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ECONOMIC CHOICE MODELING: THE USE OF SOCIAL PREFERENCE DATA TO INFORM WHITE-TAILED DEER MANAGEMENT IN MICHIGAN

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ECONOMIC CHOICE MODELING: THE USE OF SOCIAL PREFERENCE DATA TO INFORM WHITE-TAILED DEER MANAGEMENT IN MICHIGAN

By

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ABSTRACT

ECONOMIC CHOICE MODELING: THE USE OF SOCIAL PREFERENCE DATA TO INFORM WHITE-TAILED DEER MANAGEMENT IN MICHIGAN

By

Kristy Wallmo

White-tailed deer populations in Michigan (*Odocoileus virginianus*) have risen steadily over the last 30 years, with more than one million deer in the fall counts since 1981. The abundant deer population has created both benefits and costs for the Michigan public. While attitudes toward deer are generally positive, when faced with the costs of abundant deer populations, for example deer damage to agriculture or deer-vehicle collisions, preferences for deer populations may change. With the increasing attention given to public input, wildlife managers need to be informed of preferences for deer populations in light of the benefits and costs associated with deer. Choice experiment surveys are well suited for this task, as they require individuals to make constrained choices, reflecting realistic management situations where trade-offs must be made. This research uses a choice experiment mail survey to estimate choice models of preferences for deer populations and a suite of deer-related attributes. Focus groups and in-person pretests were conducted to determine which deer-related attributes are most relevant to the Michigan public and to facilitate survey development. Deer-related attributes that were used in the survey included the number of deer, the number of mature bucks, herd health, deer damage to residential property, deer damage to agriculture, deer-vehicle collisions, and deer damage to forest ecosystems. The survey was mailed to hunters (N=1,980) and nonhunters (N=2,970) in three regions of Michigan: the western upper

peninsula, the northeastern lower peninsula, and the southwestern lower peninsula. Response rates ranged from 64% to 66% for hunters and 59% to 63% for nonhunters. Choice model results indicate that, in addition to deer numbers, other deer-related attributes have a significant effect on the utility of both hunter and nonhunter respondents, and both groups will consider the costs associated with deer when making choices among deer-management scenarios. Results suggest that while both groups will make trade-offs for changes in the deer population size, the types and magnitudes of the trade-offs differ among regions and between hunters and nonhunters. For example, for an increase in the deer population, hunters will accept larger increases in most, but not all, of the deer-related attributes than will nonhunters. Comparing the choice model results with other survey components demonstrates that preferences for deer and the related attributes are consistent across different measurement scales. Results of this survey can be used to inform management of the relative importance of different deer-related attributes and the types of trade-offs people are willing to make among them.

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KEY TO ABBREVIATIONS

CCC	Cultural Carrying Capacity
CE	Choice Experiment
IIA	Independence from Irrelevant Alternatives
MDNR	Michigan Department of Natural Resources
MNL	Multinomial Logit
MRS	Marginal Rate of Substitution
NE	Northeast Region (Alpena, Alcona, Oscoda, Montmorency, Presque Isle counties)
NW	Northwest Region (Marquette, Iron, Dickinson, Baraga counties)
QDM	Quality Deer Management
RUM	Random Utility Model
RUT	Random Utility Theory
SC	Stated Choice
SOS	Secretary of State
SW	Southwest Region (Barry, Eaton, Calhoun counties)
USFWS	United States Fish and Wildlife Service
WAC	Wildlife Acceptance Capacity
WDACP	Wildlife Damage Abatement and Claims Program
WDNR	Wisconsin Department of Natural Resources

CHAPTER 1. INTRODUCTION

White-tailed Deer in the U.S.

White-tailed deer (*Odecoileus virginianus*) populations in much of the U.S. have increased substantially over the last century. Though there is no consensus on the size of the current population in the U.S., estimates have ranged from 15 to 25 million nationwide (McCabe and McCabe 1997). There is, however, consensus among many scientists that in much of their North American range deer population densities currently exceed historical levels that prevailed at the turn of the century (Alverson et al. 1988; deCalesta 1997; Healy 1997; Woolf and Roseberry 1998). This increase has resulted in both costs and benefits to society.

In the early 1900's white-tailed deer hunters faced restrictive hunting limits due to the near extirpation of deer (Woolf and Roseberry 1998). However, by the 1920's deer herds had recovered in many states (Woolf and Roseberry 1998) and in 1996 deer were the most popular type of big game for hunters, with 10.7 million hunters spending about 131 million days hunting deer (USFWS 1996). While these are national figures and therefore include deer species other than *Odecoileus virginianus*, buck harvests in 13 northeastern states which include only white-tailed deer show an average increase of 164%, with a range of 44%-525%, during the period 1983 - 1992 (Organ and Ellingwood 2000). In addition to hunting, an abundant deer population provides more opportunities for wildlife viewing and photography. In 1996 about 13 million people in the U.S. spent time away from home observing large mammals such as deer, bears, and coyotes and about 17 million people spent time wildlife watching for large mammals around their

own home (USFWS 1996).

While increases in the white-tailed deer population have created obvious benefits in terms of more opportunities for wildlife-related activities, there are also a variety of conflicts generated from such increases. These conflicts may be viewed as the costs, or negative externalities, hereafter referred to simply as externalities, associated with deer populations, particularly the abundant populations present in many parts of the U.S. Data from the U.S. Department of Agriculture Wildlife Services shows that during the period 1994 - 1997 white-tailed deer were one of the top ten nuisance species in the northeastern U.S. (Organ and Ellingwood 2000), causing a variety of problems including damage to agriculture, trees, and plants, collisions with vehicles, and human health risks associated with deer.

Deer browsing on commercial crops may cause economic losses to agricultural producers. Research by Conover (2002) suggests that 51% of agricultural producers in the U.S. stated that deer had caused damage on their farm or ranch in the previous year, and deer were most often cited as being the source of wildlife damage. Conservative estimates put deer damage to agriculture in the U.S. at around $100 million annually (Conover 2002). Other studies have produced regional estimates of deer damage to agriculture. In Indiana reports suggest that 90% of all wildlife-related financial losses to farmers were due to deer, and in 1993 deer were responsible for approximately $4.5 million of loss in harvestable corn in Indiana, representing about one third of all harvestable corn losses due to wildlife (McCreedy et al. 1994). In Wisconsin, the Department of Natural Resources has implemented a Wildlife Damage Abatement and

Claims Program (WDACP) to provide abatement assistance and monetary payments for wildlife damage to crops. In 1999 a WDACP report stated that deer damage represented 89% of appraised losses statewide, amounting to approximately $1.5 million. Other research suggests that deer were responsible for about $37 million of loss in corn, soybean, and wheat production in Maryland, (McNew and Curtis 1997), and that fruit growers in Western New York reported average losses of $3,000 per year (Decker and Brown 1982; McNew and Curtis 1997).

Deer browsing can also cause damage to residential property by damaging ornamental plants, trees, and shrubs. In a random sample of households in the 100 largest metropolitan areas in the U.S. Conover (1997) states that 4% of homeowner respondents reported a problem with deer, with damage estimates of about $251 million per year and approximately $125 million spent annually to prevent the damage. Some regional estimates suggest that homeowners in southeastern and western New York reported median losses of $200 and $90, respectively, per household in 1988, while nursery producers in southeastern and western NY experienced an average loss of $21,628 and $3,813 due to deer in the same year. (Sayre et al. 1992).

Abundant deer populations may also result in large numbers of deer-vehicle collisions. Conover (2002) estimates that 726,000 deer-vehicle collisions are reported annually - about one-half the number that actually occur - at an average cost of $1,644 per collision. Nationwide approximately 29,000 people are injured and 200 people lose their lives each year due to deer-vehicle collisions (Conover 2002). In some regions of the U.S. increases in the annual number of deer-vehicle collisions have been considerable.

For example, Indiana experienced a 5 fold increase in the number of annual deer-vehicle collisions between 1981 (2,000 collisions) and 1993 (>10,000 collisions), though the number of collisions per billion miles driven in the state has remained nearly constant since 1992 (McCreedy et al. 2001).

Another externality associated with an abundant deer population is deer browsing in forests. Deer browsing on small trees and tree seedlings can affect both natural and commercially managed forests, causing compositional changes in the flora and fauna of the forest as well as economic losses to the forest industry. Conover (1997) suggests that nationwide deer may cause $750 million worth of damage to the timber industry annually, though the damage varies widely by region. Black et al. (1979) estimated that in the Pacific Northwest 5 years of deer browsing resulted in losses in the range of $90 to $190 million, whereas Marquis (1981) estimated that annual timber losses due to deer in the Allegheny hardwood forest of Pennsylvania amounted to $367 million per year.

Research by Tilghman (1989) demonstrated that deer browsing affects both commercial and noncommercial tree species as well as some herbaceous ground cover plants in Pennsylvania. Other studies suggest that heavy deer browsing in forests may eliminate some woody and herbaceous species, reduce overall plant species richness, and change the composition of trees in the forest (deCalesta and Stout 1997; Alverson et al. 1988). Deer browsing has also been shown to have negative effects on some endangered lilies and orchids (Miller et al. 1992) and can change the types of birds that forage and nest in the forest (deCalesta 1994; McShea and Rappole 2000).

Other externalities related to abundant deer populations include health-related

issues concerning deer and humans. For example, deer are an important reservoir for adult ticks that cause Lyme disease in humans. Lyme disease transmission has been cited as a deer related concern by respondents in several studies (Decker and Gavin 1987; Stout et al. 1997; Cristoffel and Craven 2000). Additionally, increases in the deer population can potentially decrease the overall health of the herd and the buck to doe ratio (McShea et al. 1997), both of which have been cited as deer-related concerns (Cristoffel and Craven 2000; Bull and Peyton 1999).

Management Concepts for Human-Wildlife Conflicts

The purpose of the above is to demonstrate that, in general, white-tailed deer populations are abundant in many regions of the U.S., creating both costs and benefits that affect a variety of segments of society. While many studies have shown that attitudes toward deer are positive (Lauber et al. 2001; Cristoffel and Craven 2000; Diefenbach et al. 1997; Decker and Gavin 1987; Stout et al. 1997; Curtis and Lynch 2001), theoretical and empirical work suggest that for many species that have the potential to generate wildlife-human conflicts there is a "wildlife acceptance capacity" (WAC), defined as the maximum wildlife population level in an area that is acceptable to people (Decker and Purdy 1988). Minnis and Peyton (1993) expanded the WAC concept by incorporating three additional areas: the consideration of the preferences of multiple stakeholders, the consideration that wildlife populations may not only be too high but also too low, and the consideration of human responses to wildlife populations (Gigliotti et al. 2000). Minnis and Peyton (1993) refer to this expanded concept as Cultural Carrying Capacity.

Cultural Carrying Capacity (CCC) is defined as the wildlife population level in a defined area that produces the most manageable amount of issue activity at a particular time (Minnis and Peyton 1993), where issue activity is considered to be activities undertaken by stakeholders or stakeholder groups that may potentially undermine the authority of a particular agency to manage wildlife. For example, activities such as letter writing, phone calls, attendance at public meetings, etc., may be undertaken by stakeholders to express their concerns about wildlife management. When stakeholders believe an agency is not responsive to their concerns, they may communicate their opinions to higher authorities (Decker et al. 1985). If such communications result in an agency losing control over management, the issue is considered "disruptive" (Peyton 1984). Minnis and Peyton (1993) propose that when stakeholders find the wildlife population size to be desirable or satisfactory, they will not engage in any issue activity and the issue will be considered latent. When the population size becomes tolerable, stakeholders will begin to communicate their concerns about wildlife, and the issue emerges. When the population size becomes intolerable, stakeholders will begin to actively seek to change the situation, potentially resulting in disruptive issue activity. The reactions of stakeholders to the population size – in both attitude and action (e.g. tolerance and issue activity) are identified by a stakeholder response curve. Figure 1 represents a hypothetical scenario with two stakeholder response curves to deer management. The population size that corresponds to the region where all stakeholders lie between desirable and tolerable is considered the CCC for a wildlife population (Minnis and Peyton 1993).

