general area was identified, I selected a point that would serve as the "center" of the study area; the center of each area was selected to incorporate a representative sampling of land-uses while not overemphasizing any one type (e.g., dense residential areas). From the center, a 3.2-kilometer-radius circle defined the boundaries of each study area. The study area in Bedford County was centered on the dam of the Bedford reservoir and located approximately 13 kilometers north-northeast of the City of Bedford, Virginia. The area was bordered to the northwest by the Peaks of Otter Recreation Area, a component of the Blue Ridge National Parkway. The study area in Frederick County was located approximately 9.5 kilometers south-southwest of the City of Winchester, Virginia. The area was located between Routes 622 (Cedar Grade Road) and 628 (Middle Road); additionally, Route 732 (Barley Lane) ran through the middle of the area. After delineating each area, I obtained information from each local tax office to identify individuals who owned 1 or more land parcels within the area. In Bedford County, this procedure yielded 29 individuals; in Frederick County, 36 individuals were identified.

To gain information about land-use and deer damage on properties within each study area during 1996, I developed a mail questionnaire and sent it to each landowner in each area during fall 1997 (see Appendix F). The questionnaire consisted of 6 questions regarding the survey subject's perceptions about deer damage, prevalent land-use on their land, and the role recreational hunting played on their lands during 1996. I didn't give participants any guidelines to use in defining the role of different land-uses on their property (e.g., I didn't define what should be considered "agricultural", "commercial", "residential", "pasture", or "woodland"; see Appendix F). To ensure that survey subjects considered only their landholdings within the study area, I included a map on the first page of the questionnaire and individually shaded landholdings in each questionnaire; respondents were asked to consider only the "shaded" property when completing the questionnaire. I numerically coded each questionnaire to facilitate the tracking of responses.

Survey subjects initially were sent a packet containing a questionnaire, a postage-paid return envelope, and a cover letter that explained the purpose of the study and the need for participant input. Two weeks later, I sent all non-respondents another questionnaire, a postage-paid return envelope, and a new cover letter. Finally, 4 weeks after the initial mailing was sent, I sent each non-respondent, via certified mail, another copy of the questionnaire, a postage-paid return envelope, and a cover letter announcing the closure of the survey and encouraging their participation.

Data Analysis

I assigned numbers to specific categorical responses and entered them into a Statistical Package for Social Sciences (SPSS 7.0) database. Because of the small number of individuals surveyed and the objectives of the survey, I did not conduct inferential tests. Rather, I calculated simple descriptive statistics such as frequencies, means, and measures of variability using SPSS protocol (SPSS, Inc. 1996a) to describe responses pertaining to landholding within each area.

Additionally, property boundary maps were digitized and converted to ArcView files. Values representing key variables (e.g., land-use, perceptions regarding damage, intensity of hunting) were assigned to each tract of land based on responses received by the owner; the resulting maps were color-coded to indicate differing values. I subjectively evaluated these data to identify possible trends and relationships between the prevalence of recreational hunting and perceptions regarding deer damage.

RESULTS

Response Rates

Among the 29 survey subjects in Bedford County, Virginia, 23 individuals returned a properly completed questionnaire and 2 were returned as undeliverable by the U.S. Postal Service. Using these figures, I calculated the adjusted response rate as 85.2%. Perhaps more importantly, responses represented 87.5% (765.9 ha) of the total land area within the site (875.2 ha). Among the 36 survey subjects in Frederick County, 30 individuals returned a properly completed questionnaire and 1 was returned as undeliverable by the U.S. Postal Service. Using these figures, I calculated the adjusted response rate as 85.7%. Again, I calculated the percentage of land accounted for by responses; responses accounted for 85.2% (938.0 ha) of the total land area (1101.6 ha).

Characterization of Study Areas

I found that the City of Bedford owned 20.2% (177.2 ha) of all lands within the Bedford County study area; in Frederick County, all lands were privately owned. Data representing lands owned by the City of Bedford were obtained via personal interview with the city planner.

Of the 765.9 ha owned by respondents in Bedford County, woodlands comprised the most total area (72.0%, 550.8 ha), followed by pastures (15.5%, 118.8 ha), agricultural uses (9.4%, 71.6 ha), residential uses (3.1%, 24.0 ha), commercial uses (0.02%, 0.2 ha), and gardens (0.007%, 0.05 ha) (Figure 76 and 77). The Frederick County study area was more agricultural than that in Bedford County. Agriculture was listed as a primary land use on 651.0 hectares (69.4%) of the 938.0 hectares owned by respondents, followed by woodlands (13.7%, 130.1 ha), pasture (13.2%, 123.9 ha), residential areas (2.8%, 26.4 ha), gardens (0.05%, 0.5 ha), and commercial uses (0.005%, 0.04 ha) (Figure 76 and 78).

In Bedford County, mean size of land ownership among respondents, excluding that owned by the City of Bedford, was 25.7 ha (n = 23, SE = 14.5). Mean size of land ownership among respondents in Frederick County was slightly larger ($\bar{x}$ = 31.3 ha, n = 30, n = 30, SE = 27.1). Among Bedford County residents, most (34.8%, n = 8) had owned their land for > 20 years; in Frederick County, more respondents had owned their land for that long (53.3%, n = 16) (Figure 79).

Perceptions Regarding Deer Damage

Among respondents from the Bedford County study area, many (43.5%, n = 10) experienced damage by deer during 1996. Overall, damage occurred on 40.7% (311.6 ha) of the land area within the study site. Of those who incurred damage, most (60.0%, n = 6) perceived the level of damage they experienced as moderate whereas few viewed the damage as low (30.0%, n = 3) or severe (10.0%, n = 1) (Figure 80). Respondents incurred damage to apple trees (n = 6), hay and alfalfa (n = 5), gardens (n = 4), ornamental plantings (n = 3), and corn (n = 1). Similarly, 40% (n = 12) of respondents in the Frederick County study area experienced damage by deer during 1996 and involved 77.7% (855.8 ha) of all land within that area. Again, most (66.7%, n = 8) of those with damage perceived it as being moderate whereas few described damage as low (8.3%,

n = 1) or severe (25.0%, *n* = 3) (Figure 81). Crops damaged in Frederick County included apples and peaches (*n* = 11), corn (*n* = 3), alfalfa (*n* = 2), ornamental plantings (*n* = 1), small grains (*n* = 1), and pumpkins (*n* = 1). Most respondents in Bedford (52.2%, *n* = 12) and Frederick (46.7%, *n* = 14) Counties believed that severity of damage by deer on their land had remained about the same since 1991 whereas few respondents in Bedford (17.4%, *n* = 4) and Frederick (16.7%, *n* = 5) Counties believed damage had increased over that 5-year period.

Role of Recreational Hunting on Respondents Land

Most respondents (65.2%, *n* = 15) in Bedford County had allowed hunting on their lands at some point during the period 1991 – 1995; in Frederick County 53.3% (*n* = 16) allowed hunting on their lands during the same period. During 1996, 56.5% (*n* = 13) of private landowners in Bedford County allowed hunting on their land during 1996; in Frederick County, 56.7% (*n* = 17) did so (Figures 82 and 83). Additionally, the City of Bedford traditionally has prohibited hunting city property within the study area. Thus, 55.7% (426.3 ha) of land area within the Bedford County study area made available for deer hunting during 1996. In contrast, hunting was allowed on 97.4% (913.7 ha) in Frederick County. In Bedford County, if I assumed that lands owned by non-respondents were hunted during 1996, hunted lands would have accounted for 61.3% (536.2 ha) of all lands in the area; if I assumed that lands owned by non-respondents were not hunted during 1996, hunted lands accounted for only 48.7% (426.3 ha) of all lands within the area. In Frederick County, 97.8% (1,076.9 ha) of all lands would have been hunted if I assumed that lands owned by non-respondents were hunted on; if I assumed they were not hunted, 82.9% (913.7 ha) of all lands in the area would have been hunted during 1996.

In Bedford County, the mean number of deer harvested on respondents' land who allowed hunting during 1996 was 3.8 deer (*n* = 13, SE = 0.8; Figure 81); this equates to a mean of 16.9 (*n* = 13, SE = 5.6) deer harvested/km^2. Overall, 50 deer were harvested on respondents' lands in Bedford County during 1996. Among individuals in Frederick County who allowed hunting during 1996, the mean number of deer harvested on a respondent's land was 2.9 deer (*n* = 17, SE = 0.9; Figure 82) and the mean number of deer harvested/km^2 was 10.2 (*n* = 17, SE = 5.7). Again, hunters harvested 50 deer on respondents' land in Frederick County during 1996. Considering all lands represented by responses, hunters in Bedford County removed more animals/unit area than did hunters in Frederick County (5.7 deer/km^2 versus 4.5 deer/km^2, respectively).