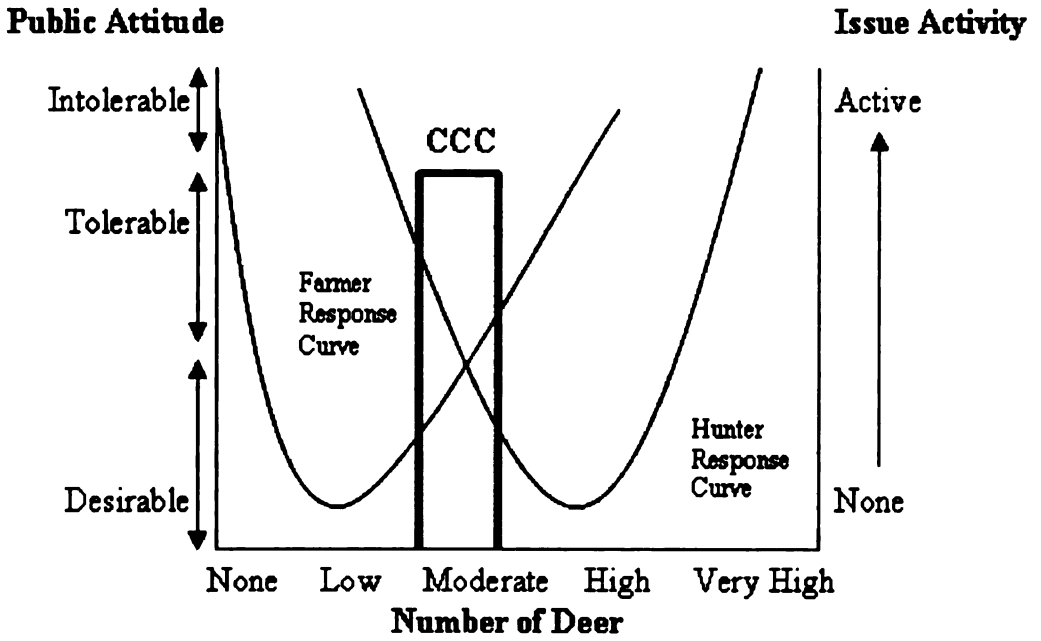


Figure 1. **Hypothetical Cultural Carrying Capacity for Deer**

Monitoring of wildlife damage reports is a fundamental tool used by many state agencies to address the concepts of WAC and CCC (Organ and Ellingwood 2000). Other tools include citizens task forces, used in New York to gain stakeholder input into the management of white-tailed deer (Carpenter et al. 2000) and the "Inquisitive Approach," described by Decker and Chase (1997) as actively seeking input through public hearings, telephone and mail surveys, open houses, and focus groups. However, as Gigliotti et al. (2000) point out, many managers already know that deer hunters want more deer and landowners want fewer deer - indeed a variety of research has been conducted on

stakeholder preferences for increasing and decreasing deer populations (Decker and Gavin 1987; Stout et al. 1997; Diefenbach et al. 1997; Lauber et al. 1999). Further, as noted above, previous studies have shown that people generally have a positive attitude regarding deer - it is the existence of deer-related externalities, the magnitude of which depends at least in part on the size of the deer population, for which people become intolerant.

Previous research concerning attitudes toward deer and deer-related externalities has shown that women tend to be more concerned about many deer problems than do men, and that people who have had direct experience with some deer-related externalities are more likely to favor decreasing deer populations (Lauber et al. 2001; Decker and Gavin 1987). Other studies have documented the importance of herd health (Cristoffel and Craven 2000) and property damage, crop damage, landscape damage, and deer-vehicle collisions (Curtis and Lynch 2001; Connelly et al. 1987; Decker and Brown 1986; Stout et al. 1993; Sayre et al. 1992). This type of information may be useful to managers, as it can reveal something about *why* stakeholders might prefer increases or decreases in the deer population and their level of concern about certain externalities. However, additional information about stakeholder preferences may facilitate managers in maintaining deer populations that are most acceptable to a variety of stakeholders.

Like most types of resource management, deer management involves trade-offs. For example, a person may benefit from being able to view deer in their yard but may incur the cost of deer damage to residential property. To some extent the person will "trade-off" increases in residential damage to be able to view more deer. However, there

may be a certain amount of damage for which additional increases in viewing deer do not make the person better off, and at some point the person may prefer to have less deer in order to decrease the amount of property damage. Further, while a person may accept a certain increase in residential property damage in order to view more deer, they may be less willing to accept increases in another deer-related externality, such as deer-vehicle collisions. While most managers already know that experiences such as residential damage and deer-vehicle collisions are externalities associated with a deer population, they may not know the relative importance of these externalities to different stakeholder groups. Additionally, answers to questions such as "*how many more deer-vehicle collisions would be acceptable to stakeholders who want a deer population increase?*", or conversely, "*how much of a decrease in deer-vehicle collisions is needed to compensate stakeholders for a deer population decrease?*" may benefit wildlife managers responsible for developing management goals and strategies, as well as assisting them in public communication efforts. To date the literature has not addressed these types of questions related to the management of white-tailed deer.

Research Framework

White-tailed Deer in Michigan

The state of Michigan provides a framework for examining stakeholder preferences for deer and deer-related externalities. A brief history of deer management in Michigan (MDNR 1994) shows that, like many states, the deer population in Michigan was nearly decimated at the turn of the century due to market hunting and limited hunting

restrictions. Deer populations at that time were estimated to be as low as 45,000 animals. Stringent hunting regulations helped the population rebound by the 1930's, and with reports of approximately 1.125 million deer talk began of a "deer problem." Despite attempts to manage the herd, the deer problem continued until the late 1940's, when the population peaked at about 1.5 million deer. However, in combination with liberal hunting regulations and a deterioration of deer habitat, populations began to fall, declining to about 0.5 million in 1972. At that time many deer hunters voluntarily restricted their hunting effort to bucks only. In addition, the Deer Range Improvement Program was initiated to improve habitat and acquire land for deer to help attain a goal of 1 million deer in the spring of 1981 (Langenau 1994). Since 1972 deer populations have shown a marked increase (Figure 2). The Michigan Department of Natural Resources (MDNR) currently maintains a white-tailed deer population goal of 1.3 million deer in the fall herd.

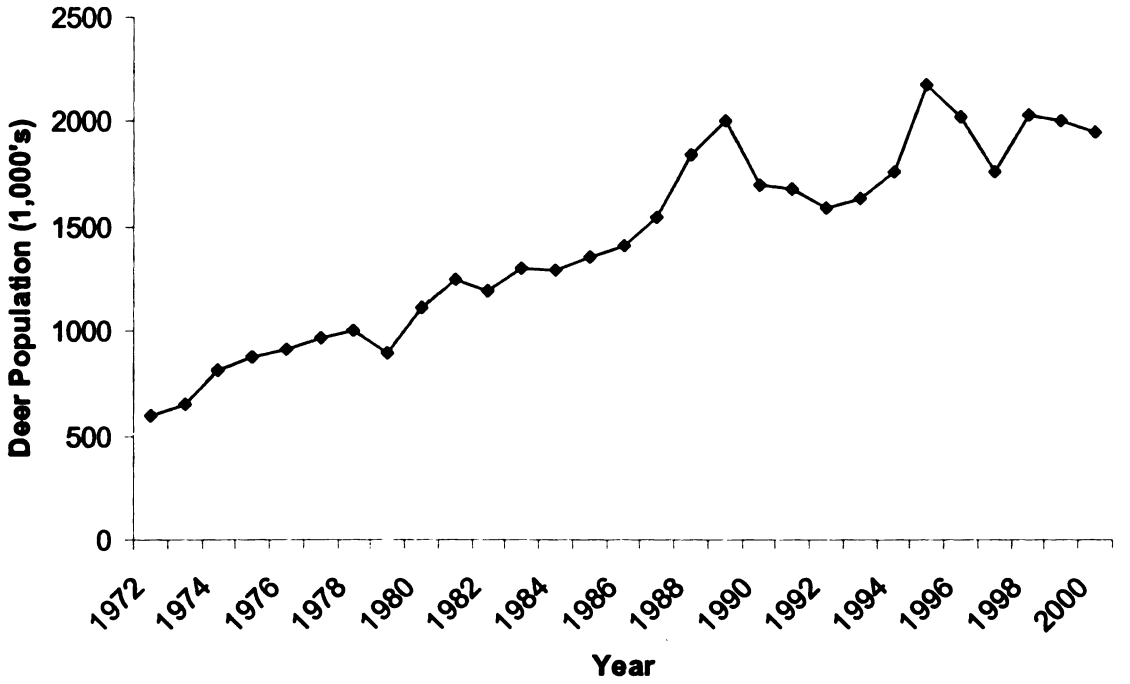


Figure 2. **Trend in Michigan's White-tailed Deer Population**

The abundant deer population in Michigan has resulted in increases in many of the externalities previously discussed. For example, deer-vehicle collisions have increased from 34,352 in 1986 to 68,233 in 1996, declining slightly to 67,669 in 1999 (Figure 3). An average insurance claim after a collision is about $1,000 (MDNR 1987). Deer crop damage is also an externality relevant to the state of Michigan. In 1989 nearly 2,000 agricultural producers in Michigan incurred economic losses attributable to deer (Langenau 1993). Campa et al. (1997) estimate average crop losses due to deer for alfalfa ($13/acre, 4.7%), corn ($15/acre, 6.5%), soybeans ($19/acre, 8%), and table beans

($29/acre), based on farmer's self-reports. Other deer damage estimates derived from Fritzell (1998) suggest that median percent losses of corn ranges from 1.8% in the southern lower peninsula of Michigan to 16.8% in the upper peninsula; losses of soybeans range from 4.3% in the south to 6.7% in the north; and losses of alfalfa range from 0.4% in the south to 21.8% in the north.

Additional deer-related externalities are more difficult to quantify, but may include health related issues, damage to residential property, and damage to commercial and natural forests. Research in northern Michigan has shown that deer browsing can affect the regeneration of Hemlock, Northern White Cedar, and Aspen (Alverson and Waller 1997; Campa et al. 1996; Verme et al. 1986, Frelich et al. 1985) and deer browsing may contribute to changing ecology in northern Michigan's conifer swamps and may change the structure of plant communities in areas of high deer density (Van Deelen 1996).

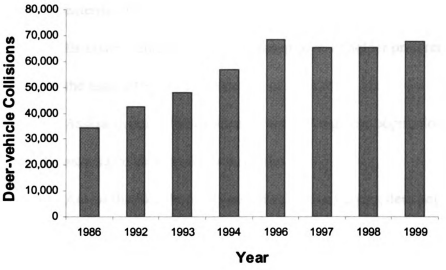


Figure 3. **Annual Deer-vehicle Collisions in Michigan**

Research Objectives and Questions

Deer management professionals as well as various stakeholders have questioned the basis of the current goal of 1.3 million deer in the fall herd and expressed a need to re-examine this number in the context of biological and cultural carrying capacities. The goal of this research is to use a survey approach to assess the CCC for deer in three distinct regions of Michigan by examining stakeholder preferences for deer and deer-related externalities and determining the trade-offs stakeholders are willing to make for increases and decreases in the deer population. The four objectives below will facilitate the overall goal of the research:

(1) Determine the general level of concern for deer and deer-related externalities.

(2) Estimate a quantitative relationship of stakeholder preferences for deer and the associated externalities.

(3) Assess stakeholder satisfaction for varying deer population sizes and the associated changes in externalities

(4) Assess the likelihood of issue activity for varying deer population sizes and the associated externalities

The following research questions will be addressed for study sites in the western upper peninsula, northern lower peninsula, and southern lower peninsula of Michigan:

(1) How does the relative importance of deer and deer-related externalities differ among different stakeholder groups?

(2) What kinds of changes in deer populations and associated externalities are most likely to satisfy different stakeholder groups?

(3) What types of externality increases will stakeholders accept for increases in the deer population, and conversely, what types of externality decreases will compensate stakeholders for decreases in the deer population?

(4) What kinds of changes in deer populations and associated externalities are most likely to induce different stakeholder groups to engage in issue activity?

The remainder of the dissertation is organized as follows: Chapter Two describes the general framework used to guide the research, including theory, methods, and a detailed description of the survey development and implementation process; Chapter Three describes the general results of the survey, including descriptive statistics and analytical results concerning stakeholder satisfaction and issue activity; Chapter Four describes the remainder of the analytical results including the quantitative relationship of stakeholder preferences for deer and the associated externalities and the types of trade-offs stakeholders will make for increases or decreases in the deer population; Chapter Five provides a discussion of the results and the implications for white-tailed deer management in Michigan.

CHAPTER 2. ATTRIBUTE BASED DECISION MAKING

This chapter begins with a general description of attribute based decision making and the process of developing a choice experiment. A discussion of Random Utility Theory (RUT) and choice model estimation is then presented, followed by an application of RUT to white tailed deer. The chapter concludes with a description of the choice experiment survey development and implementation process for white tailed deer in Michigan.

General Framework

The approach taken in this research is based on a set of methods referred to as Stated Choice (SC), which elicit preferences by asking people to choose among one or more "goods." Generally, a survey or interview format is used to elicit preferences for what have traditionally been market goods; however, in recent years SC methods have become increasingly popular for valuing environmental goods and services (Hanley et al. 1998). The SC approach is built on the work of Lancaster (1966) and Lancastrian consumer theory, with additional behavioral foundations in judgement and decision making from economics and psychology (Adamowicz et al. 1998a).

Stated choice approaches postulate that individuals derive utility (worth or well-being) from a good based on the characteristics, or attributes, of the good (Louviere et al. 2000). For example, suppose that a fishing trip is viewed as an environmental "good." There may be certain attributes associated with going fishing that make the trip more or less enjoyable. These attributes might include things like whether the fishing is done on a

lake or a river, the scenery surrounding the fishing area, the number of other people fishing in the same area, the expected success rate of catching fish, and the distance of the fishing area from ones home. A person who doesn't mind driving in order to fish in a pristine area with few people around may prefer a fishing experience like the one described in A (Figure 4), while someone who doesn't mind a more crowded area if it takes less time to reach the fishing spot might prefer the experience described in Scenario B.

Fishing Scenario A	**Fishing Scenario B**
Fishing in this scenario involves... • Fishing on a relatively pristine river with few other people around • A low chance of catching a legal size fish • Driving several hours to reach the river	Fishing in this scenario involves... • Fishing on a lake with other fishers present as well as some boat traffic • A high chance of catching one or more legal size fish • Driving less than an hour to reach the lake

Figure 4. **Hypothetical Fishing Scenarios**

These hypothetical attributes of a fishing trip may or may not be attributes that are relevant to a particular population. In practice, when using a SC approach determining the relevant attributes of a good and describing them requires substantial research. However, the point of the above is to illustrate the concept proposed in Lancastrian consumer theory - that utility (for a fishing trip) can be decomposed into separable utilities for the attributes of the good (type of water body, scenery, crowd/congestion, success rate, and distance to fishing spot). The fact that a person would prefer A to B in

Fig. 4, or conversely, B to A, reveals something about the relative importance placed on the attributes of the good. It is important to note that SC methods themselves do not constitute a theory of behavior, but rather, they are a means to generate data about an individual's behavior (Adamowicz et al. 1998a).

Choice Experiments

Choice experiments are a specific type of SC method that elicit preference data. A choice experiment (CE) elicits data by asking people to choose between one or more constructed scenarios. These constructed scenarios describe a particular good by decomposing the good into relevant attributes, as in the fishing trip scenarios above. Alternative scenarios are constructed by varying the *levels* of the attributes according to an experimental design plan. For example, consider the attribute "success rate" in the fishing trip scenarios. Hypothetically, if "success rate" has three levels - low, moderate, and high - an experimental design plan would be used to determine the level "success rate" would take in each alternative scenario. Similarly, the design plan would specify the levels of the other attributes in each scenario, such that each scenario is different. To elicit preference data individuals are then asked, typically in either a written survey or in-person interview format, to choose which of the alternative scenarios they prefer. This type of preference data allows Random Utility Models (RUM) to be estimated, producing a quantitative model of the utility derived from attributes of a good.

There are several stages involved in developing a CE. The first is to identify the salient attributes of the good in question. Adamowicz et al. (1998a) note that this stage is

the most important stage of the study, as it characterizes a decision problem in terms that are both relevant and understandable to the decision maker. Ultimately, sparse attention to this stage can lead to irrelevant, meaningless, or biased models. Louviere and Timmermans (1990) suggest using multiple qualitative techniques such as in-depth interviews, focus groups, and direct questioning, in addition to planning and policy guidelines, to identify a set of salient, nonredundant attributes that characterize the good.

The next stage involves specifying the levels for each attribute. The levels may be specified using a variety of criteria, including research objectives, current or future planning horizons, physical constraints, prior research or experience, and the believability of levels by potential respondents (Louviere and Timmermans 1990; Adamowicz et al. 1998a). Generally the levels are set by the researcher, though exploratory research can be used to determine level ranges or endpoints.

The next stage involves the use of statistical design theory to combine the levels of the attributes into different scenarios. Generally each combination of attribute levels (scenario) is referred to as a treatment in the design literature (Louviere and Timmermans 1990). The use of a full factorial design would imply that all possible combinations of levels and attributes have been designated as a treatment for the experiment. For example, suppose that a good is characterized by four attributes, where two of the attributes have three levels and two have four levels. The full factorial would be $3^2 \times 4^2$, or 144 treatments. As this number of treatments would be impractical, subsets of the full factorial are generally used, with "main effects" designs - orthogonal subsets of the full factorial - being a popular design used in many CE's (Adamowicz et al. 1998a). One

drawback of the main effects plan is the strictly additive (no interaction terms) model that can be estimated from this design, though Louviere et al. (2000) state that for linear models main effects typically account for 70% to 90% of the explained variance. Statistical designs can then be used to combine alternative scenarios into a choice set, from which individuals are asked to choose their preferred scenario.

The next stage involves developing a questionnaire/interview script in which an individual is ultimately faced with at least one, but usually multiple, choice sets. Theoretically, an individual evaluates the alternatives in a choice set based on the utility derived from the attribute levels of one alternative as compared to the other alternatives in the choice set, implicitly trading off levels of one attribute against levels of another (Adamowicz et al. 1998a). While the overall goal of this stage is to collect information on choices, the questionnaire or interview can also be used to collect other types of data such as demographic, attitudinal, or behavioral data. Additionally, questionnaires and interviews can be used to set the stage for respondent's decision making, conveying information about the good, the selected attributes, status quo information, policy information, or any other material the respondent would need in order to make an informed choice. Pre-testing and pilot testing of the questionnaire/interview script is recommended by most researchers involved in CE studies (Adamowicz et al. 1998a).

The final stages of a CE involve data collection from the desired sample population and model estimation. As with any experiment, if statistical inferences are to be made from the sample population, simple random or stratified random sampling of the target population is used. Random Utility Theory (RUT) forms the basis for model

estimation. The choice model structures are based on RUT and are appropriate for describing discrete choices in a utility maximizing framework (Boxall et al. 1996). Maximum likelihood techniques are frequently used to estimate binary or multinomial logit models, though other specifications such as the multinomial probit and the nested multinomial logit have been applied to CE data (Adamowicz et al. 1998a).

Random Utility Theory

Choice models are based on Random Utility Theory (RUT), a utility maximizing framework that allows individuals to value attributes of a good (Adamowicz et. al 1998b). Random utility theory specifies that utility (U) for a good consists of a systematic, known component (V) and a random component (E). Based on RUT, the utility that individual *i* receives from a given alternative, *a,* can be expressed as

$$U_{ia} = V_{ia} + E_{ia} \qquad (1)$$

where U_{ia} is the unobservable utility that *i* associates with *a*, V_{ia} is the quantifiable, known portion of utility, and E_{ia} is the random, unobservable effects associated with *a* for individual *i*. Alternative *a* can be decomposed into specific attributes, and the systematic component of utility V_{ia} can be expressed as

$$V_{ia} = \beta X_a \qquad (2)$$

where X_a is a vector of attributes and the associated levels for alternative *a* and β is a vector of attribute coefficients. Although theoretically the attributes could vary among individuals, for the CE used in this research the attributes are the same for all individuals, thus the subscript i is dropped from the right hand side of equation (2). Substituting the

expression for V_{ia}, the utility function can be expressed as

$$U_{ia} = \beta X_a + E_{ia} \qquad (3)$$

The presence of the random component allows probabilistic statements to be made about preferences and/or behavior, ultimately allowing for model estimation. Under the assumption that individuals are utility maximizers, RUT specifies that the probability that an individual *i* will choose alternative *a* from a set of C alternatives is equal to the probability that the utility derived from *a* is greater than the utility derived from any other alternative in the choice set C. This can be expressed as

$$\begin{aligned} \text{Prob}_i(a|C) &= \text{Prob}(U_{ia} > U_{ij}) \qquad \forall j \in C \\ &= \text{Prob}(V_{ia} + E_{ia} > V_{ij} + E_{ij}) \quad \forall j \in C \\ &= \text{Prob}(\beta X_a + E_{ia} > \beta X_j + E_{ij}) \quad \forall j \in C \end{aligned} \qquad (4)$$

Equation (4) implies that the probability that an individual will choose alternative *a* is equal to the probability that the systematic component of utility plus the associated error for *a* is greater than the systematic and associated error components of all other alternatives in the choice set C (Adamowicz et al. 1998b).

To operationalize (4), an error distribution must be assumed. Type I extreme value distributions, such as Gumbel or Weibull distributions, are used extensively in discrete choice models (Louviere et al. 2000). If a type I extreme value distribution is assumed for the random component of (4), a multinomial logit model (MNL) can be expressed as

$$\begin{aligned} \text{Prob}_i(a|C) &= \exp(\lambda V_{ia}) / \sum j \in C \exp(\lambda V_{ij}) \\ &= \exp(\lambda \beta X_a) / \sum j \in C \exp(\lambda \beta X_j) \end{aligned} \qquad (5)$$

The parameter λ is a scale parameter that is imbedded in RUT based models, but not identifiable separately from β. Generally λ is normalized to one, and the model is estimated as if λ β are the attribute coefficients (Hensher et al. 1999). An additional property of MNL is the Independence from Irrelevant Alternatives (IIA). The IIA property means that the ratio of the probability of choosing one alternative over the probability of choosing another is unaffected by the presence or absence of any additional alternatives in the choice set. In many situations, the IIA property is not wholly desirable, and can be relaxed by nesting the model (see Chapter 4).

Equation (5) can be estimated using maximum likelihood techniques. If choice observations are ordered so that the first n1 individuals chose alternative a, the next n2 individuals chose alternative b, the next n3 individuals chose alternative c, and so on for all j elements of the choice set C, the likelihood function can be written as

$$L = \prod_{i=1}^{n_1} P_{ia} \ldots \prod_{i=n_1+1}^{n_1+n_2} P_{ib} \ldots \prod_{i=n_1+n_2+1}^{n_1+n_2+n_3} P_{ic} \ldots \prod_{i=I-n_j+1}^{I} P_{ij}$$

Defining a dummy variable f_{ij}, where $f_{ij} = 1$ when alternative j is chosen and $f_{ij} = 0$ otherwise, the function can be simplified to the log-likelihood function

$$\ln L = \sum_{i=1}^{I} \sum_{j=1}^{J} f_{ij} \ln P_{ij} \qquad (6)$$

The term P_{ij} in (6) can be replaced with (5) so that the only unknown terms are λ β. Using maximum likelihood techniques, parameter estimates for elements of β can be

estimated for each of the attributes that have been selected to characterize the good.

Application to White-tailed Deer

Random Utility Theory can be used to determine preferences for white-tailed deer populations and some of the externalities associated with white-tailed deer that have been discussed previously. For example, assume that individuals derive some level of utility (well being) from deer, and that this utility can be "decomposed" into a set of deer-related attributes, which may include some of the deer-related externalities. Suppose that the utility for deer is a function of the population size, the number of deer-vehicle collisions, and the amount of deer crop damage. Assuming that the utility function is linear, equation (3) can be expressed as

$$U = V + E$$

$$= \beta X + E$$

$$= \beta_1 * \text{Deer population size} + \beta_2 * \text{Deer-vehicle collisions} + \beta_3 * \text{Deer crop damage} + E.$$

where β_k are the parameter estimates that indicate the relative importance of each attribute.

Preference data can be collected by showing individuals alternative scenarios that contain varying levels of population size, collisions, and crop damage and asking them to choose which scenario they like best, as shown in the hypothetical example in Figure 5.

Which Deer Scenario Do You Prefer?

Scenario A	Scenario B	Scenario
Scenario A includes... • High deer densities	Scenario B includes... • Moderate deer densities	Scenario C includes... • Low deer densities
• A moderate increase in annual deer-vehicle collisions relative to the number of collisions last year	• A moderate increase in annual deer-vehicle collisions relative to the number of collisions last year	• A moderate decrease in annual deer-vehicle collisions relative to the number of collisions last year
• About the same amount of deer-crop damage that occurred in the last year	• A small decrease in the amount of deer-crop damage that occurred in the last year	• A large decrease in the amount of deer-crop damage that occurred in the last year

Figure 5. **Hypothetical Choice Scenario**

In this example the attributes population size, collisions, and crop damage represent X in equation (5) and Scenarios A, B, and C represent the j alternatives. By asking individuals in a sample population to make choices among a sufficient number of alternative scenarios, obtained through a statistical design plan, preference data are collected and equation (6) can be estimated. The output includes coefficients for each of the deer-related attributes that indicate the relative importance each attribute has on utility. The output can also be used to examine the trade-offs individuals will make among the attributes. For example, for a specified change in the size of the deer population, the model output can indicate the amount of change in annual collisions, or any other attribute, that individuals will "trade-off" (accept increases or decreases) and still be as

well off (have the same utility) as they were before any changes occurred. These trade-offs are referred to as the marginal rate of substitution (MRS). MRS is expressed by the negative of the ratio of two attribute coefficients, e.g. - β_1/β_2. The concept of MRS if further explained in Chapter 4.

In the above example three attributes served to characterize the good "deer." As stated previously, the identification of the salient attributes of a good is of critical importance to a CE study, and in practice more (or less) attributes may be needed to characterize preferences for deer. The following sections describe the process of identifying and describing deer-related attributes for a CE and the subsequent stages of survey development and implementation.

Survey Development and Implementation

Background and Description of Study Sites

A choice experiment survey was developed to determine preferences for deer populations and deer-related externalities, referred to as *deer-related attributes* in a CE setting. The survey was developed for two primary stakeholder groups – white-tailed deer hunters and a more general group of the public. While other stakeholder groups do exist, e.g. landowners or farmers, time and resources constrained the number of stakeholder groups that were able to be included, in particular because choice experiment surveys require a large number of survey versions due to the experimental design. However, information was collected in the survey pertaining to respondent land use and ownership so that this, as well as other socio-demographic characteristics, can help explain

preference heterogeneity.

Survey regions were selected primarily to fit in with a larger MDNR project that consisted of three components: habitat modeling, deer population modeling, and stakeholder preferences. Habitat and deer population components dictated that the survey regions should be distinct in deer densities and available deer habitat. Additionally, representation from both the upper and lower peninsula of Michigan was desired. Three regions of Michigan were surveyed: a northwestern region (Baraga, Dickinson, Iron, and Marquette counties), a northeastern region (Alpena, Alcona, Montmorency, Oscoda and Presque Isle counties), and a southwestern region (Barry, Calhoun and Eaton counties) (Figure 6). Each region is briefly characterized below, with attention to characteristics that may relate to deer and deer management.