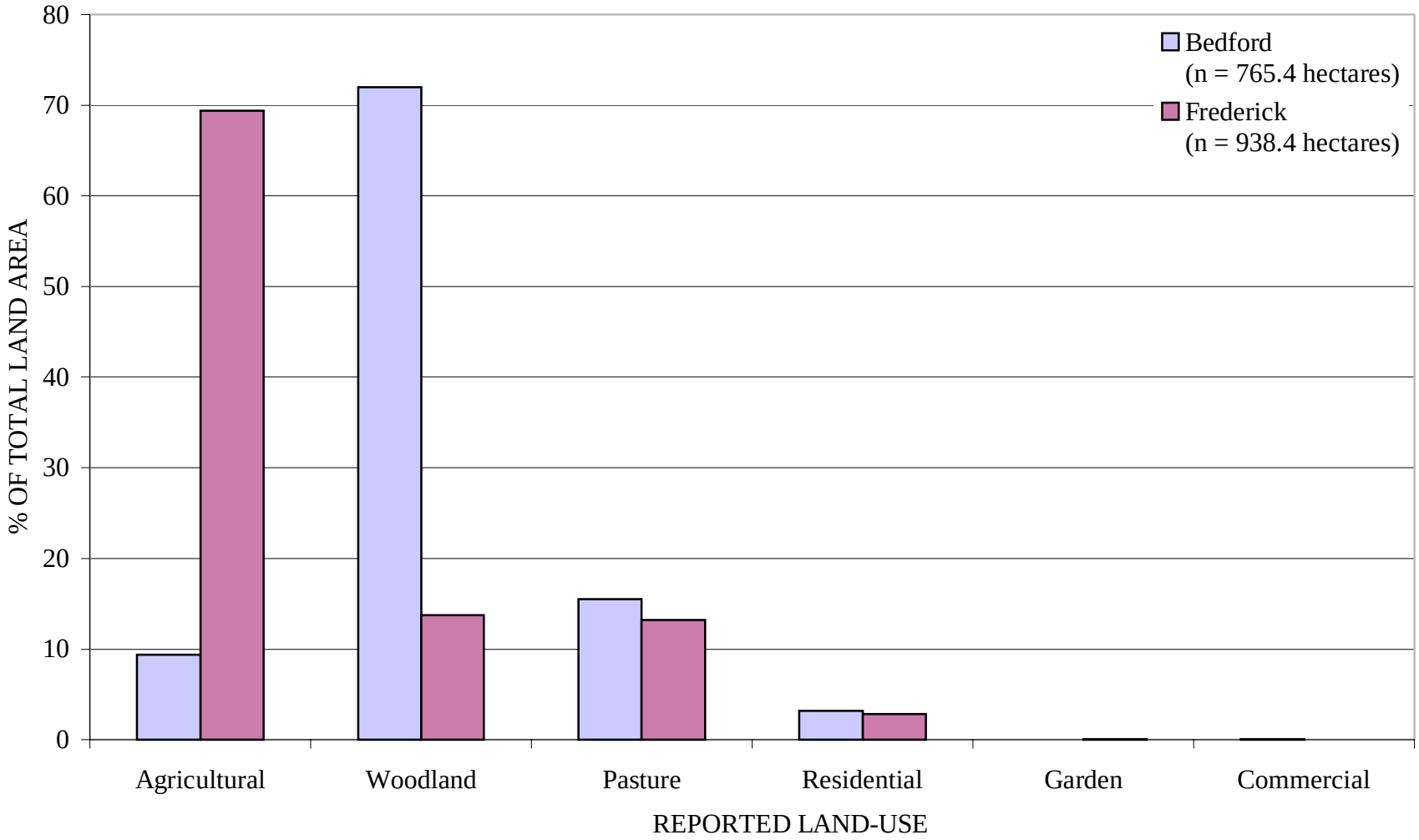

Figure 76. Land-uses within survey areas, expressed as the percentage of total land area as reported by respondents in Bedford and Frederick Counties, Virginia, during 1996.

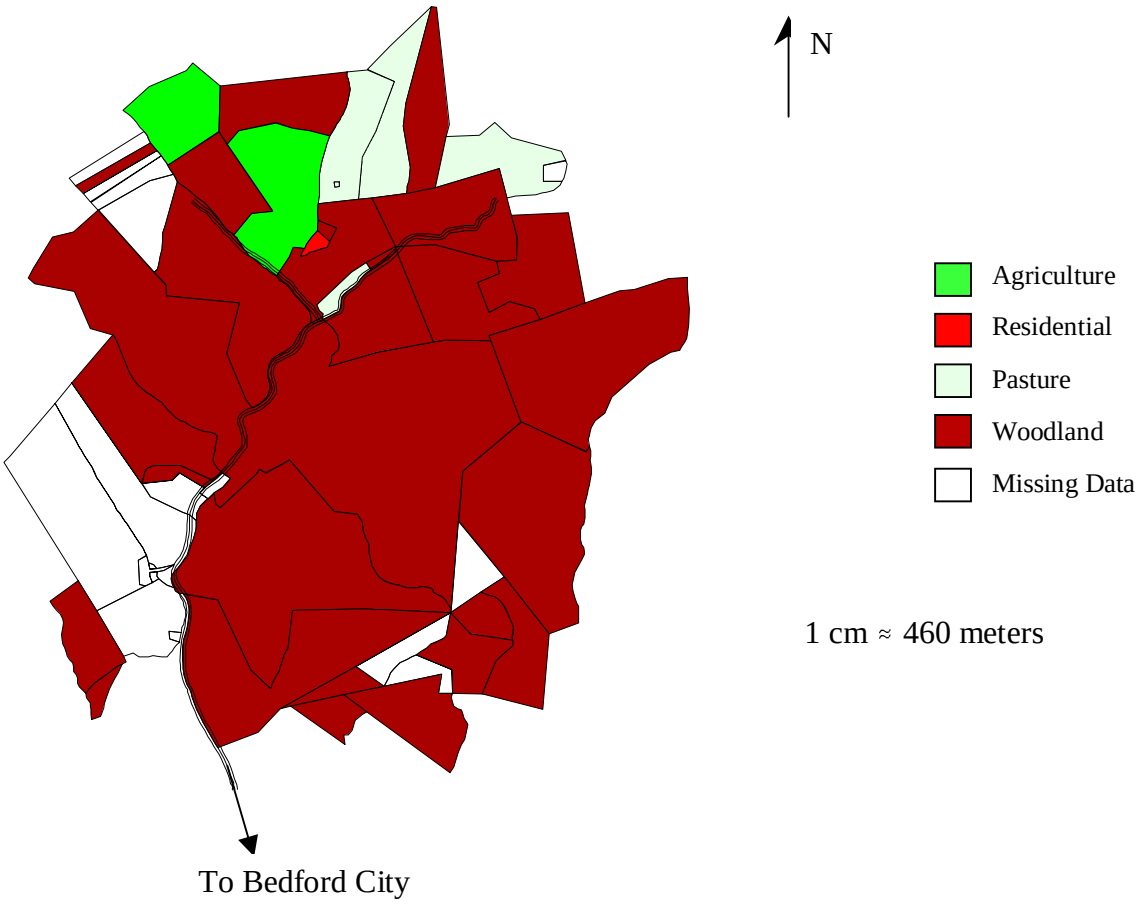

Figure 77. Predominant land-uses during 1996 in the Bedford County, Virginia, study area as reported by respondents to a survey on deer damage.

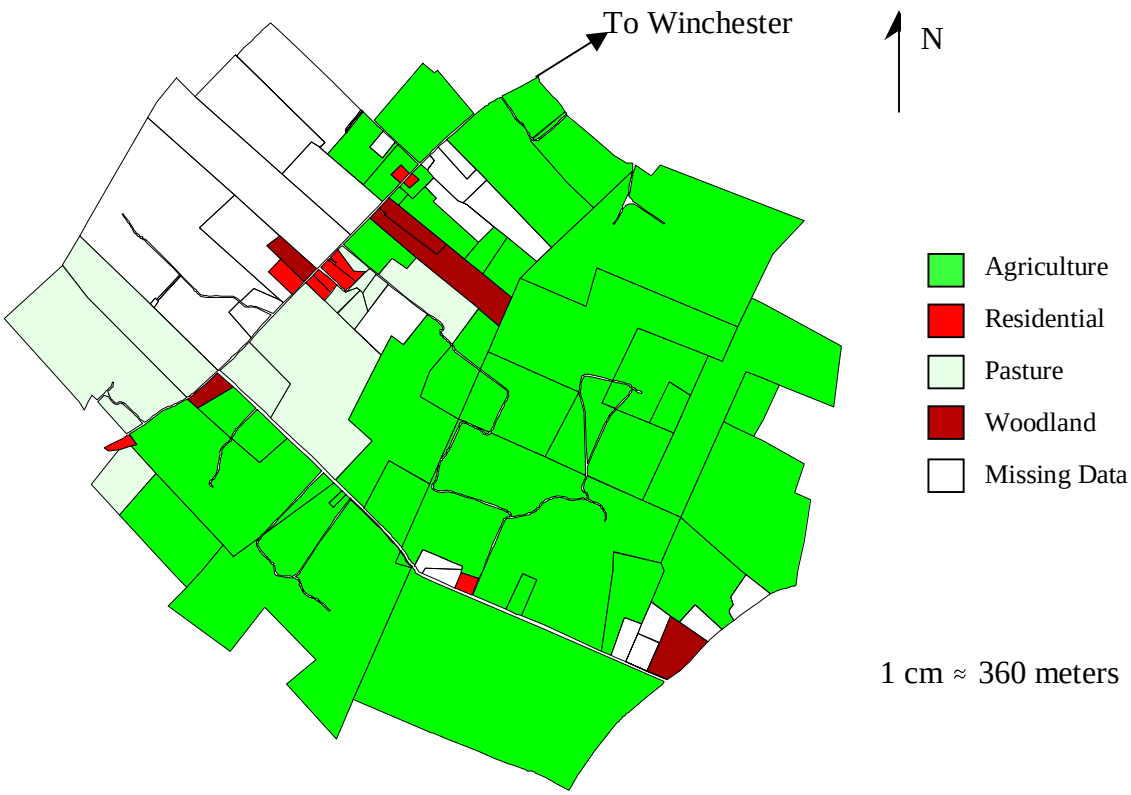

Figure 78. Predominant land-uses during 1996 in the Frederick County, Virginia, study area as reported by respondents to a survey on deer damage.

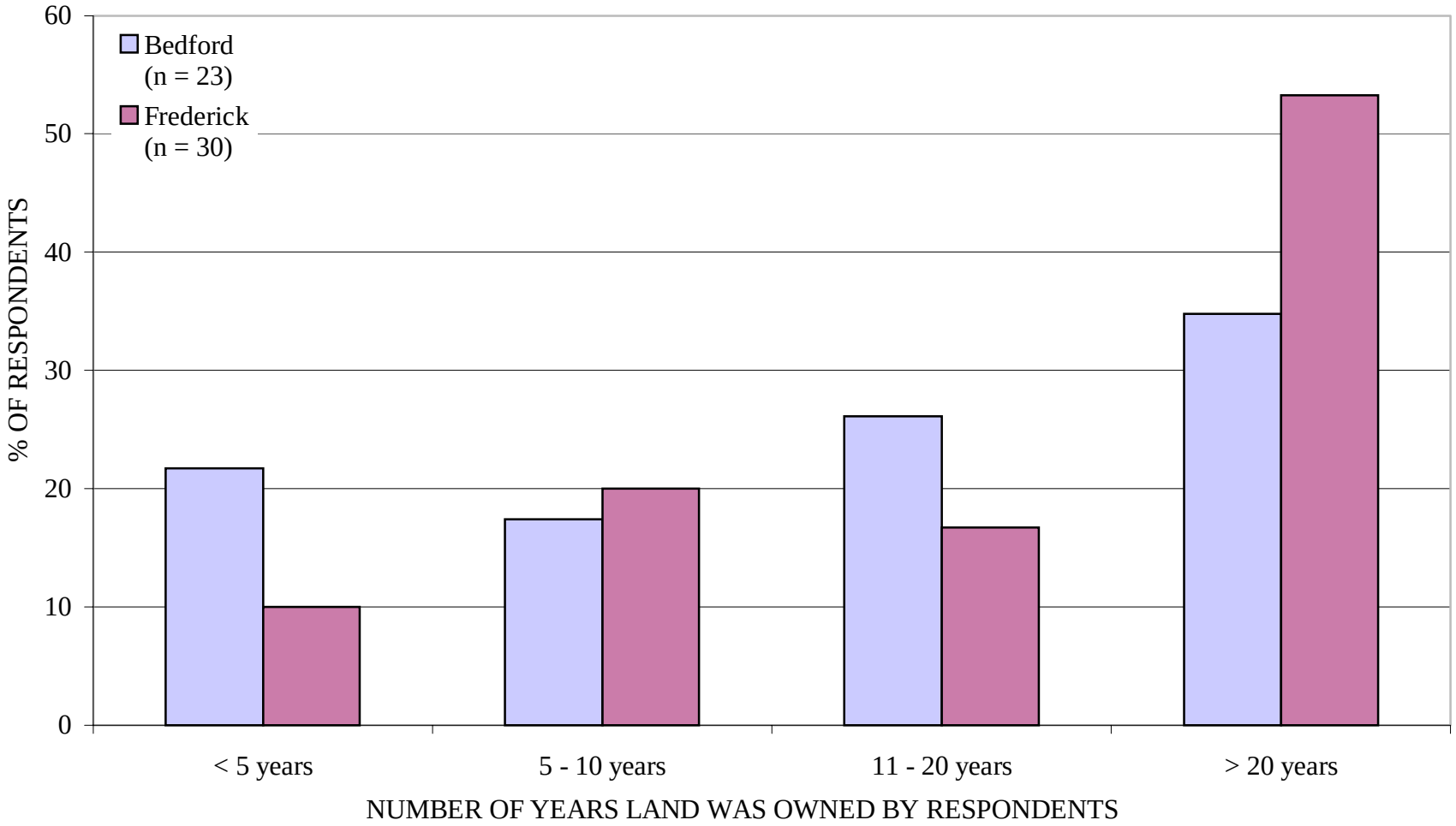

Figure 79. Tenure of land ownership among respondents from within Bedford and Frederick County study areas, Virginia, as of 1996.

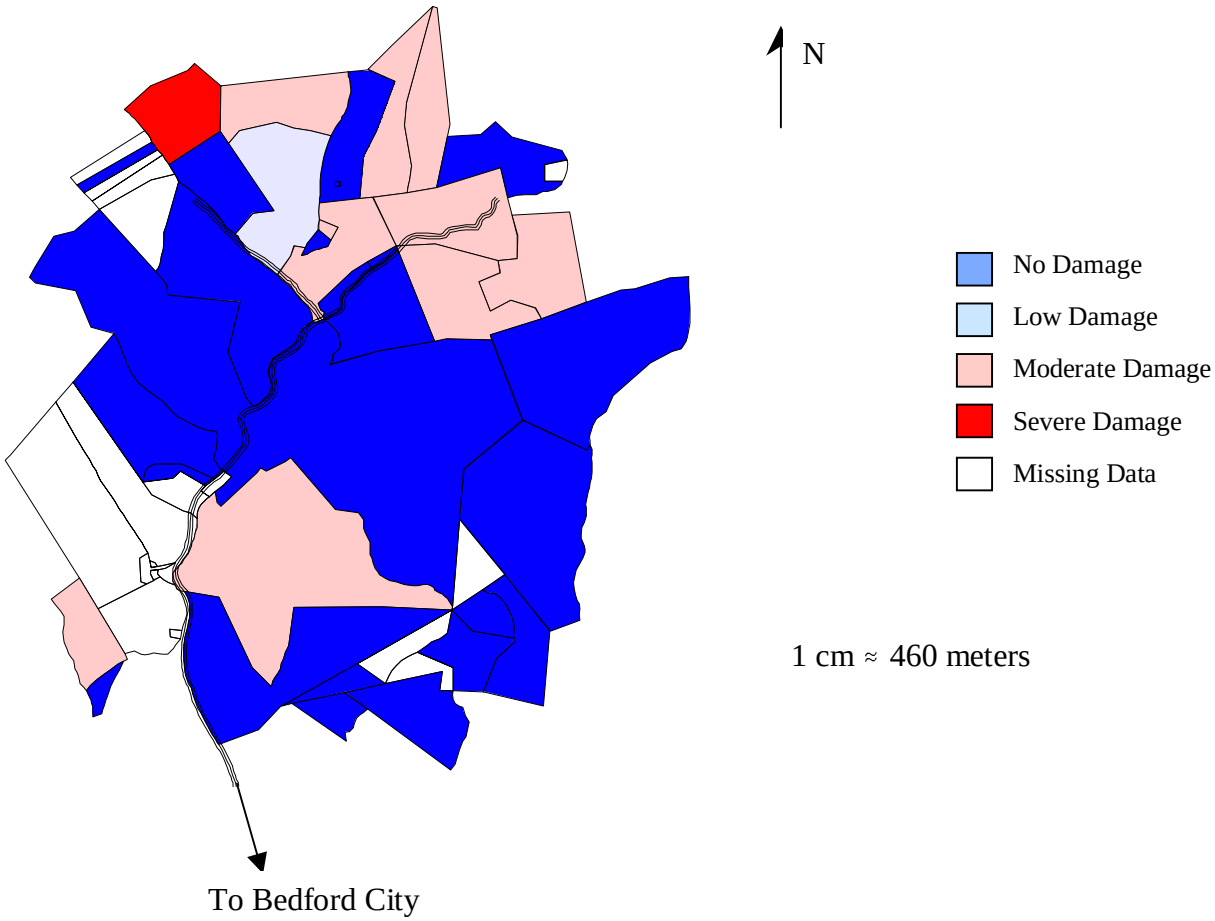

Figure 80. Perceptions regarding the occurrence and severity of deer damage during 1996 among landowners in the Bedford County, Virginia, study area.

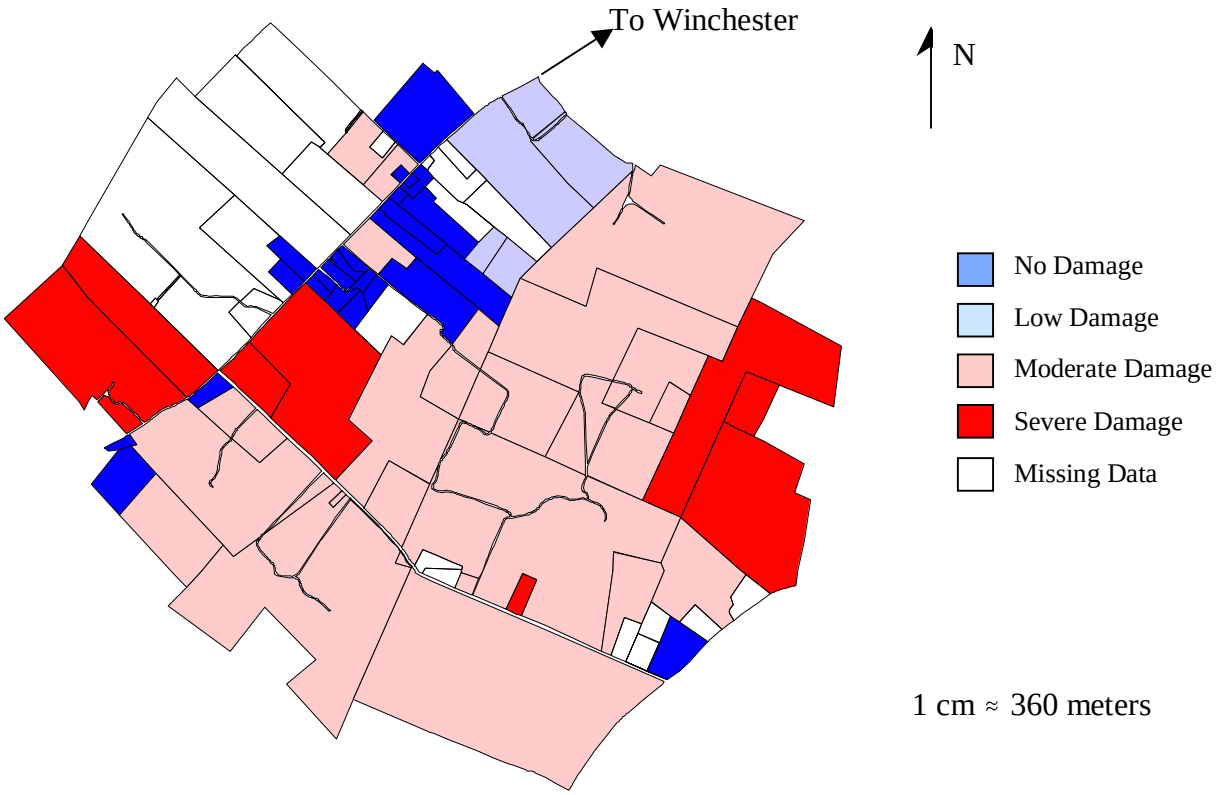

Figure 81. Perceptions regarding the occurrence and severity of deer damage during 1996 among landowners in the Frederick County, Virginia, study area.

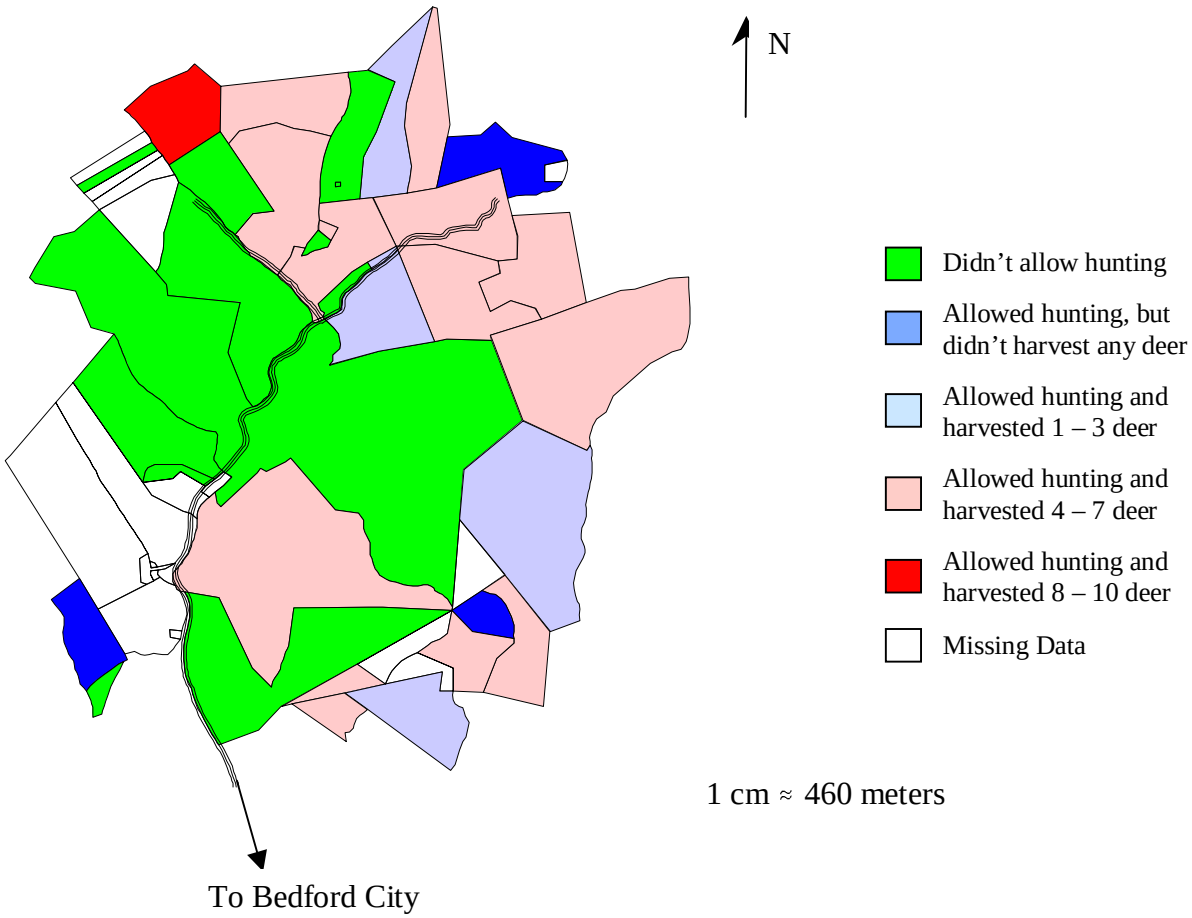

Figure 82. The allowance of hunting and number of deer harvested during 1996 on lands owned by respondents within the Bedford County, Virginia, study area.