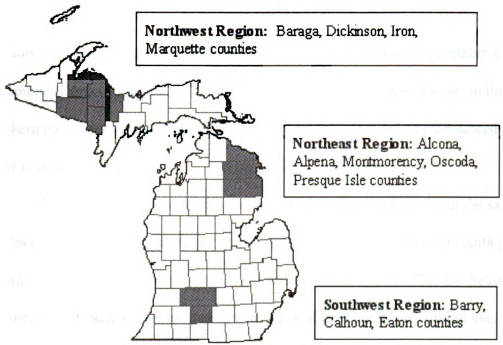


Figure 6. **Study Areas**

The population of the northwest region (Region I) is approximately 110,369, with a population density of about 24 people per square mile. Per capita personal incomes range from $18,500 - $21,175, depending on the county. About 1.7% of the land area is devoted to agriculture, with hay and alfalfa being the predominant crops grown. Of the three regions, the northwest region has the highest percentage of forest land, with more than 80% of the land in each county classified as forest land. The forest industry owns less than 10% of forest land in Iron county, 10% - 20% in Marquette and Iron counties, and 40% of the forest land in Baraga county. State and national forest ownership is at

least 20% and can be higher than 40%, depending on the county. The MDNR estimates deer densities to be fairly low in this area relative to the northeast and southwest regions. Additionally, during the winter months, deer tend to migrate from the northern counties to the southern counties in this region, resulting in higher deer concentrations in the southern part of the region. This type of winter movement is not as pronounced in the other two study regions.

The population density of the northeast region (Region II) is about the same as the northwest, with about 25 people per square mile (total pop. 74,834). Per capita personal income ranged from $16,541 - $22,000, depending on the county. The northeast region has more cropland than the northwest, with 8.2% of the land in agricultural use. Grain or seed corn is the predominant crop, though the region also grows wheat, soybeans, table beans, and alfalfa. In Presque Isle, Alpena, and Alcona counties between 60% and 80% of the land is classified as forest land, while over 80% of the land in Montmorency and Oscoda counties is forest land. Less than 10% of the land in each county is owned by the forest industry, though state and national ownership ranges from less than 10% to over 40%, depending on the county. The MDNR has estimated moderate deer densities in Presque Isle and Alpena counties and higher densities in Montmorency, Alcona, and Oscoda counties. Relative to the northwest region deer densities are generally higher throughout the northeast.

The southwest region (Region III) is the most densely populated of the three regions, with 161 people per square mile and a total population of 295,527. Per capita personal incomes are also higher in the southwest than in either the northeast or

northwest, ranging between $23,111 - $24,690, depending on the county. Forty-three percent of the land in the southwest region is devoted to agriculture, growing predominantly grain and seed corn. As a reference, the southwest region grows almost 15 times the amount of corn grown in the northeast region. In each county in the southwest region 20% - 40% of the land is classified as forest land. Less than 10% of forest land is used by the commercial forest industry in the southwest, and state and national ownership is less than 20% in all counties. Deer densities in this region are higher than the northeast and northwest, and the MDNR considers this region to have some of the highest deer densities in the state.

The choice experiment survey used here is one component of a larger deer management project, hereafter referred to as Eco-Deer, which includes a habitat component, biological component, and the stakeholder preference component. A choice experiment survey format was chosen for the stakeholder preference component because this format requires respondents to make trade-offs in their decision-making, which often typefies real life decisions concerning natural resources. The choice experiment format also allows preferences to be estimated in a quantitative model, facilitating the Eco-Deer project goal of integrating results of the habitat, biological and stakeholder components to develop a holistic deer management tool. The following describes the choice experiment survey development and implementation process.

Attribute Selection

In a choice experiment framework, attributes of the deer herd are things that are related to the existence of a deer population. For example, crop damage may occur in some areas due to the deer population. Likewise, a deer population means that recreational opportunities for viewing and hunting exist. Having a deer population in an area may even affect local economies during peak hunting seasons. Presumably, there is a large set of deer-related attributes; however, due to limited space, appropriate experimental design, and task complexity faced by the respondent, it was not possible to use the entire set of deer-related attributes in the choice experiment survey. Thus it was necessary to select a subset of attributes for use in the survey. The initial step in selecting the subset was conducting informal interviews and discussions with deer management professionals and researchers on the Eco-Deer project to determine which attributes are salient to deer management, thus narrowing the list of all possible deer-related attributes. These interviews and discussions occurred during the period of May to August 2000.

After the initial interviews, three focus groups were conducted in October 2000 and February 2001 to facilitate survey development. The primary goals of the focus groups were (1) to narrow the subset of deer-related attributes to those that are most relevant to hunters and public and (2) to develop a choice experiment framework that would enable participants to make well-informed, meaningful trade-offs among the attributes. The October focus group was held in Lansing, Michigan. Participants were randomly selected from the Greater Lansing Area phone book. The two February focus groups were held in Gaylord, MI. Participants were selected from computer generated

telephone listings for Gaylord and the surrounding areas. Initial contacts were made by telephone. Efforts to recruit a sample of the general public (for October and February groups) and a sample of deer hunters (for February group only) required that potential participants be screened for various socio-demographic characteristics. From the initial telephone contacts 13, 14, and 12 people agreed to participate in the October general public, February general public, and February hunter focus groups, respectively. Participants were sent a confirmation letter and map to the focus group location approximately 5 days before the discussion. The evening before the discussion participants were called to remind them of their commitment. All participants were paid $30. Attendance at the focus groups is reported in Table 1.

Table 1. **Focus Group Attendance**

Focus Group	Attendance
October General Public (Lansing)	6 (4 women, 2 men)
February General Public (Gaylord)	7 (6 women, 1 man)
February Hunter (Gaylord)	11 (all men)

In the focus group discussions a set of deer-related attributes emerged that were relevant to the public and hunters, and thus were selected for the survey. Attributes for the public survey included the number of deer, herd health, residential property damage, agricultural damage, deer-vehicle collisions, and the effect of deer on the forest ecosystem. All attributes are specific to each of the three regions. Attributes for the hunter survey were identical to the attributes for the public with the inclusion of one additional attribute, the number of mature bucks. Focus group discussions revealed that

participants were able to consider the types of trade-offs that could be made among the attributes - for example, participants were able to think about what they may have to trade-off in some of the attributes in order to have an increase or decrease in the deer population.

Attribute Description

The next step in developing the survey was to determine how to describe each attribute in a manner that facilitated quantitative measurement and would allow levels of the attribute to be specified. Focus groups and informal discussions among eco-deer researchers were used to develop these descriptions. Focus groups revealed that while the meaning of some of the attributes, such as deer-vehicle collisions, was very straightforward, other attributes, such as deer browsing and the forest ecosystem, needed more detailed descriptions. Feedback from focus group participants, informal discussions with eco-deer researchers and deer management professionals, and literature reviews were used to the develop the attribute descriptions that were provided in the survey. Abbreviated attribute descriptions are provided below, along with the associated units of measure used to vary the attribute levels. Complete survey instruments for hunters and public are contained in Appendix A.

Abbreviated Attribute Descriptions

> **The Number of Deer** refers to the current number of deer in the region (see graphic in survey instrument). *Unit of measure is the percent change in the population relative to the status quo.*

The Number of Mature Bucks refers to the number of bucks in the region that are at least two and a half years old with at least four antler points on one side. *Unit of measure is the percent change in the population relative to the status quo.*

Herd Health refers to the physical well being of the herd. The health of the herd may be considered excellent, even though a few individual deer may be in poor health. When the number of deer in poor health increases, the health of the deer herd decreases. When a deer is in poor health it may have at least one of these characteristics:

- smaller body size than expected
- low reproductive success
- disease
- lower chance of surviving long winters

Unit of measure is the percent of deer in the region that have at least one characteristic of poor health.

Residential Property Damage is caused by deer feeding on plants, trees, and shrubs that people plant in their yards. *Unit of measure is the percent of residential properties in the region experiencing some damage due to deer.*

Deer Damage to Agriculture is caused by deer feeding on agricultural crops. *Unit of measure is the deer damage per acre of cropland in region, expressed as $ per acre.*

Deer-Vehicle Collisions refers to the number of collisions between deer and vehicles during a given time period. *Unit of measure is the number of reported annual deer-vehicle collisions.*

Deer and the Forest: In a forest, deer generally feed, or browse, on plants, shrubs, and tree seedlings. Over time, deer browsing may change the types of plants, trees, and animals that live in the forest. The extent of the changes depends on how much browsing occurs in the forest. In forest areas that experience deer browsing for 5 to 10 years:

- some types of wildflowers may be eliminated while some grasses and ferns increase.
- Some trees, like white cedar and maples, may be eliminated while trees like spruce and fir may increase.
- The elimination of certain kinds of trees may cause losses in the commercial forest industry.
- Some birds, like warblers, may be eliminated while cardinals and bluejays may increase.
- In general, the habitat will support fewer kinds of plants and wildlife.

Besides the changes described above, many scientists believe that changes in the forest may also cause the forest to function differently in the long-term, with uncertain consequences. For example, the forest may be less able to adjust to events like fires and floods. *Unit of measure is the percent of forest area in the region experiencing heavy deer browsing.*

In order to help "ground" respondents, information about the status quo of each attribute was also provided in the descriptions. For example, in the choice experiment levels of the attributes are specified to create alternative situations. Knowledge of the current level, or status quo, of the attribute would presumably help respondents in making an informed choice concerning their preferences for the attributes and attribute levels in their region. Because limited published data on the status quo for each attribute exists, particularly at the regional level, a variety of unpublished sources were consulted to develop estimates for each region.

Status quo estimates for herd health were developed by consulting regional white-tailed deer biologists and veterinarians in the MDNR and asking them to provide estimates of the percent of deer with at least one characteristic of poor health. Eco-deer researchers from the population and habitat components were then asked to review these estimates and provide an estimate of their own. For the herd health attribute estimates from each source were consistent in the northwest and southwest regions. In the northeast region there was some disagreement among sources. Using input from Eco-deer researchers, the status quo estimate provided in the survey was slightly lower than the estimates provided by the MDNR.

To develop status quo estimates for deer damage to residential property private landscaping and tree nursery companies in each region were contacted and asked to

provide an estimate of the percent of residential properties in the region that had experienced any deer damage. In each region between 4 and 7 companies were contacted. Efforts were made to contact a company in each of the counties that comprised a region; however in the northeast this was not possible, as no landscaping or tree nursery companies were listed in the phone book or on the internet for two of the counties. Once companies were contacted discussions with managers and technicians lasted between half an hour to an hour each. With the exception of one company in the northwest region, all estimates within a region varied by less than 20%. Averages were calculated and used as the status quo estimate. One potential bias of the estimates results from most companies acknowledging that they were quite familiar with deer damage occurring in the surrounding area, but much less familiar with damage occurring throughout the entire county and the multiple-county region. To address this issue the attribute description emphasized that the estimate was for the entire region, and damage could be higher or lower in certain areas, depending on deer density in an area.

To develop status quo estimates for deer browsing in the forest regional white-tailed deer biologists and management unit supervisors from the forestry division of the MDNR were consulted and asked to provide estimates of the percent of forest area in their region experiencing heavy deer browsing. Similar to the estimates provided for deer damage to residential property, the majority of management unit supervisors stressed that they were more familiar with certain areas within the region but less familiar with deer browsing throughout the entire region. Eco-deer researchers from the population and habitat components were also asked to provide an estimate. Variance was higher among

estimates of deer browsing than for any of the other status quo estimates. Generally, input from the Eco-deer researchers resulted in lowering the estimates provided from other sources. In the survey the attribute description emphasized that the estimate was for the entire region, and damage could be higher or lower in certain areas, depending on the deer density in an area.

Unlike most of the attributes, some estimates for deer crop damage in Michigan are reported in the literature, though the variance of the estimates is rather large. In addition, the Wisconsin Department of Natural Resources (WDNR) maintains a database containing information on deer crop damage on a county level basis. Using the Wisconsin database and Wisconsin deer densities, regression models were developed at the Wisconsin county level for predicting deer crop damage. A number of different independent variables, all calculated per county, were included in different models, including acres of cropland, number of farms, average size of farms, percent of mixed hardwoods, percent of aspen, acres of corn, acres of soybean, acres of alfalfa, and overwinter deer density categories. For these models the dependent variable was the total amount of deer damage per county. Data for these variables was obtained from the WDNR database on deer crop damage and the Wisconsin Department of Agriculture. The only significant predictor of deer damage was the overwinter deer density category.

The dependent variable was then recalculated to represent the deer damage per acre of cropland in the county. Independent variables that were significant in this model included the percent of land in the county devoted to agriculture and the overwinter deer density category. The deer crop damage model implies that deer crop damage increases

as the overwinter deer density increases and as the percent of land devoted to agriculture in a county decreases (Table 2).

Table 2. **Model of Deer Crop Damage in Wisconsin**

Independent Variable	**Coefficient (std. error, p-value)**
Overwinter deer density	0.28 (0.09, 0.00)
Percent of land devoted to agriculture	-0.01 (0.01, 0.00)
Model Significance	F=10.37, p=0.00, R-squared=0.22

Overwinter deer densities for the counties in Michigan comprising the survey regions and the percent of land in these counties devoted to agriculture were then plugged into the model to produce estimates of deer crop damage in the northwest, northeast, and southwest survey regions. These estimates were compared to other deer crop damage estimates reported in the literature (Campa et. al 1997; Fritzell 1998) and weighted averages were computed for the final crop damage estimate.

The Michigan State Police maintains county level data on the annual number of reported deer-vehicle collisions. The most recent available data (1999) were used for the status quo estimates of deer vehicle collisions. Estimates were not obtained for the number of deer or the number of mature bucks (hunters only) in the region due to the complexity of deer density estimates, thus the number of deer and number of mature bucks was referred to simply as the current number in the region. Figure 7 shows the status quo estimates for each attribute by region.