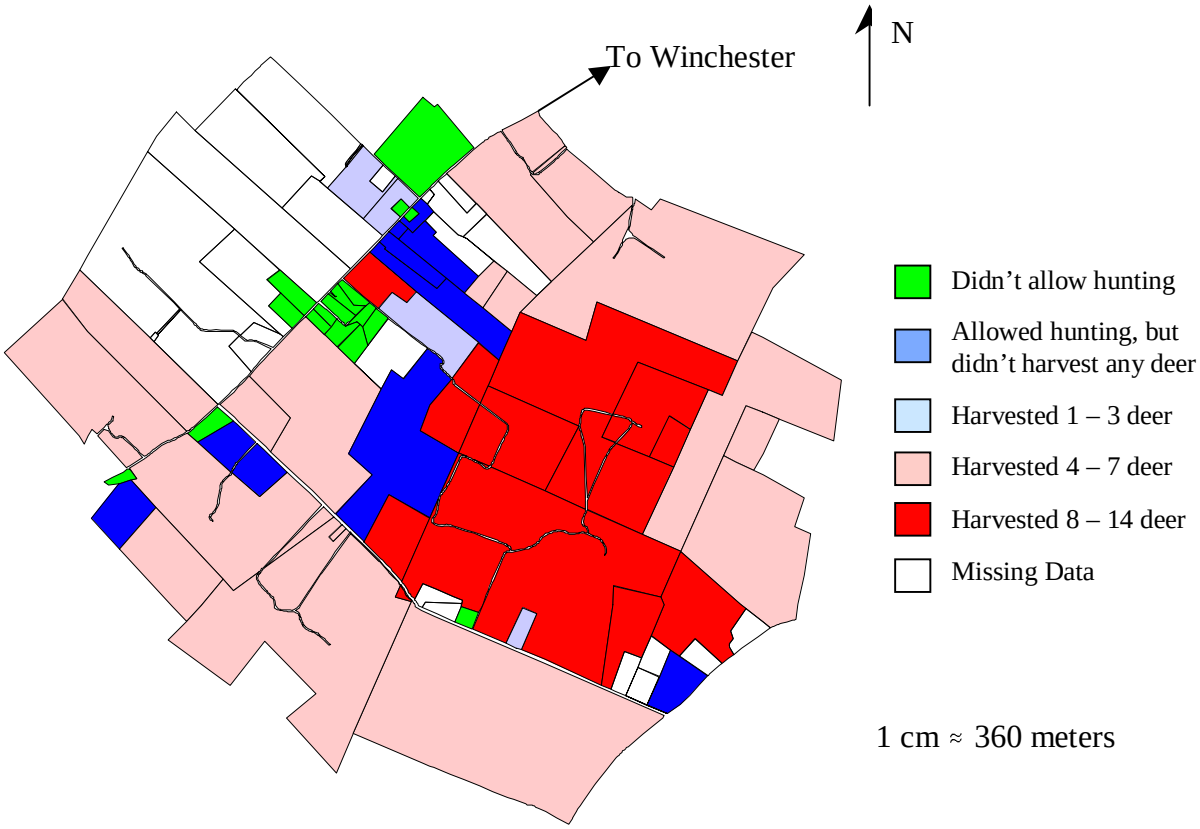

Figure 83. The allowance of hunting and number of deer harvested during 1996 on lands owned by respondents within the Frederick County, Virginia, study area.

DISCUSSION

The response rates I obtained were greater than the minimum response rate (65%) necessary to avoid non-response bias, as suggested by Dolsen and Machilis (1991). More importantly, responses accounted for a high percentage of the total land area at each site. Thus, I assumed the effects of non-response bias on data interpretation were negligible.

Because this effort was designed simply as a pilot study, I did not anticipate the results would allow me to make definitive conclusions regarding the relationships between deer damage, land-use, and recreational hunting. However, the results do provide a foundation for future studies and emphasize the importance of spatial variation when formulating deer management strategies.

These results confirm observations made by Campa et al. (1997) that great variation in the extent and severity of deer damage may exist in local areas. In both counties, adjoining landowners often displayed differing perceptions about the occurrence and severity of deer damage. Land-use seems to partially explain this disparity; landowners who owned land with some agricultural use were much more likely to report damage. Additionally, local habitat characteristics (e.g., amount of cover around the crop field) and prior experiences with deer-related conflicts likely contributed to these differences as well.

One of the most obvious relationships I observed was the strong relationship between land-use and the occurrence of deer damage. Although damage occurred on a much greater percentage of lands within the Frederick County site than in Bedford County, this relationship appeared to be driven by land-uses in each area; in each county, deer damage occurred on nearly all lands that were predominated by or included some agriculture. Agricultural uses were more dominant in Frederick County that in Bedford County, hence, a greater opportunity of damage to occur existed within the Frederick County site. Further, damage was perceived as being more severe on agricultural properties.

Respondents to this survey were less likely to incur damage and characterized damage as less severe than that reported by respondents to my previous survey (see Chapter 1). However, the sampling design of my first survey targeted individuals who were know to be either agricultural producers or homeowners who actively engaged in gardening or landscaping; the latter did not target these individuals specifically. Given the strong relationship between land-use and perceptions regarding damage, it seems that producers within the Bedford and Frederick County sites reported damage at a similar rate as that observed in the first study.

Recreational hunting was prominent in both areas. During 1996, county-wide averages for the number of deer harvested/km^2 in Bedford County was 3.1; in Frederick County, the mean number of deer harvested/km^2 was 3.6 (VDGIF, unpubl. data). In comparison, hunters in each study area harvested more deer/km^2 than the mean harvest for each county. Thus, hunting pressure within each study area was relatively high.

Relationships between hunting pressure and perceptions regarding deer damage were difficult to identify. However, it seems that a high harvest rate failed to reduce damage to acceptable levels on some respondents' lands in both study areas. In Bedford County, those who perceived the greatest damage also reported harvesting the greatest number of deer during 1996. A similar

trend appeared in Frederick County; those with the greatest damage reported harvesting more deer from their lands. This supports my findings in Chapter 1 that hunting pressure was correlated with the severity of damage experienced, but the cause of this relationship is not clear. It would appear that those with increasingly severe damage have attempted to cope with it via increased hunting pressure.

The success of a lethal-removal strategy in controlling deer damage to control deer damage is influenced by several factors, but primarily by the initiative of the landowner (Horton and Craven 1997). In this study, the high harvest rates suggest that individual landowner initiative was high. Although Vercauteren and Hygnstrom (1998) concluded that deer causing damage on a property are available for harvest regardless of the presence of hunting on surrounding lands, Erickson and Geissman (1989) found that a localized lethal harvest program was ineffective in controlling deer damage. Unfortunately, Erickson and Geissman (1989) failed to interpret the impacts of surrounding lands that were not enrolled in the program and on which deer had not been removed. It is unclear whether refugia in the Bedford or Frederick County study areas protected a proportion of the deer population in each respective area as McCullough (1984) suggested could occur. However, given the strong presence of hunting within the Frederick County site, local refugia were rare and probably affected deer population dynamics negligibly. In contrast, hunting was prohibited on much of the total land area within the Bedford County study area and this presence of refugia may have negatively impacted landowner efforts to control deer damage via lethal methods.

Despite the higher harvest rate in Bedford County, a higher proportion of lands were available for hunting in Frederick County during 1996. This primarily is due to the large tract of land owned by the City of Bedford, which was closed to recreational hunting during 1996. Had this land been accessible to hunters, the amount of land available for hunting in Bedford County would have equaled that in Frederick County. Regardless, the amount and type (e.g., habitat type) of unhunted land in Bedford County would seem sufficient to serve as refugia for the local deer population. In Frederick County, the presence of refugia seemed less influential; a vast majority of the lands within the study area were hunted during 1996. Additionally, lands adjacent to the study areas may not have been hunted during 1996 and lessened the impacts of hunting within the area, particularly on lands located in the periphery of the study area. In Bedford County, the adjoining Peaks of Otter Recreational Area potentially provides a massive amount of refuge habitat to the local deer population; in Frederick County, residential areas that bordered the study area could theoretically do the same.

Hansen et al. (1997) suggested that in areas with $\geq$ 5% permanent cover (e.g., woodland), refuges can have detrimental effects on efforts to stabilize or reduce deer populations. Under these criteria, refuge habitats certainly had the potential to negatively affect landowner efforts to control damage via recreational hunting in each area, but particularly in Bedford County. The fact that landowners who reported severe damage in Bedford County also harvested high numbers of deer from their land reaffirms Hansen et al.'s (1997) statements.

In conclusion, these results should be interpreted only as preliminary observations. Despite the limits of this study, it does suggest directions in research and management that should be considered in light of increasing intolerance for deer among stakeholder groups. Specifically, additional research should be accomplished to identify factors that may influence the ability of

an area to protect deer from harvest. Although some work has been done to evaluate deer use of refugia when confronted with hunting pressure, little has been done to define the factors that may determine whether an area functionally serves as a refuge.

Sufficient evidence exists to suggest, at least in some situations, that the presence of local refugia in an area can limit a landowner's ability to control deer damage via recreational hunting. Determining the mechanisms behind this relationship will be of paramount importance in determining future management strategies. If refuge habitats are used by deer during the hunting season, kill permits used throughout the year may be valuable in reducing local deer populations (Horton and Craven 1997). Assuming this hypothesis is correct, the kill permit program (see Appendix E) may be useful in allowing landowners to manage deer damage throughout the year. In contrast, if refuge habitats act as a "source" from which deer disperse onto hunted lands, increased hunting efforts on hunted lands may not achieve desired results (Pulliam 1988); in this event, the only viable option may be to develop cooperative partnerships among adjoining landowners to collectively determine deer management goals and adjust harvest strategies accordingly (Coffey and Johnston 1997). The deer management assistance program (DMAP; see Appendix E) may be an important tool to achieve these objectives.