	Northwest	Northeast	Southwest
Number of Deer in Region	Current Number	Current Number	Current number
Percent of Deer in Region with at Least One Characteristic of Poor Health	25%	30%	5%
Percent of Properties in Region Experiencing Some Deer Damage	30%	20%	20%
Deer Damage per Acre of Cropland in Region ($/acre)	$6	$3	$3
Annual Number of Deer-Vehicle Collisions in Region	3,562	2,346	4,552
Percent of Forest Area in Region Experiencing Heavy Deer Browsing	30%	30%	30%

Figure 7. **Status Quo Levels of Deer-related Attributes**

After reading the attribute descriptions and information about the status quo respondents were asked several questions concerning attitude towards and experience with each attribute. These questions were intended to break up large amounts of text and encourage respondents to read the attribute descriptions carefully. Additionally, they were intended to collect data that not only describe attitudes and experience but also may prove insightful in interpreting choice model results. Because it was expected that some respondents would disregard or disagree with the baseline estimates provided in the survey, a set of Likert scale agree/disagree statements was developed to help determine the credibility respondents gave to the estimates. Responses to these statements may

help in ad-hoc explanation of the choice experiment results.

Experimental Design

Choice experiment surveys require respondents to compare a number of different situations, referred to as a choice set, and choose which situation they prefer. Different situations are created by varying the "levels" of each of the attributes. Depending on the research needs, the "status quo" may be provided as one situation in the choice set, in which case the levels of each attribute would simply be the current status of the attribute. Experimental design plans are used to vary the attribute levels and form alternative situations, and designs generally require that the levels of each attribute vary independently. However, independent variation among all the deer-related attributes would have created some counterfactual situations, e.g. a situation with a large increase in deer numbers but a large decrease in deer-vehicle collisions, relative to the status quo. Feedback from focus groups revealed that when given choices that contained these types of counterfactual situations most respondents refused to make a choice, citing that the situations were not logical or possible to exist in real life. For this reason 3 types of choice sets were constructed in the survey: (1) attribute levels increase relative to the status-quo (2) attribute levels decrease relative to the status-quo (3) attribute levels increase or decrease but changes are marginal (small) relative to the status-quo. The public survey contained a fourth choice set which included the status-quo and one increasing, decreasing, and marginal alternatives. Because of the additional attribute 'number of mature bucks' in the hunter survey, which took an additional page for

description, the hunter survey did not contain the fourth choice set.

In summary, respondents receiving the public survey version were asked to make four separate choices: a choice among the status quo and alternative situations in which attribute levels increase; a choice among the status quo and alternative situations in which attribute levels decrease; a choice among the status quo and alternative situations in which attributes either increase or decrease, but any changes are marginal; and a choice that contained all types of alternative situations. Respondents receiving the hunter survey version were asked to make only the first three choices.

In each type of choice set each attribute could take one of two levels. For the increasing choice set each level represented a specified increase from the status quo. For the decreasing choice set each level represented a decrease from the status quo, and for the marginal situation each level represented a small change - either an increase or a decrease - from the status quo. The magnitude of the change for each level was set primarily by consensus among eco-deer researchers with some input from individuals who participated in pre-testing. To create alternative situations in each type of choice set, levels of each attribute were varied according to a 6 x 2 (public) and 7 x 2 (hunters) main effects experimental design plan. Thus independent variation was maintained among the attributes *within each type of choice set.* The design plan assumes linear preferences and no interactions between any attributes. The design plan was generated using Minitab software, and resulted in 16 different survey versions per region (8 for hunters and 8 for public), for a total of 48 versions.

Pre-testing

Regional specific survey instruments were developed for hunters and public and pre-tested in July and August 2001. To select pre-test participants names were randomly selected from computer generated telephone listings in each of the three survey regions. Participants were contacted first by telephone and asked several screening questions to determine selected socio-demographic characteristics and whether or not they hunt white-tailed deer in their region. From these initial telephone contacts 29, 28, and 25 people agreed to participate in the pre-tests in the northwest, northeast, and southwest region, with approximately one third of the participants in each region being hunters. The same protocol used to remind focus group participants of their commitment was followed for pre-test participants. All participants were paid $35. Attendance at pre-tests is reported in Table 3.

Table 3. **Pre-test Attendance**

Pre-test Location	**Attendance**
Marquette (northwest region)	21 (9 women, 12 men)
Alpena (northeast region)	22 (6 women, 16 men)
Battle Creek (southwest region)	19 (11 women, 8 men)

Pre-tests revealed that when comparing alternative situations to the status quo some respondents did not compare among all attributes, but tended to make choices based solely on changes in deer numbers. In efforts to encourage respondents to compare among all the attributes, three alternative situations were provided in a choice set - a "status-quo" (the current situation of the attributes in a specific region) choice, and two

alternatives each with the same change in deer numbers but different changes among the other attributes. An example of a choice set for the Northwest region is shown in Figure 8.

	Current Situation	Scenario A	Scenario B
Number of Deer in Region	Current Number	20% more than current number	20% more than current number
Percent of Deer in Region with at Least One Characteristic of Poor Health	25%	30%	30%
Percent of Properties in Region Experiencing Some Deer Damage	30%	40%	35%
Deer Damage per Acre of Cropland in Region ($/acre)	$6	$8	$7
Annual Number of Deer-Vehicle Collisions in Region	3,562	4,300	4,600
Percent of Forest Area in Region Experiencing Heavy Deer Browsing	30%	35%	40%
Which do you prefer for your region? (Check one)	Current ❑	Scenario A ❑	Scenario B ❑

Figure 8. **Choice Set for Northwest Region**

Satisfaction and Issue Activity Models

Questions were developed to enable satisfaction and issue activity models to be estimated. Data for the satisfaction models were collected by asking respondents to rate how satisfied they would be if the first alternative to the status quo, e.g. Scenario A in

Fig. 8, was the situation in their region. Satisfaction was rated using a 5 point Likert scale ranging from "Extremely satisfied" to "Extremely Dissatisfied." The question was asked after each choice set (increasing, decreasing, and marginal). Because an experimental design was used to create the scenarios for the choice experiment, there were a total of 144 different "Scenario A's" (48 survey versions times 3 types of choice sets).

After respondents rated their satisfaction with "Scenario A" they were asked if they would engage in specific types of issue activity if "Scenario A" was the situation in their region. Specific types of issue activity included "contacting someone with authority to get the situation changed" or "taking steps myself to change the situation." Two options were also available for respondents who would not engage in issue activity if "Scenario A" were the situation in their region. Like the satisfaction ratings, 144 different situations were evaluated among all respondents concerning engagement in issue activity.

Sample Population

In an effort to sample two stakeholder groups, deer hunters and a more general group referred to as "public," the survey sample was drawn from two separate sources, the Michigan Secretary of State (SOS) and a database of white-tailed deer hunters maintained by the MDNR. The SOS provided a random sample of 5,000 names (including addresses, age, and sex) for each region, and the MDNR provided a random sample of 2,000 hunter names per region. Both sources were asked to provide names of

individuals over 20 years of age. Sources were cross-checked to eliminate any duplicate names, though it was expected that a percentage of names on the SOS lists would also hunt deer. Random samples of 990 and 660 names were then drawn from SOS and MDNR lists for each of the three regions, for a total of 4950 names. The male to female ratio was 1:1 for the public sample (SOS) and 9:1 for the hunter sample (MDNR). The age distribution for both hunters and public was a slightly skewed normal distribution with the mean age being 47 for hunters and 41 for public.

Survey Mailing

Using guidelines outlined in Dillman (2000), respondents were contacted five times, unless a reply was received, in efforts to increase response rates. Examples of all contact letters are contained in Appendix B. The first contact consisted of a pre-notice letter sent in late August 2000. In each region the letter was sent to the 990 and 660 randomly selected names from the SOS and MDNR lists, for a total of 4,950 letters. The letter informed respondents that as a resident of the northwest/northeast/southwest region they had been selected to participate in a survey, which they would be receiving shortly.

The first survey mailing occurred on Sept. 11, 2001 and included a cover letter, a return postage-paid survey booklet, and three first class stamps as a token incentive to complete the survey. There were 286 nondeliverable prenotice letters and 11 refusals, thus a total of 4,653 surveys were sent in the first survey mailing.

A reminder postcard was sent on Sept. 25, 2001. The reminder postcard was sent to all individuals who had received a survey on the first mailing, thanking those

individuals who had already sent in their completed survey and reminding those who had not to please do so, as their input was important to deer management in their region.

A second survey mailing occurred on Nov. 15, 2001 and included a new cover letter and a survey booklet. After removing nondeliverables and refusals from the first mailing, a total of 2,607 surveys were sent in the second mailing.

A final survey mailing occurred on Dec. 6, 2001, and included a new cover letter and survey booklet. Nondeliverables and refusals from the second mailing were removed and a total of 1,895 surveys were sent in the third mailing. Table 4 shows the regional response rates and Table 5 shows the disposition of the MDNR and SOS samples and response rate. All surveys returned by Jan. 5, 2002 were included in the dataset for analysis.

Table 4. **Survey Response Rates by Region**

Sample Group	**MDNR (Hunter)**			**SOS (Public)**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Response Rate	65%	66%	64%	63%	62%	59%

Table 5. **Disposition of the SOS and MDNR Samples**

Contact	Number Mailed	Completions	Refusals[1]	Non-deliverables[2]	Response Rate	Cum. Response
Prenotice						
MDNR	1,980	NA	2	36	NA	NA
SOS	2,970		9	250		
Total	4,950		11	286		
First Mailing						
MDNR	1,942	897	5	14	47%	NA
SOS	2,711	1,036	17	77	39%	
Total	4,653	1,933	22	91	42%	
Second Mailing						
MDNR	1,026	244	3	9	24%	59%
SOS	1,581	427	4	25	27%	56%
Total	2,607	671	7	34	26%	57%
Third Mailing						
MDNR	770	126	0	3	16%	66%
SOS	1,125	138	2	8	12%	62%
Total	1,895	264	2	11	14%	63%
Full Survey Total	**14,105**	**2,868**	**42**	**422**	**63%**	

[1]Refusal is defined as a blank survey returned by a respondent asking to be taken off the mailing list or a returned unopened survey with "Refused" or "Return to Sender" written on the envelope.

[2]Nondeliverable is defined as a survey returned due to an incorrect address or a respondent who is no longer at the address.

CHAPTER 3. SURVEY ANALYSIS AND RESULTS

Partial results of the choice experiment survey are presented in this chapter. The chapter begins with the background characteristics of respondents, then discusses respondents attitudes and experience with deer and deer-related attributes and differences between hunters and nonhunters. Attitude differences among respondents with different demographic characteristics are also examined. The chapter concludes with an assessment of issue activity and stakeholder satisfaction with different deer/externality situations.

Characteristics of Survey Respondents

Data were obtained for several demographic variables. As can be seen in Table 6, in the public sample slightly more men returned the survey than did women. From the 2000 Census data for Michigan, the population consists of about 49% men and 51% women, thus the survey returns based on sex are slightly different than the general population; however, this may be due to the nature of the survey and the fact that more men hunt than do women. The mean age of respondents from the MDNR sample is 48 (median = 47) and 51 (median = 49) for respondents from the SOS sample. For convenience these samples will be referred to as hunters and public, unless otherwise noted. Median annual income category is $35,000-$49,000 for both groups. Both hunters and public have lived an average of 46 years in Michigan. The survey sample compares well to the 2000 Census data for Michigan for income variables; however, the median age of respondents is a little over 10 years older than the median age in Michigan

(36), according to the Census. The 2000 Census data shows that the median income in Michigan is $44, 667, which is within the median annual income category for survey respondents. Education level of survey respondents is similar to that of the general population. The 2000 Census data shows that about 30% of the population in Michigan has a high school degree, about 23% has some college, 7% has an associate's degree, 14% has a bachelor's degree, and 8% has a graduate degree. It should be noted that the characteristics of the sample population for this survey are not expected to match those of the 2000 Census, as the current sample is drawn from primarily rural regions in Michigan and includes only people over 21 years of age.

On average, hunters have spent 35 years in their region, while public have spent 33 years. Approximately 6%, 4%, and 5% of the public respondents derived income from farming, forestry, and tourism, respectively. For hunters, 9%, 8%, and 4% of respondents derived income from farming, forestry, and tourism. The majority of both hunters and public owned property in their region, with the median property size for hunters of 18 acres (mean acreage is 67) and the median size for public of 5 acres (mean acreage is 81). Respondents stated that their property was used for a variety of purposes. For respondents in the public sample, uses included primary residence (68%), hunting (21%), wildlife viewing (21%), recreational residence (13%), farming (10%), and forest products (7%). Hunters stated primary residence (63%), hunting (42%), wildlife viewing (35%), recreational residence (20%), farming (15%) and forest products (13%) as property uses. More detailed respondent characteristics, stratified by region, are provided in Table 6. To adjust for item non-response, percentages are based on the number of

respondents answering the question.

Table 6. **Characteristics of Survey Respondents**

Stakeholder Group	**Hunter (MDNR)**			**Public(SOS)**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Sex*						
% Male	89	91	89	55	57	56
% Female	11	9	11	45	43	44
N=	415	448	410	516	600	484
Age*						
% 18-34	20	21	21	20	20	23
% 35-44	28	24	21	28	24	20
% 45-54	20	19	22	20	19	22
% 55-64	16	19	18	17	19	18
% 65-74	10	12	12	9	13	12
% Over 75	6	6	6	6	5	5
N=	415	448	410	516	600	484
Education						
% Less than high school	5	10	6	5	8	5
% High school graduate/GED	37	33	31	32	36	24
% Vocational/Trade	8	8	9	8	8	5
% Associates degree	18	21	24	20	20	25
% Some college	9	13	13	8	10	13
% College graduate	15	10	11	16	9	18
% Graduate/Professional	8	5	6	11	9	10
N=	400	403	388	483	533	453
Item non-response (n)	15	38	22	33	67	31
Income						
% Less than $14,999	6	9	5	12	12	8
% $15,000 - $24,999	14	19	7	15	16	12
% $25,000 - $34,999	19	17	12	16	19	13
% $35,000 - $49,999	23	23	20	26	23	17
% $50,000 - $74,000	22	20	32	17	17	28
% Over $75,00	16	12	24	14	13	22
N=	359	349	354	426	448	404
Item non-response (n)	56	92	56	90	152	80
Years in Michigan						
% 0 - 10	4	1	2	5	2	4
% 11 - 25	15	7	7	11	6	8
% 26 - 40	23	25	29	26	21	29
% 41 - 60	39	39	45	36	40	42
% Over 60	19	28	17	22	31	17
N=	402	430	395	484	552	462
Item non-response (n)	13	11	15	32	48	22

Table 6 cont'd.

Stakeholder Group	Hunter (MDNR)			Public(SOS)		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Property ownership in region						
% Yes	80	85	83	80	87	82
% No	20	15	17	20	13	18
N=	404	431	394	479	536	455
Item non-response (n)	11	10	16	37	64	29
Property Size (acres)						
% Less than 2	22	17	13	32	27	45
% 2 - 10	26	29	27	24	30	32
% 11- 50	27	28	34	25	20	15
% 51 - 100	13	10	10	10	9	4
% Over 100	12	16	16	9	14	4
N=	319	319	320	330	416	343

* Sex and age were not asked in the survey but were provided in the SOS and MDNR sample frames, thus there is no item non-response for these characteristics.

Data concerning hunting activity were also collected in the survey. While over 90% of respondents in the hunter sample stated that they hunt deer in the region, a relatively large percentage (40%) of the public sample also stated that they hunt in the region. This potential bias is addressed in the next section 'Attitudes and Experience with Deer and Deer-related Attributes.' The mean number of years hunting in a region was 26 and 25 for hunters in the MDNR sample and SOS sample, respectively. On average hunters in the MDNR sample hunted for 16, 17, and 17 days in the northwest, northeast, and southwest regions, respectively, in the year 2000. Hunters from the SOS sample hunted an average of 14, 14, and 13 days in the northwest, northeast, and southwest regions in 2000. More detailed respondent characteristics, stratified by region, are provided in Table 7. Percentages have been adjusted for item non-response.

Table 7. **Hunting Activity of Survey Respondents**

Stakeholder Group	**Hunter (MDNR)**			**Public (SOS)**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Hunt in region						
% Yes	92	95	91	49	50	30
% No	8	5	9	51	50	70
N=	401	434	396	469	535	454
Item non-response (n)	14	7	14	47	65	30
Years hunted in region						
% 0 – 10	17	18	27	21	16	34
% 11 – 25	36	28	35	32	34	34
% 26 – 40	27	29	30	31	33	24
% 41 – 60	19	23	8	13	17	8
% Over 60	1	2	<1	3	<1	<1
N=	376	414	363	241	274	137
Days hunted last year						
% 0 – 5	18	19	20	29	31	34
% 6 – 15	49	48	46	49	42	34
% 16 – 30	22	23	22	15	17	24
% Over 30	11	10	12	7	10	8
N=	380	398	362	239	272	135

Attitudes and Experience with Deer and Deer-related Attributes

As stated previously, to familiarize respondents with the choice experiment attributes they were provided with attribute descriptions and then asked to complete several attitude and experience questions. While the primary purpose of these questions was to familiarize respondents with the attributes, the questions do provide data concerning perceptions of and experience with externalities associated with deer. A general summary of responses is described below, with more detailed regional responses provided in tables. As described in the 'Survey Development' section, respondents were also asked to rate their level of agreement with several statements concerning the credibility of the attribute descriptions and baseline estimates. An analysis of these

responses shows that the majority of hunters and public accepted the baseline estimates and attribute descriptions provided in the survey.

In the state of Michigan, a sample of "the general public" would generally contain a percentage of hunters, ranging between 3% and 20%, depending on the region (Peter Bull, pers. comm.). However, the percentage of respondents from the public (SOS) sample who stated that they hunt was considerably larger than the percentages given above. For this reason, and due to an expressed interest in comparing different segments of the general population, hunter responses from the SOS sample were analyzed with responses from the MDNR hunter sample. This segmentation created two distinct groups of hunters and nonhunters. The remaining analyses in this chapter have been conducted on responses from these two groups, as opposed to responses from the public (SOS) and hunters (MDNR).

Deer

Combining all regions 38% of hunters stated that they frequently saw deer in their own yard or neighborhood. The percentage was higher in the northwest (46%), lower in the northeast (28%) and about the same as all regions combined for the southwest. Twenty-eight percent of hunters stated that they frequently took a drive or a walk for the specific purpose of viewing deer, with only slight differences (< 2%) among the three regions. On average, relative to the year 2000, hunters in the northwest and southwest regions stated they would like about 25% more deer in future years, while hunters in the northeast region wanting about a 50% increase. Forty-five percent of hunters stated they

would be very concerned if the number of deer in their region decreased in future years by 20%. In the northeast region this percent was much higher (57%) while the northwest and southwest regions were lower, at approximately 38%.

Similar to the hunter sample, combining all regions 33% of nonhunter respondents stated that they frequently see deer in their own yard or neighborhood, but only 10% of this sample stated that they frequently took a drive or a walk specifically to see deer. The percentage of nonhunters who see deer frequently was highest in the northwest (41%), with 32% in the northeast and 35% in the southwest. In all regions the percentage of nonhunters who took drives or walks specifically to see deer was between 8% and 11%. On average, relative to the year 2000, nonhunters stated that they would like about the same number of deer in future years, with minimal differences among regions. Thirty-eight percent of nonhunters stated that they would be very concerned if the number of deer in their region decreased in future years by 20%, with only marginal differences among regions. Table 8 provides detailed regional responses of hunters and nonhunters.

Table 8. **Respondent Attitudes/Experience With Deer**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Frequency of seeing deer in own yard or neighborhood last year						
% Never	10.4	13.5	13.6	15.5	17.9	25.1
% Rarely	14.5	26.4	11.7	16.7	20.7	18.7
% Sometimes	29.3	32.3	34.2	27.1	28.9	26.9
% Frequently	45.8	27.8	40.5	40.7	32.5	29.2
N=	598	659	486	258	280	342
Item non-response (n)	7	23	12	7	7	10
Frequency of taking drive/walk specifically to view deer						
% Never	12.6	12.7	11.5	32.4	31.6	48.5
% Rarely	19.7	19.6	17.8	25.7	27.4	20.7
% Sometimes	38.8	39.4	41.8	30.8	30.1	22.9
% Frequently	29.0	28.3	28.7	11.1	10.9	7.9
N=	580	639	478	253	266	328
Item non-response (n)	25	43	20	12	21	24
Number of deer desired in region in future years						
% none	0.2	0.0	0.0	0.8	1.4	2.3
% 75% less	1.7	0.7	1.2	3.8	2.9	3.5
% 50% less	9.6	6.6	5.3	17.3	12.3	15.4
% 25% less	9.6	2.8	8.4	11.5	8.0	10.2
% Same as last year	27.7	19.7	39.4	28.8	24.3	33.4
% 25% more	14.3	13.9	14.9	6.5	5.8	3.5
% 50% more	20.2	29.3	17.3	5.4	12.7	5.5
% 75% more	3.5	5.4	2.9	1.5	0.4	0.3
% Twice as many or more	7.3	16.6	6.9	1.9	5.1	0.9
% Unsure	4.0	4.6	2.7	15.8	21.0	16.9
% Don't care	1.9	0.4	1.0	6.5	6.2	8.1
N=	593	670	490	260	276	344
Item non-response (n)	12	12	8	5	11	8
Concern if the number of deer in the region decreased by 20% in future years						
% Very concerned	37.9	59.2	37.3	13.4	16.6	10.1
% Concerned	26.1	21.6	27.8	25.6	30.7	19.7
% Somewhat concerned	14.5	9.3	18.1	21.4	20.5	26.3
% Not concerned at all	21.56	10.0	16.8	39.7	32.2	43.6
N=	601	681	493	262	283	346
Item non-response (n)	4	1	5	3	4	6

The MDNR hunter sample was also asked about the number of mature bucks in their region – defined as the number of bucks two and a half years or older with at least four antler points on one side. As compared to last year (2000), hunters stated that they would like to have about 50% more mature bucks in their region in future years, with only slight differences among regions (<1%). Sixty-three percent of hunters stated that they would be very concerned if the number of mature bucks in their region decreased in future years by 20%. The percentage was higher in the northeast (69%) and lower in the southwest (57%).

Table 9. **Respondent Attitudes Toward Mature Bucks**

Stakeholder Group	**Hunter (MDNR sample)**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Number of deer desired in region in future years						
% none	0.3	0.5	0.3			
% 75% less	0.3	0.2	0.3			
% 50% less	1.4	0.7	1.7			
% 25% less	0.8	0.2	1.7			
% Same as last year	8.8	7.3	17.1			
% 25% more	13.5	13.6	17.7			
% 50% more	37.9	33.3	32.6	NA	NA	NA
% 75% more	4.7	6.6	2.8			
% Twice as many or more	28.8	30.8	21.9			
% Unsure	1.9	4.4	3.1			
% Don't care	1.6	2.4	0.8			
N=	403	433	397			
Item non-response (n)	12	8	13			
Concern if the number of mature bucks in the region decreased by 20% in future years						
% Very concerned	64.8	70.8	58.5			
% Concerned	24.6	18.6	26.6			
% Somewhat concerned	8.2	6.3	10.9	NA	NA	NA
% Not concerned at all	2.5	4.3	3.9			
N=	406	435	398			
Item non-response (n)	9	6	12			

Herd Health

In the attribute description of herd health four characteristics of a deer in poor health – smaller body size than expected, low reproductive success, disease, and low chance of surviving long winters – were provided along with an estimate of the percent of deer in the region that have at least one of these characteristics. Fifty-eight percent of hunters indicated that they would be very concerned if the percent of deer in their region with at least one characteristic of poor health increased (relative to the status quo) in future years. There were slight differences (<4%) among regions. Respondents were also asked to rate the health of the deer herd in their region based on their own opinion and experience. Twenty-nine percent of hunters rated the health of the herd in their region as excellent. In the northwest and northeast regions only 23% of hunters thought that herd health was excellent, while in the southwest the percentage was much higher at 44% .

Thirty-eight percent of nonhunters said they would be very concerned if the percent of deer with at least one characteristic of poor health increased in future years. This percent was highest in the northeast region (51%), with slight differences between the northwest (34%) and the southwest (31%). In contrast to the hunter sample, only 11% of nonhunters rated the health of the herd in their region as excellent. The percent was highest in the southwest (17%), and lower in the northwest (10%) and northeast (6%). The majority of nonhunters in all regions rated the health of the herd as "good." Table 10 shows detailed, regional responses.

Table 10. **Respondent Attitudes Toward Herd Health**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Concern if percent of deer in region with at least one characteristic of poor health increased by 10% in future years						
% Very concerned	56.3	56.0	60.7	34.1	51.8	31.7
% Concerned	33.7	32.0	31.5	40.9	34.0	40.1
% Somewhat concerned	7.7	8.8	6.9	19.3	9.9	19.3
% Not concerned at all	2.4	3.1	1.0	5.3	4.3	8.9
N=	597	671	496	264	282	347
Item non-response (n)	8	11	2	1	5	5
Rating of herd health in region						
% Excellent	23.0	23.2	44.6	10.0	5.7	17.3
% Good	38.8	38.2	22.4	45.2	27.2	30.3
% Fair	31.8	26.9	27.8	19.5	23.0	11.5
% Poor	3.2	4.2	1.6	2.7	6.4	<1.0
% Unsure	3.2	7.4	3.6	22.6	37.8	40.3
N=	595	672	496	261	283	347
Item non-response (n)	10	10	2	4	4	5

Deer Damage to Residential Property

Combining all regions 38% of hunters had experienced residential property damage from deer. In the northwest region the percentage was higher (50%), while in the northeast and southwest approximately 30% of hunters experienced residential damage from deer. In the northwest deer damage caused 43% of respondents to change the types of plants in their yards. This percentage was lower in the northeast (30%) and southwest (20%). In the northwest about 16% of hunters felt that it was very important to substantially decrease the current level of property damage, while in the northeast and southwest this percentage was approximately 8%.

Thirty-five percent of nonhunter respondents had experienced residential property damage from deer. Similar to the hunter sample, the percentage was higher in the northwest (45%) than in the northeast or southwest (30%). In the northwest and northeast the damage caused 50% of nonhunters to change the plants in their yards, while 30% of nonhunters in the southwest changed the types of plants in their yard. In the northwest and northeast less than 20% of nonhunters felt that it was very important to decrease the current level of property damage, while in the southwest this percentage was about 28%. Table 11 shows detailed regional responses.