Despite the uncertainties that exist regarding the use of refugia by deer populations, deer managers should be aware of the potential impact of these habitats on deer management efforts. In each study area, removing deer appeared ineffective in reducing damage to a level acceptable to the landowner; this is in direct opposition to traditional concepts of deer management. If the amount of land available for hunting and the number of hunters statewide continues to decline, deer managers may find it difficult to stabilize burgeoning deer populations via traditional methods. In light of the intolerance for deer displayed by respondents (see Chapter 1), the inclusion of the potential effects of refugia into management strategies may be integral to the success of continued deer management.

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APPENDICES

Appendix A. The questionnaire sent survey subjects in Virginia to assess deer damage during 1995.

A Study of Deer Damage during 1995 in Virginia

Virginia Cooperative Extension
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

HOW DO YOU DESCRIBE YOURSELF?

Q-1 The first step in completing this survey is to select one of two categories, either **"Producer of Agricultural Commodities"** or **"Homeowner/Hobbyist."** Check the box next to the category that best describes your activities **in 1995**.

☐ **PRODUCER OF AGRICULTURAL COMMODITIES**

Greater than $1,000/yr. income from your operation

☐ **HOMEOWNER/HOBBYIST**

Do not sell plantings or less than $1,000/yr. from sales

Q-2 Under each category below, you will find a list of crops and plantings. Within the category that you selected in Q-1 above, please identify what you consider to be the **two** most important individual crops/plantings you raised or produced in 1995 by putting a **"1" next to your primary crop/planting** and a **"2" next to your secondary crop/planting**. For example, if you consider yourself a commodity producer and you raised primarily soybeans and secondarily wheat in 1995, you would place a "1" next to soybeans and a "2" next to wheat. From this point on in the survey, soybeans will be referred to as your primary planting and wheat will be referred to as your secondary planting. If you only produced or grew one crop/planting in 1995, identify it as your primary planting with a "1" and ignore any references to secondary plantings for the remainder of the survey.

Producer of Agricultural Commodities

Grains
____Barley
____Corn
____Oats
____Sorghum
____Wheat

Fruits
Tree Fruits
____Apples
____Peaches
____Cherries
____Pears
Shrub/Bed Fruits
____Blueberries
____Brambles
____Strawberries

Nursery
____Trees
____Shrubs
____Bedding Plants
____Sod

Vegetables
____Tomatoes
____Sweet Corn
____Potatoes
____Sweet Potatoes

Forage
____Corn (silage)
____Alfalfa Hay
____Other Hay

Miscellaneous Crops
____Cotton
____Christmas Trees
____Soybeans
____Peanuts
____Pumpkins
____Melons

Tobacco
____Flue-cured
____Burley

Other Agricultural Commodities (please specify)
____ _____
____ _____

Homeowner/Hobbyist

Fruit
Tree Fruit
____Apples
____Peaches
____Cherries
____Pears
____Shrub Fruits
____Bedding Fruits

Woody Ornamental/Landscaping
____Trees
____Shrubs
____Groundcover Plants

Vegetable Garden
____Personal Vegetables

Flower Beds
____Perennial Flowers
____Annual Flowers

Other Plantings (please specify)
____ _____
____ _____

Q-3 Depending upon which category you checked in Q-1 above, answer only one of the questions below.

If you checked **"Producer of Agricultural Commodities"**, please indicate if you consider yourself a full-time or part-time producer and then provide the amount of land (in acres) you had in production for your primary and secondary plantings in 1995.

☐ Part-time producer

☐ Full-time producer (at least 1 full-time operator employed, including yourself)

	Approximate total acreage
Primary	_____
Secondary	_____

If you checked **"Homeowner/Hobbyist"**, please indicate the amount of land (square footage) used for production OR the number of plants you grew for your primary and secondary plantings in 1995.

	Approximate square feet	OR	Total # of Plants
Primary	_____		_____
Secondary	_____		_____

Q-4 How many years have you produced/grown your primary and secondary plantings? (Please provide the appropriate number of years in each space provided)

	No. of years you have produced your primary and secondary plantings
Primary	_____
Secondary	_____

Q-5 Depending upon which category you selected in Q-1 above, answer only one of the questions below.

If you checked **"Producer of Agricultural Commodities"**, please indicate the Virginia county(s) where your primary and secondary planting were in 1995. (Write in the county of production for each of your plantings in the space provided)

County(s) of Production

Primary	Secondary
_____	_____
_____	_____
_____	_____
_____	_____

If you checked **"Homeowner/Hobbyist"**, please indicate the Virginia county or city that you lived in during 1995. (Identify if you lived in a county or city in 1995 by checking the appropriate answer. Then write the name of the county or city in the space provided)

County ☐

City ☐

County or City of Residence in 1995

_____

DEER DAMAGE TO YOUR PRIMARY AND SECONDARY PLANTINGS

Q-6 During 1995, did white-tailed deer cause any damage to your primary and/or secondary plantings?

No ☐ (if no, please go to Q-15)

Yes ☐

Q-7 Listed below are some methods used to determine that damage to plantings is caused by deer. Please rank these methods in order of importance (1=Most Important, 5= Least Important) based upon how you determined that the damage to your primary and secondary plantings in 1995 was caused by deer. If you did not use a method listed below in 1995, leave the space next to that item blank.

	Primary	Secondary
Saw deer causing damage	_____	_____
On-site evidence (e.g., tracks, feces)	_____	_____
Way in which commodity was damaged	_____	_____
Advice from neighbors or friends	_____	_____
Advice from professionals	_____	_____
Other (Please specify)_____	_____	_____

Q-8 For the primary and secondary plantings that you produced/grew in 1995, during which month(s) did damage by deer occur? (Please circle the month(s) in which deer damage occurred)

	Months in which damage occurred											
Primary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Secondary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Q-9 Of the months that you circled in Q-8 above, during which one month would you consider damage by deer was most severe? (Write the one month in which damage was most severe for each of your primary and secondary plantings)

	Month in which deer damage was most severe
Primary	_____
Secondary	_____

Q-10 During the month(s) that you indicated in Q-9, did the damage to your primary and secondary plantings occur mainly because of foraging/feeding by deer or because of antler rubbing? (Check one response for your primary and one for your secondary plantings)

	Primary	Secondary
Foraging/feeding	☐	☐
Antler rubbing	☐	☐

Q-11 In 1995, how would you rate the severity of damage to your primary and secondary plantings? (Check one response for each planting)

	Severity of damage in 1995				
	No Damage	Low	Moderate	Severe	No Opinion
Primary	☐	☐	☐	☐	☐
Secondary	☐	☐	☐	☐	☐

Q-12 Depending upon the category you checked in Q-1 at the beginning of the survey, answer one of the questions below:

If you checked **"Producer of Agricultural Products"**, are you able to estimate the reduction in yield OR the number of plants lost or affected as a result of deer damage in 1995? (Check the appropriate response)

No ☐ (if no, go to Q-13)

Yes ☐

If you checked **"Homeowner/Hobbyist"**, are you able to estimate the % of plants affected or lost as a result of deer damage in 1995? (Check the appropriate response)

No ☐ (if no, go to Q-13)

Yes ☐

→ If yes, please provide your best estimate of the loss you experienced because of deer damage in 1995. (Provide the appropriate response in the space provided)

	Producer of Ag. Commodities			**Homeowner/Hobbyist**
	% yield loss	OR	% plants lost or affected	% plants lost or affected
Primary	_____		_____	_____
Secondary	_____		_____	_____

Q-13 Depending upon the category you checked in Q-1 at the beginning of the survey, answer one of the questions below.

If you checked **"Producer of Agricultural Products"**, can you estimate the economic loss in dollars of the of damage by deer to your primary and secondary plantings during 1995? (Check the appropriate response)

No ☐ (if no, go to Q-14)

Yes ☐

If you checked **"Homeowner/Hobbyist"**, can you estimate the monetary value (cost required to replace) of those plants affected by or lost because of deer damage in 1995? (Check the appropriate response)

No ☐ (if no, go to Q-14)

Yes ☐

→ If yes, please provide your best estimate for the economic loss you experienced because of deer damage in 1995 for each of your plantings. (Indicate the economic loss in dollars because of deer damage in the space provided)

	Producer of Ag. Commodities	**Homeowner/Hobbyist**
	Economic loss in dollars	Cost to replace affected or lost plants
Primary	_____	_____
Secondary	_____	_____

Q-14 How would you describe the damage to your primary and secondary plantings in 1995? (Please check the appropriate response for your primary and secondary plantings)

	Opinion of Deer Damage to Your Plantings in 1995			
	Negligible	Significant but Tolerable	Intolerable	No Opinion
Primary	☐	☐	☐	☐
Secondary	☐	☐	☐	☐

Q-15 How much deer damage to your primary and secondary plantings would you be willing to tolerate in the future? (Check the appropriate level of tolerance for your primary and secondary plantings)

	Damage Tolerated in the Future				
	No damage	Limited damage	Moderate damage	Severe damage	No Opinion
Primary	☐	☐	☐	☐	☐
Secondary	☐	☐	☐	☐	☐

Q-16 How would you compare the damage to your primary and secondary plantings **in 1995** with that experienced in the last 5 years (1990-1994)? (Check one response for your primary and one for your secondary plantings)

	Primary	Secondary
Much higher in 1995 than in the last five years	☐	☐
A little higher in 1995 than in the last five years	☐	☐
About the same in 1995 as in the last five years	☐	☐
A little less in 1995 than in the last five years	☐	☐
Much less in 1995 than in the last five years	☐	☐
Don't Know	☐	☐

Q-17 Based upon your personal knowledge of deer damage, what is your opinion of the severity of deer damage to others in your County or City of residence who produce the same plantings that you designated as your primary and secondary plantings? (Check only one response for each of your plantings)

	Severity of damage				
	No Damage	Low	Moderate	Severe	No Opinion
Primary	☐	☐	☐	☐	☐
Secondary	☐	☐	☐	☐	☐

Q-18 How much would you be willing to pay each year for deer damage control or prevention? (Check the only one response for your primary and secondary planting)

	Nothing	A Small Amount	A Moderate Amount	Whatever it takes
Primary	☐	☐	☐	☐
Secondary	☐	☐	☐	☐

Q-19 During 1995, did you use any methods to try to prevent deer from causing damage to your primary or secondary plantings?