Table 11. **Respondent Attitudes/Experience with Deer Damage to Residential Property Damage**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Experienced residential property from deer						
% Yes	50.6	31.0	32.0	45.4	32.7	28.7
% No	49.4	69.0	68.0	54.6	67.3	71.3
N=	593	661	490	262	278	342
Item non-response (n)	12	21	8	3	9	10
Damage resulted in changing types of plants in yard						
% Yes	43.9	30.8	20.7	51.3	47.3	29.3
% No	56.0	68.3	79.3	47.1	51.6	68.7
% Unsure	<1.0	<1.0	0	0.8	1.1	2.0
N=	303	224	169	119	93	99
Importance of decreasing current level of damage by 10%						
% Very important	16.2	7.8	8.7	16.8	11.8	13.0
% Important	25.4	21.7	26.2	31.3	28.0	27.1
% Somewhat important	35.0	32.3	34.1	34.7	35.8	35.2
% Not important at all	23.4	38.2	30.9	17.2	24.4	24.8
N=	594	668	492	262	279	347
Item non-response (n)	11	14	6	3	8	5

Deer Damage to Agricultural Crops

Fifty-five percent of hunters had either experienced themselves or knew someone in the region who had experienced deer damage to agriculture. On a regional level this percent was much higher in the southwest (70%) than in the northwest and northeast (50%); however in all regions the damage was most frequently categorized as relatively unimportant economic loss. Less than 20% of hunters in each region stated that they would be very concerned with a large increase in the amount of deer damage to agriculture.

In contrast to the hunter respondents, between 36% and 40% of the nonhunter respondents experienced or knew someone in the region who experienced deer damage to agriculture. In all regions the damage was most frequently categorized as a moderately important economic loss. Approximately 25% of nonhunters in each region stated that they would be very concerned with a large increase in the amount of deer damage to agriculture. Table 12 shows detailed regional responses.

Table 12. **Respondent Attitudes/Experience with Deer Damage to Agriculture**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Experienced or know someone in region who experienced deer damage to agriculture						
% Yes	47.0	51.4	71.2	39.8	37.4	36.0
% No	53.0	48.6	28.2	60.2	62.6	64.0
N=	592	666	486	261	273	342
Item non-response (n)	13	16	12	4	14	10
Economic loss from damage:						
% Major loss	6.4	4	4.3	9.6	5.9	6.5
% Moderately important loss	36.5	27.1	38.5	41.3	30.4	37.4
% Relatively unimportant loss	37.2	53.0	43.0	29.8	30.4	30.9
% Unsure	19.9	15.6	14.2	19.2	31.4	23.6
N=	282	247	351	104	102	123
Concern with large increase in deer damage to agriculture						
% Very concerned	21.5	12.9	18.7	25.1	23.0	24.4
% Concerned	32.4	27.1	35.2	36.5	31.7	34.9
% Somewhat concerned	33.4	36.2	32.7	28.9	33.5	30.2
% Not concerned at all	12.7	23.8	13.4	9.5	11.9	10.9
N=	599	668	492	263	278	348
Item non-response (n)	6	14	6	2	9	4

Deer-vehicle Collisions

Seventy-one percent of hunters were aware that the majority of deer-vehicle collisions take place on local or rural roads rather than highways and freeways. Eighty-one percent of hunters stated that they or someone in their immediate family had been involved in a deer-vehicle collision, with only marginal differences among regions. In the northwest and southwest regions approximately 30% of hunters said it would be very important to decrease the annual number of collisions, while only 20% of hunters in the northeast stated that this would be very important.

Sixty-seven percent of the nonhunters were aware that most deer-vehicle collisions occurred on local or rural roads, and approximately 75% of nonhunters stated that they or someone in their immediate family had been involved in a deer-vehicle collision. Importance placed on decreasing the number of collisions was highest in the northwest, and lower in the northeast and southwest. Table 13 shows detailed regional responses.

Table 13. **Respondent Attitudes/Experience with Deer-vehicle Collisions**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Yourself or someone in immediate family involved in deer-vehicle collision						
% Yes	83.9	78.6	82.6	77.4	77.2	74.1
% No	15.6	22.1	17.2	21.8	21.4	24.1
N=	596	673	489	261	281	344
Item non-response (n)	9	9	9	4	6	8
Importance of decreasing annual deer-vehicle collisions by 10% in future years						
% Very important	32.4	20.0	28.2	43.8	38.1	46.7
% Important	29.7	27.1	33.7	35.8	34.5	30.7
% Somewhat important	29.0	30.0	26.5	15.4	22.1	17.7
% Not important at all	8.9	22.9	11.6	5.0	5.3	4.9
N=	596	669	490	260	281	345
Item non-response (n)	9	13	8	5	6	7

Deer Browsing and Forest Ecosystems

Thirty percent of hunters stated that they had seen effects of deer browsing in forested areas. The percentage was higher in the northwest (42%) than in the northeast (26%) and southwest (22%). Hunters in all regions were more concerned with the effects

deer browsing has on other types of wildlife and the forest ecosystem and less concerned about losses to the forest industry caused by deer browsing.

Twenty-six percent of nonhunters stated that they had seen effects of deer browsing. Similar to hunters, a higher percentage of nonhunters in the northwest (40%) had seen effects of deer browsing than in the northeast (22%) or southwest (20%). Nonhunters in all regions were most concerned with the effects deer browsing on wildlife and the forest ecosystem and least concerned about losses to the forest industry caused by deer browsing. Table 14 shows detailed regional responses.

Table 14. **Respondent Attitudes/Experience with Deer Browsing in the Forest**

Stakeholder Group	**Hunter**			**Nonhunter**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Have seen examples of deer browsing in the forest						
% Yes	42.5	26.1	22.5	37.9	22.3	19.5
% No	52.8	68.6	71.4	48.3	62.8	64.4
% Unsure	2.3	3.5	4.1	13.8	14.8	16.0
N=	598	678	493	261	282	343
Item non-response (n)	7	4	5	4	5	9
Concern if percent of forest area experiencing heavy deer browsing increases by 10% in future years						
% Very concerned	21.8	11.7	13.4	23.1	15.9	22.6
% Concerned	32.9	28.1	32.0	36.4	33.2	34.0
% Somewhat concerned	33.2	30.8	36.3	28.0	33.6	30.9
% Not concerned at all	12.1	29.4	18.3	12.5	17.3	12.6
N=	602	676	493	264	283	350
Item non-response (n)	3	6	5	1	4	2

Table 14 cont'd

Stakeholder Group	Hunter			Nonhunter		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
Concerned about browsing because of changes to wildlife						
% Strongly agree	10.8	5.0	7.1	13.9	10.4	14.2
% Agree	33.3	20.4	36.9	44.8	37.4	40.8
% Neither agree/disagree	34.3	34.7	32.7	30.5	34.5	35.8
% Disagree	16.5	26.7	15.8	8.5	14.4	7.2
% Strongly disagree	5.0	13.2	7.5	2.3	3.2	2.0
N=	600	666	493	259	278	346
Item non-response (n)	5	16	5	6	9	6
Concerned about browsing because of long-term effects to forest ecosystem						
% Strongly agree	14.8	5.7	9.8	19.4	10.7	19.6
% Agree	36.9	21.4	39.2	42.2	39.9	40.1
% Neither agree/disagree	27.8	30.5	24.8	27.1	31.7	31.7
% Disagree	16.1	29.3	18.9	9.3	13.93	6.6
% Strongly disagree	4.3	13.0	7.3	1.9	3.9	2.0
N=	601	668	492	258	281	347
Item non-response (n)	4	14	6	7	6	5
Concerned about browsing because of losses to commercial forestry						
% Strongly agree	9.7	2.6	3.9	8.5	5.8	8.4
% Agree	26.0	12.5	18.4	34.5	23.1	25.5
% Neither agree/disagree	34.4	30.5	36.2	32.6	43.7	41.4
% Disagree	20.0	30.9	24.3	19.0	17.7	18.0
% Strongly disagree	9.8	23.6	17.2	5.4	9.7	6.7
N=	599	666	489	258	277	345
Item non-response (n)	6	16	9	7	10	7

Belief Statements

Near the end of the survey, respondents were asked to express their level of agreement with a set of "belief statements." In part, these belief statements were designed to aid in determining whether respondents found the externality information presented in the survey credible, with the expectation that a low percentage of

respondents would express disagreement with statements C, E, G, and J, and a high percentage of respondents would express disagreement with statement F in Table 15. Results in Table 15 support the expectation, but there are respondents who do not accept the baseline estimates. Other belief statements were included in the survey because of their potential as explanatory variables in various types of models, as well as a means for gathering additional data that may be useful to deer management.

Table 15. **Respondent Agreement with Belief Statements**

Stakeholder Group	**Hunter**			**Public**		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
***A.* When deer-vehicle collisions increase in an area, car insurance rates usually increase**						
% Strongly Agree/Agree	56	59	63	60	55	70
% Neither Agree nor Disagree	29	26	24	27	27	20
% Strongly Disagree/Disagree	15	15	13	13	18	10
N=	401	423	392	475	540	456
Item non-response (n)	14	18	18	41	60	28
***B.* People can avoid most deer-vehicle collisions**						
% Strongly Agree/Agree	47	56	49	35	43	28
% Neither Agree nor Disagree	19	15	19	14	17	20
% Strongly Disagree/Disagree	34	29	32	51	40	52
N=	403	424	392	475	542	455
Item non-response (n)	12	17	18	41	58	29
***C.* Deer browsing can prevent some types of trees from reproducing in the forest**						
% Strongly Agree/Agree	68	53	59	69	54	69
% Neither Agree nor Disagree	20	27	28	21	27	24
% Strongly Disagree/Disagree	12	20	13	10	19	7
N=	399	421	385	476	538	455
Item non-response (n)	16	20	25	40	62	29

Table 15 cont'd.

Stakeholder Group	Hunter			Public		
Region	**NW**	**NE**	**SW**	**NW**	**NE**	**SW**
***D.* The effects of deer browsing in the forest are significant in the nw/ne/sw region of Michigan**						
% Strongly Agree/Agree	32	19	22	37	32	29
% Neither Agree nor Disagree	38	35	40	42	40	53
% Strongly Disagree/Disagree	30	46	38	21	28	19
N=	402	423	392	473	539	453
Item non-response (n)	13	18	18	43	61	31
***E.* When comparing scenarios I accepted that 30% of the forest areas in the nw/ne/sw region of Michigan experience heavy deer browsing**						
% Strongly Agree/Agree	42	23	41	45	33	45
% Neither Agree nor Disagree	32	33	30	30	35	36
% Strongly Disagree/Disagree	26	44	29	25	32	19
N=	401	419	386	470	530	453
Item non-response (n)	14	22	24	46	70	31
***F.* A deer with at least one characteristic of poor health has a disease**						
% Strongly Agree/Agree	21	19	20	21	24	28
% Neither Agree nor Disagree	35	29	38	38	32	37
% Strongly Disagree/Disagree	43	52	42	41	44	35
N=	403	420	391	473	535	451
Item non-response (n)	12	21	19	43	65	33
***G.* When comparing scenarios I accepted that 35%/30%/5% of deer in the nw/ne/sw region have at least one characteristic of poor health**						
% Strongly Agree/Agree	44	26	55	48	40	64
% Neither Agree nor Disagree	33	36	30	34	30	28
% Strongly Disagree/Disagree	23	38	15	18	30	8
N=	401	420	389	471	534	451
Item non-response (n)	14	21	21	45	66	33

Table 15 cont'd.

Stakeholder Group	Hunter			Public		
Region	NW	NE	SW	NW	NE	SW
***H.* There is a significant amount of deer damage to agricultural crops in the nw/ne/sw region of Michigan**						
% Strongly Agree/Agree	42	25	49	45	35	49
% Neither Agree nor Disagree	34	37	31	33	36	36
% Strongly Disagree/Disagree	24	38	20	22	29	15
N=	403	425	392	474	537	454
Item non-response (n)	12	16	18	42	63	30
***I.* There is a significant amount of deer damage to residential properties in the nw/ne/sw region of Michigan**						
% Strongly Agree/Agree	40	14	21	41	22	31
% Neither Agree nor Disagree	28	30	34	28	34	40
% Strongly Disagree/Disagree	42	56	45	31	44	29
N=	403	425	391	475	537	455
Item non-response (n)	12	16	19	41	63	29
***J.* When comparing scenarios I accepted that 30%/20%/20% of residential properties in the nw/ne/sw region of Michigan experience some deer damage**						
% Strongly Agree/Agree	60	41	49	55	49	57
% Neither Agree nor Disagree	20	29	29	27	28	30
% Strongly Disagree/Disagree	20	30	12	28	23	13
N=	402	423	391	471	534	452
Item non-response (n)	13	18	19	45	66	32
***K.* The number of bucks can increase in a deer herd even if the total number of deer stays the same**						
% Strongly Agree/Agree	54	47	55	36	34	34
% Neither Agree nor Disagree	20	27	22	39	43	49
% Strongly Disagree/Disagree	26	26	21	25	23	17
N=	401	424	391	472	531	452
Item non-response (n)	14	17	19	44	69	32

Respondent Segmentation Analysis

Segmentation Based on Respondent Characteristics

Data on selected respondent characteristics were collected in the survey and cross-tabulated or correlated with attitudes toward deer and deer-related attributes in order to help explain preference heterogeneity. Selected characteristics are listed below:

- hunter or nonhunter
- number of years living in the northwest/northeast/southwest region
- type of residential area, e.g. rural, semi-rural, town/city
- number of years hunting deer in northwest/northeast/southwest region
- income category
- education category
- age

Cross tabulation analyses were conducted to examine differences between hunters and nonhunters. All other variables contained at least 4 ordered categories, with the exception of "type of residential area" which contained 3. Assuming ordinal data, Pearson correlation coefficients were computed. Significance level was set at $p \leq 0.05$ for both chi-square and correlation statistics. Significant relationships are described below. Test statistics and significance levels are presented in Tables 16 and 17. All significant correlations have a Pearson's correlation coefficient ranging from 0.07 to 0.12. In the remainder of this chapter, a correlation of this magnitude will be referred to as weakly significiant. Measurement scales for questions asking respondents about their 'concern for an externality increase' or the 'importance placed on decreasing an

externality' ranged from 1= "very concerned" or "very important" to 4 = "not concerned at all" or "not important at all," thus the coefficient signs in Tables 16 and 17 may appear the reverse of what would be expected.