No ☐ (if no, go to Q-20)

Yes ☐

→If yes, what method(s) did you use to protect your primary and secondary plantings in 1995 and how would you rate their effectiveness? (Using the Key of Effectiveness provided below, write the letter for the appropriate level of effectiveness beside each preventive measure that you used in 1995 for your primary and secondary plantings. Leave the spaces blank beside each method that you did not use in 1995)

KEY OF EFFECTIVENESS

Problem completely eliminated	A
Successful but not eliminated	B
Limited success	C
No effect	D

EXAMPLE

Let's say that in 1995 you used permanent electric fencing and temporary non-electric fencing to protect your primary planting. You consider the permanent electric fencing completely effective and the non-electric fencing to have no effect. Also, you used permanent electric fencing for your secondary planting in 1995 and consider it to be successful but did not eliminate the problem.. Thus, you would fill in the blanks as follows:

	Primary	Secondary
permanent, electric	____	____
temporary, non-electric	____	____

	Primary	Secondary
FRIGHTENING		
Ultrasound/ultrasonic devices	____	____
Shot blanks	____	____
Pyrotechnics (like firecrackers)	____	____
Played radio	____	____
Propane/Gas exploder	____	____
Shouted	____	____
Flashing lights	____	____

(Q-19 continued)

Scarecrow	____	____
Other (specify)	____	____
_____	____	____
DOGS		
Dogs inside Invisible Fence® or other similar product	____	____
Tethered dogs	____	____
Free roaming dogs	____	____
FENCING		
Permanent, non-electric	____	____
Permanent, electric	____	____
Temporary, non-electric	____	____
Temporary, electric	____	____
REPELLENTS AND PHYSICAL DETERRENTS		
Deer-Away®	____	____
Hinder®	____	____
Thiram	____	____
Miller's Hot Sauce®	____	____
Tankage (putrefied meat scraps)	____	____
Ro-pel®	____	____
Human Hair Bags	____	____
Bar Soap	____	____
Leader caps	____	____
Tube protectors	____	____
Other (specify) _____	____	____
REMOVAL BY SHOOTING	____	____

HUNTING ON YOUR PROPERTY

In answering Q-20 through Q-25, consider only the land that you used to produce/grow your primary and secondary plantings in 1995.

Q-20 Did you or other family members hunt deer on the land used to grow/produce your primary and secondary plantings in 1995?

No ☐ (if no, go to Q-21)

Yes ☐

→If yes, please indicate the approximate number of man-days (1 individual hunting 8 hours = 1 man-day) that you or other family members spent deer hunting on these lands in 1995.

Man-days you or other family members spent hunting deer in 1995 _____

Q-21 In the past five years (1990-1994), have you or other family members hunted deer on the land used to grow/produce your primary and secondary plantings in 1995?

No ☐ (if no, go to Q-22)

Yes ☐

→If yes, would you indicate which of the following years you or other family members deer hunted on these lands? (Circle all that apply.)

1990 1991 1992 1993 1994

Q-22 During 1995, did you allow others (non-family) to hunt deer on your property on the land used to grow/produce your primary and secondary plantings in 1995?

No ☐ (if no, go to Q-23)

Yes ☐

→If yes, please provide the approximate number of man-days (1 individual hunting 8 hours = 1 man-day) that others (non-family) spent hunting deer on these lands during 1995.

Man-days others (non-family) spent hunting deer on these lands in 1995 _____

Q-23 In the past 5 years (1990-1994), have you allowed others (non-family) to hunt deer on on the land used to grow/produce your primary and secondary plantings in 1995?

No ☐ (if no, go to Q-24)

Yes ☐

→If yes, please identify the years in which you allowed others (non-family) to hunt deer on these lands? (Please circle all that apply)

1990 1991 1992 1993 1994

Q-24 Do you know how many different landholdings border the land used to grow/produce your primary and secondary plantings in 1995?

No ☐ (if no, go to Q-26)

Yes ☐

→If yes, please indicate the number of different landholdings that border these lands?

Number of landholdings that border these lands_____

Q-25 Of the landholdings that border the land used to grow/produce your primary and secondary plantings in 1995, do you know how many have been open to hunting or have been hunted on for deer in the last five years (1990-1994)?

No ☐ (if no, go to Q-26)

Yes ☐

→If yes, please indicate how many of the landholdings that border your property have been open to hunting or have been hunted on for deer in the last five years (by you or others).

Number of bordering landholdings open for hunting or hunted on in last five years_____

DEER MANAGEMENT PROGRAMS IN VIRGINIA

Q-26 In 1995, did you participate in any deer management or deer damage control programs administered by the Virginia Department of Game and Inland Fisheries?

No ☐ (if no, go to Q-30)

Yes ☐

Q-27 Which programs did you participate in during 1995? (Check all programs you participated in during 1995)

Damage Control Assistance Program (DCAP) ☐

Deer Management Assistance Program (DMAP) ☐

Kill Permit Program ☐

Q-28 Of the deer management or deer damage programs that you participated in during 1995, how satisfied were you with the program? (Check level of satisfaction for each program you participated in during 1995)

	Level of Satisfaction			
	Completely Satisfied	Moderately Satisfied	Not Satisfied At All	No Opinion
Damage Control Assistance Program (DCAP)	☐	☐	☐	☐
Deer Management Assistance Program (DMAP)	☐	☐	☐	☐
Kill Permit Program	☐	☐	☐	☐

Q-29 If you were not satisfied with any of the deer management or deer damage control programs that you participated in during 1995, please briefly indicate why you were not satisfied and give suggestions on how the program might be improved.

_____

_____

_____

_____

Q-30-32 Based upon your personal opinion, please indicate whether you strongly agree, agree, disagree, strongly disagree, or have no opinion of the following statements. (Check <u>one</u> response for each statement)

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Q-30 Hunters should pay a fee to compensate those affected by deer damage	☐	☐	☐	☐	☐
Q-31 Those affected by deer damage should be compensated with general state funds	☐	☐	☐	☐	☐
Q-32 Those affected by deer damage should not be compensated at all	☐	☐	☐	☐	☐

Q-33-40 Listed below are different options to manage deer populations. Please indicate if you strongly agree, agree, disagree, strongly disagree, or have no opinion of using the following options to manage the deer population in Virginia. (Check one response for each statement)

		Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Q-33	Recreational Hunting	☐	☐	☐	☐	☐
Q-34	Allow nature to take its course	☐	☐	☐	☐	☐
Q-35	Birth control/contraception	☐	☐	☐	☐	☐
Q-36	Introduce predators	☐	☐	☐	☐	☐
Q-37	Trap and relocate	☐	☐	☐	☐	☐
Q-38	Professional sharpshooters	☐	☐	☐	☐	☐
Q-39	Supplemental feeding	☐	☐	☐	☐	☐
Q-40	Fencing and repellents to manage conflicts	☐	☐	☐	☐	☐

DEER AND VEHICLE COLLISIONS

Q-41 During 1995, did you experience a collision with a deer while driving your vehicle?

No ☐ (if no, go to Q-49)

Yes ☐

Q-42 During 1995, did you experience more than one collision with deer while driving your vehicle?

No ☐ (if no, go to Q-43)

Yes ☐

→If yes, please indicate the number of collisions you had with deer while driving your vehicle during 1995.

Number of collisions with deer during 1995_____

If you experienced more than one collision with a deer while driving your vehicle during 1995, consider only the first collision you experienced when answering Q-43 through Q-48.

Q-43 During which month did you experience the collision with a deer during 1995?

Month during which the collision occurred

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Q-44 Did the collision cause physical damage to your vehicle?

No ☐ (if no, go to 46)

Yes ☐

Q-45 Whether or not you repaired the vehicle, can you estimate the cost that would have been required to repair the damage to your vehicle that resulted from the deer collision?

No ☐ (if no, go to Q-46)

Yes ☐

→ If yes, would you please indicate the actual or estimated cost of repairing your vehicle as a result of the deer collision?

Actual or estimated cost of repairing vehicle_____

Q-46 Were you or other passengers injured as a result of the deer collision?

No ☐ (if no, go to Q-48)

Yes ☐

Q-47 Are you able to estimate the cost of the medical treatment required for the injuries to yourself or other passengers as a result of the deer collision?

No ☐ (if no, go to Q-48)

Yes ☐

→ If yes, would you please estimate the total cost of medical treatment required for injuries to yourself and/or other passengers as a result of the deer collision?

Total cost of medical treatment_____

Q-48 Did you file a police report about the collision?

No ☐

Yes ☐

Q-49 During 1995, did you experience an automobile accident because you were avoiding but did not hit a deer while driving? (example -- you ran off the road to miss a deer)

No ☐

Yes ☐

Q-50 Overall, how would you rate the danger of vehicle collisions with deer in your County or City in 1995? (Check only one response)

Negligible	Moderate	Severe	No Opinion
☐	☐	☐	☐

PARTICIPANT OPINIONS ABOUT DEER

Q-51 Compared to the number of deer in Virginia in 1995, which of the following best describes your opinion concerning future deer population management in Virginia? (Check only one response)

The deer population in Virginia should be managed so that there will be:

- A dramatic decrease in deer numbers ☐
- A moderate decrease in deer numbers ☐
- A slight decrease in deer numbers ☐
- No change in deer numbers ☐
- A slight increase in deer numbers ☐
- A moderate increase in deer numbers ☐
- A dramatic increase in deer numbers ☐
- No Opinion ☐

Q-52-54 Based upon your opinion of the deer population in 1995, please indicate whether you strongly agree, agree, disagree, strongly disagree, or have no opinion of the following statements. (Check only one response for each statement)

		Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Q-52	Deer are a nuisance; they should not be tolerated	☐	☐	☐	☐	☐
Q-53	Deer cause some problems but I enjoy having them around	☐	☐	☐	☐	☐
Q-54	Deer don't cause any problems	☐	☐	☐	☐	☐

PARTICIPANT DEMOGRAPHICS

Q-55 What is your sex?

- female ☐
- male ☐

Q-56 What is your age? _____

Q-57 Please check the highest level of education you have completed.

- Less than High School ☐
- High School Diploma ☐
- Bachelor's degree ☐
- Graduate or other advanced degree ☐

Q-58 What is the approximate net income (after federal and state taxes) of your household? (Check the appropriate range)

- less than $15,000 ☐
- $15,000 - $30,000 ☐
- $30,000 - $59,999 ☐
- $60,000 - $89,999 ☐
- $90,000 - $119,999 ☐
- $120,000 - $149,999 ☐
- $150,000 - $179,999 ☐
- Greater than $180,000 ☐

Q-59 Which one of the following environments best describes your upbringing or background?

- Farm ☐
- Rural ☐
- Small city (population less than 50,000) ☐
- Urban/City (population 50,000 or greater) ☐

Q-60 Which of the following environments best describes your living situation since 1990?

- Farm ☐
- Rural ☐
- Small city (population less than 50,000) ☐
- Urban/City (population 50,000 or greater) ☐

Q-61 Please indicate the Virginia county or city that you lived in during 1995. (Identify if you lived in a county or city in 1995 by checking the appropriate answer. Then write the name of the county or city in the space provided)

- County ☐
- City ☐ County or City of Residence in 1995 _____

We would like to thank you for your time and cooperation in the completion of this survey. The information that you have provided is valuable and important to the continuing management of white-tailed deer in Virginia. Please use this space to provide any additional comments or opinions you have concerning deer management or damage in Virginia.

After all questionnaires have been returned, the information provided by respondents will summarized. Would you like us to mail you a summary of these results? (Please indicate your preference below)

____ Yes, I would like a summary of the results
____ No, I do not wish to receive a summary of the results

If you have any questions or comments, please write or call. Thanks again for your cooperation and input.

James A. Parkhurst and Ben C. West
Department of Fisheries and Wildlife
100 Cheatham Hall
Virginia Tech
Blacksburg, VA 24061
(540) 231-3329

Appendix B. Specific commodities grown by producers included as part of a general commodity group

Specific commodities grown by producers included as part of a general commodity group

Commodity Group	Specific Commodities Included in the General Commodity Group
Christmas Trees	Christmas Trees
Forages	Silage Corn, Hay (Other than Alfalfa)
Grains	Barley, Corn, Oats, Sorghum, Wheat
Nursery Plants	Trees, Shrubs, Bedding Plants, Sod
Peanuts	Peanuts
Pumpkins and Melons	Pumpkins and Melons
Shrub Fruits	Blueberries, Brambles
Soybeans	Soybeans
Strawberries	Strawberries
Tobacco	Flue-Cured Tobacco, Burley Tobacco
Tree Fruits	Apples, Peaches, Cherries, Pears
Truck Crops	Tomatoes, Sweet Corn, Potatoes, Sweet Potatoes, Other Miscellaneous Vegetables
Miscellaneous	Any commodity listed under "Other Agricultural Commodity" that did not conform to the above classifications[a]
Undefined	Occurred when respondent failed to identify one specific crop or general category as their primary or secondary planting

[a] see Q-2 in Appendix 1

Appendix C. Specific plantings grown by homeowners included as part of a general planting group.

Specific plantings grown by homeowners included as part of a general planting group

Planting Group	Specific Plantings Included in the General Planting Group
Tree Fruit	Apples, Peaches, Cherries, Pears
Shrub Fruit	Shrub Fruits
Bedding Fruit	Bedding Fruits
Woody Ornamentals	Trees, Shrubs, Groundcover Plants, General Woody Ornamentals (i.e., respondent selected multiple woody ornamentals for their primary or secondary planting)
Vegetable Garden	Personal Vegetables
Flowers	Perennial Flowers, Annual Flowers
General Ornamentals	Occurred when respondent selected multiple ornamentals (woody ornamentals or flowers) as their primary or secondary planting
Miscellaneous	Any planting listed under "Other Plantings" that did not conform to one of the above classifications[a]
Undefined	Occurred when respondent failed to identify one specific planting or general category as their primary or secondary planting

[a] see Q-2 in Appendix 1

Appendix D. Virginia Cities and Counties Grouped by VDGIF Administrative Regions and Districts.

Cities and Counties of Virginia, grouped by VDGIF administrative regions and districts

REGION 1		REGION 2		REGION 3		REGION 4		REGION 5	
District 1	District 2	District 1	District 2	District 1	District 2	District 1	District 2	District 1	District 2
Charles City	Accomack	Amherst	Amelia	Bland	Buchanan	Alleghany	Clarke	Culpeper	Albemarle
Essex	Greensville	Bedford	Appomattox	Carrol	Dickenson	Augusta	Frederick	Fairfax	Caroline
Gloucester	Isle of Wright	Botetourt	Brunswick	Craig	Grayson	Bath	Page	Fauquier	Chesterfield
James City	Northampton	Campbell	Buckingham	Floyd	Lee	Highland	Rockingham	Greene	Fluvanna
King George	Prince George	Franklin	Charlotte	Giles	Russell	Rockbridge	Shenandoah	Loudon	Goochland
King & Queen	Souhampton	Henry	Cumberland	Montgomery	Scott		Warren	Madison	Hanover
King William	Surry	Nelson	Dinwiddie	Pulaski	Smyth			Orange	Henrico
Lancaster	Sussex	Patrick	Halifax	Wythe	Tazewell			Prince William	Lousia
Mathews	*Chesapeake*	Pittsylvania	Lunenburg		Washington			Rappahanock	Powhatan
Middlesex	*Norfolk*	Roanoke	Mecklenburg		Wise			Stafford	Spotsylvania
New Kent	*Suffolk*	*Roanoke*	Nottoway						
Northumberland	*Virginia Beach*		Prince Edward						
Richmond									
Westmoreland									
York									
Hampton[a]									
Newport News									

[a] *Italicized* entries represent cities in Virginia rather than counties

Appendix E. Descriptions of deer management programs administered by VDGIF.

Descriptions of deer management programs administered by VDGIF

Deer Management Assistance Program (DMAP)

DMAP was implemented by the VDGIF in 1988. DMAP is a site specific deer management program that increased a landowner's or hunt club's management options by allowing a more liberal harvest of anterless deer than could be obtained under the current system of county regulations. DMAP tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary goal of DMAP is to allow landowners and hunt clubs to work together on a local level to manage their deer herds. Secondary objectives are to increase the Department's biological data base and to improve communication between deer hunters, landowners, and the Department. In 1996, nearly 17,000 DMAP tags were issued to 430+ cooperators on more than 1.13 million acres.

Damage Control Assistance Program (DCAP)

Like DMAP, DCAP was started in 1988. DCAP is a site specific deer damage management program that increased a landowner's management options by allowing a more liberal harvest of antlerless deer than could be obtained under the existing system of county regulations. DCAP permit tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary objective of DCAP is to provide site specific assistance in the control of crop depredation by deer or other property damage. Secondary objectives are to maximize hunter participation in the control effort and to shift closed-season Kill Permit deer harvest(s) into the open deer season. In 1996, there were over 500 DCAP cooperators.

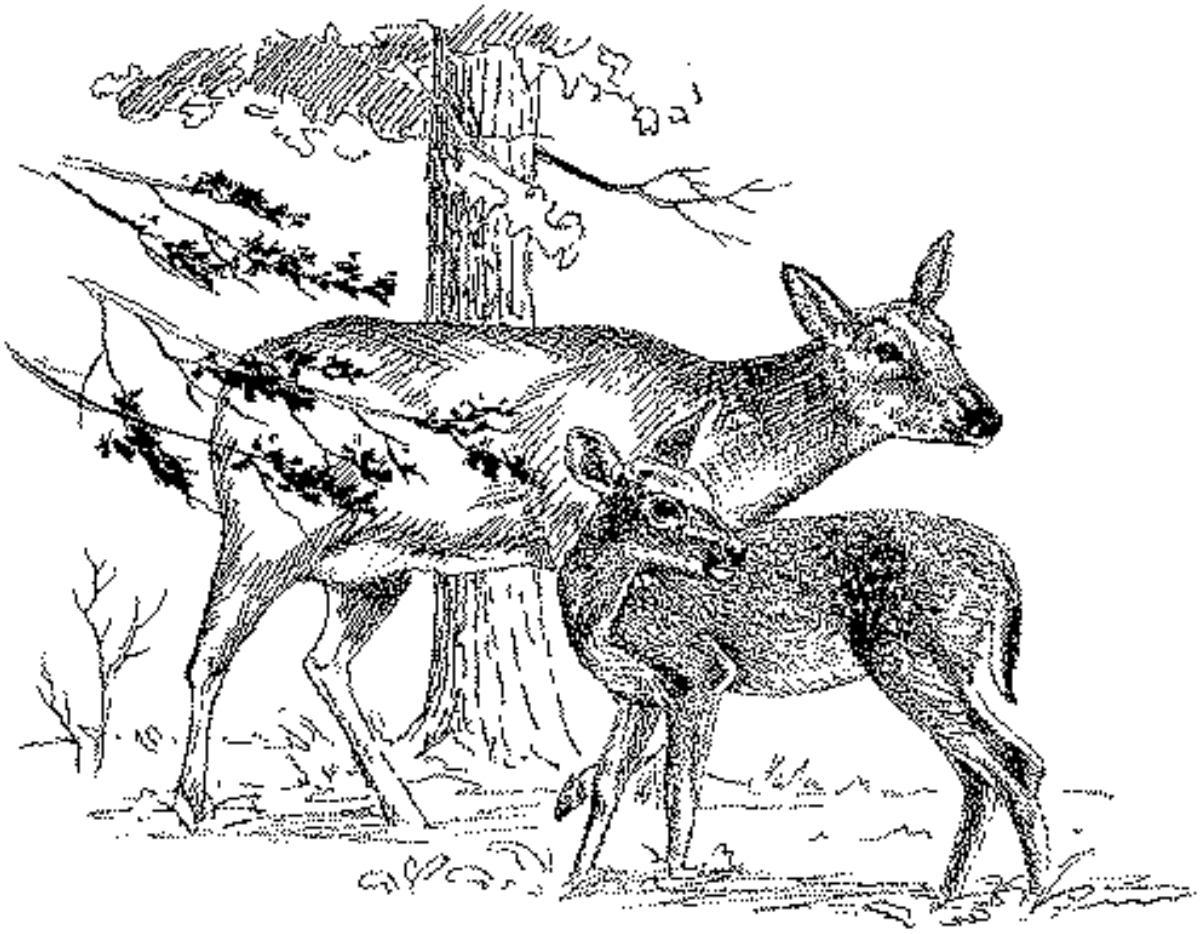
Kill Permit Program (KPP)

The VDGIF is mandated by law to permit owners or lessees of land on whose lands deer are causing damage to kill such deer. Under the KPP, a landowner/lessee sustaining deer damage must report the damage to the local wildlife officer for investigation. If upon the investigation the officer (or designee of the Director of VDGIF) determines that deer are responsible for the reported damage, he/she is required to authorize in writing that the owner/lessee, or other person(s) designated by the officer, be allowed to kill deer when they are found upon the property where the damage occurred. Additionally, at the discretion of the wildlife officer, regulations governing "fair-chase" restrictions may be suspended (e.g., participants are often allowed to lethally harvest deer at night) and participants may harvest deer during periods other than the regular hunting season. In calendar year 1996, 1,324 kill permits were issued for deer and 4,000+ deer were reported killed.

Appendix F. Questionnaire sent to individuals owning land in the Bedford and Frederick county study areas.

A Survey of (Frederick or Bedford) County Landowners

The Relationship Between Deer Hunting and Deer Damage in (Frederick or Bedford) County



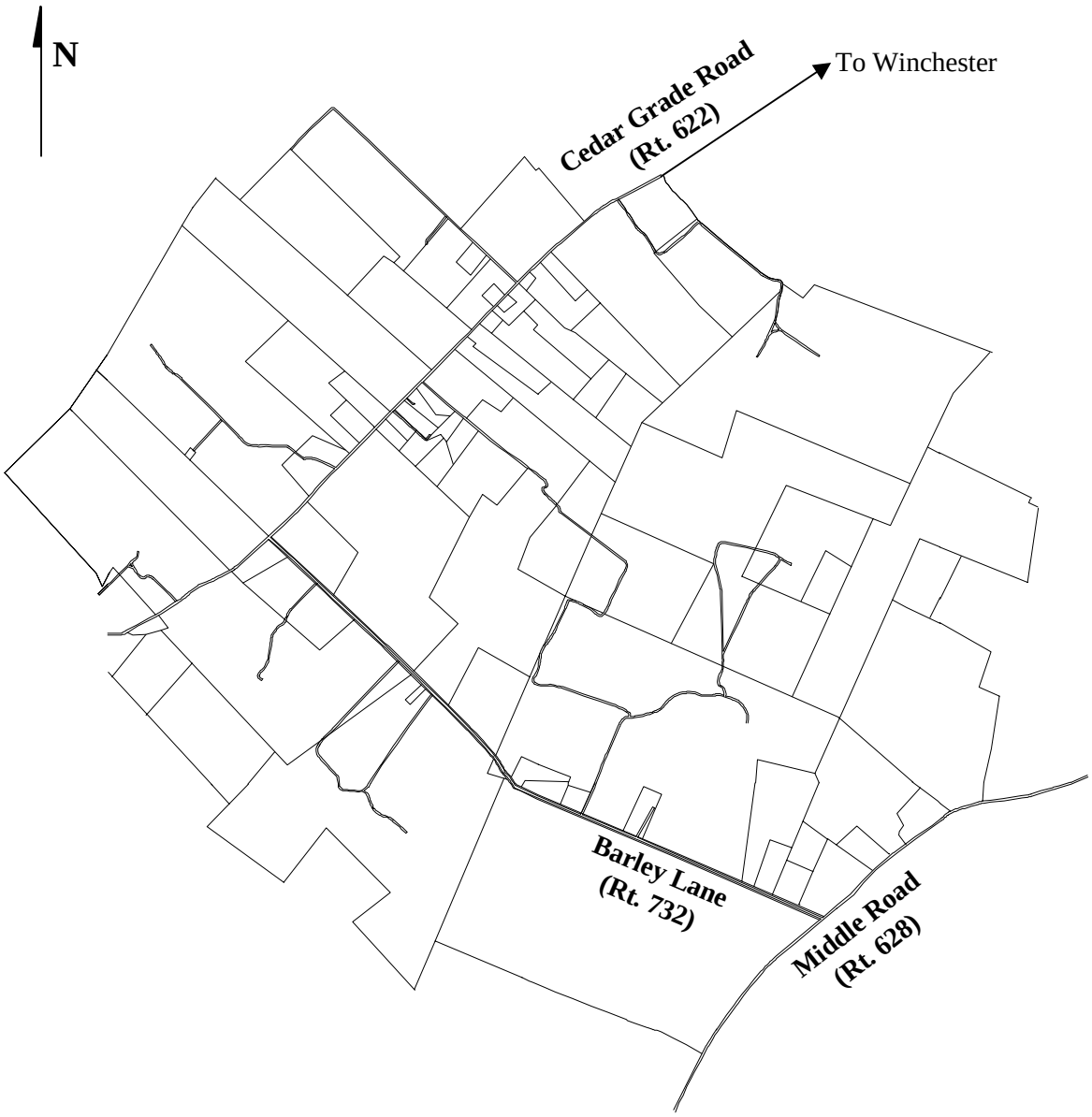
Virginia Cooperative Extension

Knowledge for the Commonwealth

Virginia Tech

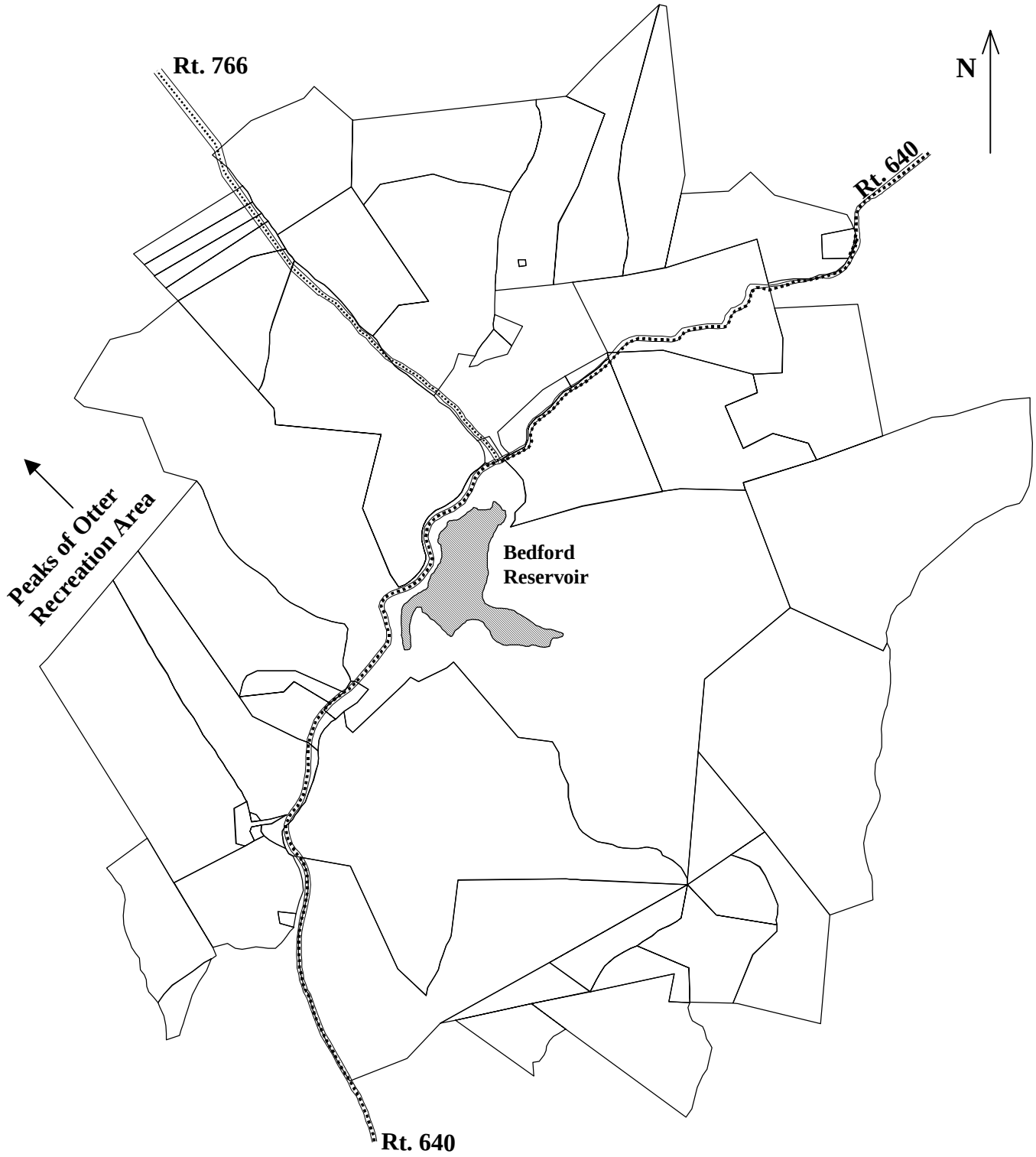
Map of Frederick County Landowners

(Your property is shaded)



Map of Bedford County Landowners

(Your property is shaded)



Q-1 First, we would like to know a little about how you used your land during 1996. Please provide an estimate of the percent of your land (as indicated on the map) that was used for each of the following land-use categories during 1996. For example, if 90% of your land shown on the map was woodland and the remaining 10% was used for residential purposes during 1996, you would write 90% in the box next to "Woodland" and 10% in the box next to "Residential."

☐ Residential	☐ Production Agriculture
☐ Commercial/Industrial	☐ Woodland
☐ Pasture	☐ Other (please specify) _____
☐ Other (please specify) _____	☐ Other (please specify) _____

Q-2 On average, how many years have you owned the land shown on the map? (please check only one response)

☐ Less than 5 years ☐ 5 to 10 years ☐ 11 to 20 years ☐ Greater than 20 years

Q-3 Did deer damage any crops or ornamental plantings on any of your land during 1996? (please check the appropriate response and continue to the next question)

☐ No

Please continue to Q-4 on the next page

☐ Yes

Please continue to Q-3A

Q-3A If yes, please list the crops or ornamental plantings damaged by deer on your land during 1996 and then provide your opinion of damage severity for each (if you need additional space, please use the last page of the questionnaire)

Crop/Plants Damaged	Severity Rating
_____	☐ Low ☐ Moderate ☐ Severe ☐ No Opinion
_____	☐ Low ☐ Moderate ☐ Severe ☐ No Opinion
_____	☐ Low ☐ Moderate ☐ Severe ☐ No Opinion
_____	☐ Low ☐ Moderate ☐ Severe ☐ No Opinion

Q-4 In your opinion, what has been the general trend of deer damage on your land since 1991?

Has deer damage on your land: (please check only one response)

☐ Generally increased since 1991

☐ Remained about the same since 1991

☐ Generally decreased since 1991

☐ I have no opinion

Q-5 Did you or any other individuals hunt for deer on your land during 1996? (please check the appropriate answer and continue to the next question)

☐ No

Please continue to Q-6

☐ Yes

Please continue to Q-5A

Q-5A Please provide your best estimate of the number of deer harvested on your land during 1996 in the space below.

_____

Approximate number of deer legally harvested on your land during 1996

Q-6 Did you or any other individuals hunt for deer on your land during the preceding 5 year period (1991-1995)? (please check the appropriate answer and continue to the next question)

☐ No

Please continue to the next page

☐ Yes

Please continue to Q-6A

Q-6A During which of the following years did you or others hunt deer on your land? (please check <u>each year</u> that you or others hunted deer on your land)

☐ 1991 ☐ 1992 ☐ 1993 ☐ 1994 ☐ 1995

We would like to thank you for your time and cooperation in completing this survey. The information that you have provided is important to the future management of white-tailed deer in Virginia. Please use this space to provide any additional comments or opinions you have concerning deer management or damage in Virginia.

After all questionnaires have been returned, the information provided will be summarized. Would you like to receive a summary of these results? (please indicate your preference below)

☐ *Yes, I would like to receive a summary of the results*
☐ *No, I do not wish to receive a summary of the results*

If you have any questions or comments, please write or call. Thanks again for your cooperation and input.

Ben C. West and James A. Parkhurst
Department of Fisheries and Wildlife
100 Cheatham Hall
Virginia Tech
Blacksburg, VA 24061
(540) 231-4458

VITA

Benjamin Corey West was born to Wallace B. and Mary E. West on October 8, 1973 in Waverly, Tennessee. He graduated with honors from Waverly Central High School in May 1992. He began his professional career at the University of Tennessee-Martin during the fall of 1992, where he majored in Natural Resources Management with an emphasis on wildlife management. During his time at UT-Martin, he gained experience with the Tennessee Agricultural Extension Service, Fire Island National Seashore (NY), and Tennessee Valley Authority. He received his Bachelor of Science in Natural Resources Management from UT-Martin in December, 1995. In January 1996, he became a Master's Degree candidate in the Department of Fisheries and Wildlife Sciences at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. He completed his degree requirement in May, 1998.