Number of Deer Desired for the Region

In all regions hunters and nonhunters differ significantly in the number of deer they would like to have, with hunters generally preferring more deer than the current number and nonhunters preferring about the same as the current number. In the northwest region income was weakly correlated with the number of deer desired for the region, suggesting that respondents with higher incomes tend to prefer less deer for the region. In the northeast region the number of years hunting was weakly correlated with the number of deer desired for the region, suggesting that hunters with more years of hunting tend to prefer less deer. In the southwest region the type of residential area (city/town, scattered neighborhoods outside the town, rural area) was weakly correlated with preferences for deer numbers, with respondents living in rural areas tending to prefer less deer.

Concern for Deer Numbers

In all regions hunters were also more concerned with potential decreases in the number of deer than were nonhunters, although 38% of the public stated they would be very concerned if the number of deer decreased by 20% (relative to the current number) in future years. In all regions education level was weakly correlated with concern for a

decrease in deer numbers, suggesting that respondents with higher education levels tend to be less concerned with a 20% decrease in the number of deer in the northwest region than do respondents with less education. In the northeast respondents with more years hunting in the region tend to be more concerned with a 20% decrease in deer numbers.

Number of Mature Bucks Desired for the Region

Analyses concerning mature bucks were conducted on hunters from the MDNR sample only, as hunters from the SOS sample did not receive a survey version that contained questions about bucks. The only significant correlations that exist concerning the number of mature bucks desired for the region occur in the northwest region, where hunters with more years of hunting tend to desire fewer mature bucks than do hunters with less years of hunting.

Concern for the Number of Mature Bucks

In the southwest region hunters with more years of hunting tend to be more concerned with a 20% decrease in the number of mature bucks. There were no significant correlations in the northwest or northeast.

Concern for Herd Health

In all regions hunter and nonhunter ratings were significantly different, with hunters generally rating the health of the herd higher than nonhunters. In the northeast respondents living in more rural areas tended to rate health higher, whereas respondents

with higher levels of education and older respondents tended to rate the health of the herd lower. In the southwest respondents with more years living in the region tended to rate the health of the herd higher, as did respondents with more years of hunting and respondents living in more rural areas. In the southwest respondents with higher levels of education tended to give lower ratings to herd health.

Concern for Deer Damage to Residential Property

Significant difference exists between hunters and nonhunters in the northeast region in the importance placed on decreasing the amount of deer damage to residential property, where hunters felt it was less important to decrease the amount of damage than did nonhunters. However, for both groups of respondents less than 15% felt that it was *very important* to decrease the amount of deer damage to residential property. In all regions the number of years hunting was weakly correlated with importance of reducing residential damage, with hunters with more years hunting tending to place more importance on decreasing the amount of deer damage to residential property. In the northeast and southwest regions respondents with higher incomes tended to place less importance on decreasing the amount of residential property damage, and in the northeast older respondents tended to place more importance on decreasing the amount of deer damage to residential property.

Concern for Deer Damage to Agriculture

Hunters and nonhunters differed significantly in the northeast region in their concern for any increases in deer damage to agriculture, with hunters tending to be less concerned than nonhunters with an increase. In the northwest and northeast regions respondents with more years living in the region tended to be more concerned with any increases in deer damage to agriculture.

Concern for Deer-Vehicle Collisions

In all regions there were significant differences between hunters and nonhunters in the importance they placed on reducing the annual number of deer-vehicle collisions, with hunters generally placing less importance on reductions than did nonhunters. In the northeast region respondents with higher incomes tended to place less importance on reducing the annual number of deer-vehicle collisions.

Concern for Deer Browsing in the Forest

Significant differences exist between hunters and nonhunters in the northeast and southwest in their concern for increases in the amount of heavy deer browsing in forests, with nonhunters tending to be more concerned with an increase than hunters. In the northwest region respondents with more education tended to be more concerned with an increase in the amount of deer browsing in the forest.

In all regions there were significant differences between hunters and nonhunters in their concern about the effects deer browsing has on wildlife and concern about the long-

term effects of browsing on the forest ecosystem. In the northeast and southwest significant differences exist between hunters and nonhunters in their concern about the effects deer browsing has on commercial forestry. In all of the above cases hunters tended to be less concerned than nonhunters.

In the northwest region respondents with more education tended to be more concerned about the effects deer browsing has on other wildlife and the long-term effects on the forest ecosystem, while respondents with more years living in the region tended to be more concerned about the effects of deer browsing on commercial forestry. In the northeast respondents living in more rural areas tended to be less concerned about the long term effects of deer browsing on the forest ecosystem and the effects on commercial forestry. Also in the northeast respondents with more education tended to be more concerned about the long-term effects deer browsing has on the forest ecosystem, and respondents with more years living in the region tend to be more concerned about the effects of deer browsing on commercial forestry. In the southwest region respondents with higher incomes tend to be less concerned about the effects of deer browsing on commercial forestry.

Table 16. **Respondent Characteristics Correlated with Deer and Buck Numbers**

Attitude	Northwest	Northeast	Southwest
Who tends to prefer more deer?	Hunters $\chi^2 = 110.7$ (0.00)	Hunters $\chi^2 = 200.4$ (0.00)	Hunters $\chi^2 = 245.5$ (0.00)
	Resp. with less income $\chi^2 = -0.10$ (0.00)		
		Resp. with fewer years of hunting $\chi^2 = -0.10$ (0.01)	
			Resp. living in less rural areas $\chi^2 = -0.8$ (0.01)
Who tends to be more concerned with deer number decreases?	Hunters $\chi^2 = 66.7$ (0.00)	Hunters $\chi^2 = 170.8$ (0.00)	Hunters $\chi^2 = 130.8$ (0.00)
		Resp. with more years of hunting $\chi^2 = -0.09$ (0.02)	
	Resp. with less education $\chi^2 = 0.09$ (0.01)	Resp. with less education $\chi^2 = 0.11$ (0.00)	Resp. with less education $\chi^2 = 0.12$ (0.00)
Who tends to prefer more mature bucks?	Resp. with fewer years of hunting $\chi^2 = -0.14$ (0.01)		
Who tends to be more concerned with buck number decreases?			Resp. with more years of hunting $\chi^2 = -0.11$ (0.04)

Table 17. **Respondent Characteristics Correlated with Deer-related Attributes**

Attitude	Northwest	Northeast	Southwest
Who tends to be more concerned with increases in the percent of deer in poor health?	Hunters $\chi^2 = 52.1$ (0.00)		Hunters $\chi^2 = 98.5$ (0.00)
Who tends to place more importance on decreasing the amount of deer damage to residential property?		Nonhunters $\chi^2 = 22.3$ (0.01)	
		Resp. with less income $\chi^2 = 0.07$ (0.05)	Resp. with less income $\chi^2 = 0.11$ (0.00)
	Resp. with more years hunting $\chi^2 = -0.08$ (0.05)	Resp. with more years hunting $\chi^2 = -0.07$ (0.05)	Resp. with more years hunting $\chi^2 = -0.11$ (0.01)
		Older resp. $\chi^2 = -0.08$ (0.01)	
Who tends to be more concerned with increases in deer damage to agriculture?		Nonhunters $\chi^2 = 35.9$ (0.00)	
	Resp. with more years living in region $\chi^2 = -0.09$ (0.01)	Resp. with more years living in region $\chi^2 = -0.08$ (0.01)	
Who tends to place more importance on decreasing annual deer-vehicle collisions?	Nonhunters $\chi^2 = 37.2$ (0.00)	Nonhunters $\chi^2 = 74.0$ (0.00)	Nonhunters $\chi^2 = 51.4$ (0.00)
Who tends to be more concerned with increases in the amount of deer browsing in the forest?		Nonhunters $\chi^2 = 21.0$ (0.01)	Nonhunters $\chi^2 = 24.0$ (0.02)
	Resp. with more education $\chi^2 = -0.07$ (0.03)		

Segmentation Based on Experience with Externalities

A separate analysis was conducted to determine whether respondents who had experience with the negative externalities associated with the deer population tended to prefer less deer than those respondents who did not have externality experience. Preferences for deer were obtained from the question asking respondents to state the number of deer they desired for their region in future years, using a scale relative to the current number of deer in the region (see Appendix A). In all regions cross tabulation analyses suggest that respondents who have experience with deer damage to residential property, deer damage to agriculture, and deer browsing tend to prefer less deer for their region than those without these externality experiences (all χ^2 statistics were significant at $p < 0.01$). There were no significant differences between respondents with and without deer-vehicle collision experience in the number of deer preferred for the region; however, this is most likely due to the high percentage of respondents in each region with deer-vehicle collision experience (78% or more in all regions).

Correlation analyses were conducted to examine whether respondents' rating of herd health is significantly correlated to the number of deer desired for the region. The analysis suggests that respondents in the southwest who gave lower health ratings tend to prefer less deer for the region $r = 0.15$, $p < 0.01$). There were no significant correlations between health rating and preference for deer populations in the northwest and northeast regions.

Stakeholder Satisfaction and Issue Activity Related to Alternative Deer Scenarios

Satisfaction Model Estimation

Recall that respondents were asked to rate their satisfaction level of the alternative deer scenarios presented in the survey using a five point Likert scale (see Figure 9), in addition to choosing which scenario they would prefer for their region. Because an experimental design was used to vary the levels of the deer related attributes, there were a total of 144 different "Scenario A's" (48 survey versions times 3 types of choice sets, e.g. increasing, decreasing, or marginal - see Survey Development), and respondents indicated their satisfaction level for these different scenarios. Item non-response for the satisfaction ratings ranged between 4% and 9% for hunters and 9% and 10% for nonhunters, depending on the region and on the type of alternative situation. Generally item non-response was highest when respondents were asked to rate their satisfaction with a marginal situation, e.g. a situation where changes in the attribute levels are marginal relative to the status quo, though this was also the last situation respondent were asked to rate and respondent fatigue may have occurred at this point. The dataset for the satisfaction models was formed by combining ratings for increasing, decreasing, and marginal situations, thus allowing a wider range of variation among the attributes, which served as the independent variables for satisfaction models.

	Current Situation	Scenario A	Scenario B
Number of Deer in Region	Current Number	20% more than current number	20% more than current number
Percent of Deer in Region with at Least One Characteristic of Poor Health	25%	30%	30%
Percent of Properties in Region Experiencing Some Deer Damage	30%	40%	35%
Deer Damage per Acre of Cropland in Region ($/acre)	$6	$8	$7
Annual Number of Deer-Vehicle Collisions in Region	3,562	4,300	4,600
Percent of Forest Area in Region Experiencing Heavy Deer Browsing	30%	35%	40%
Which do you prefer for your region? (Check one)	Current ❑	Scenario A ❑	Scenario B ❑

How satisfied would you be if Scenario A were the situation in your region? (Check only one)

❑ **Extremely Satisfied** ❑ **Satisfied** ❑ **Neither Satisfied Nor dissatisfied** ❑ **Dissatisfied** ❑ **Extremely Dissatisfied**

Figure 9. **Respondent Rating of Satisfaction**

Satisfaction models were estimated using LIMDEP 7.0. The models assume that respondent satisfaction level with a deer situation depends on the levels of the deer-related attributes. Respondent characteristics were also included to determine their effect on satisfaction level. A systematic procedure, outlined below, was used for estimation.

1. General model: OLS model estimated to determine the effects of the deer-related attributes on Satisfaction.

2. A second OLS model was estimated which included deer-related attributes and the respondent characteristics education, age, years living in the region, type of residence area (rural, semi-rural, city/town), and years hunting in the region (hunters only) .

3. A third OLS model was estimated which included deer-related attributes and the significant respondent characteristics from (2) above. Respondent characteristics were retained if they were significant and improved the R-square value. If no respondent characteristics were significant, the General model was retained as the Satisfaction model.

All satisfaction models were significant at $p< 0.05$. Although the hunter and nonhunter models all contained significant attributes, the R-squared value on all models was low - ranging from 0.02 to 0.12 - thus their usefulness in explaining the variance in satisfaction ratings is quite limited. In an effort to improve model performance, ordered probit models were estimated from the satisfaction dataset; however, these models also performed poorly. One reason for the poor model performances may be the limited time allocated to the satisfaction questions during the qualitative research phase. During this phase most of the qualitative research was devoted to the choice experiment, as choice tasks are generally complex and ideally require the respondent to understand what the attributes of a good are as well as the trade-offs they are making among the attributes by choosing one scenario over another. Time and resource constraints dictated that the primary focus of the survey development phase was on determining and defining the choice experiment attributes and construction and presentation of the alternative

scenarios. Clearly additional qualitative work related to stakeholder satisfaction questions would have been useful. Results of the satisfaction models estimated using OLS regression are presented in Table 18.

Regional Results of Stakeholder Satisfaction

Northwest Region

The only significant attribute for hunters in the northwest region was the number of mature bucks in the region. This suggests that as the number of mature bucks in the region increases hunter satisfaction increases. Significant attributes of nonhunter satisfaction included herd health and education, suggesting that nonhunter satisfaction decreases as the percent of deer with at least one characteristic of poor health increases and as education increases.

Northeast Region

Significant attributes of hunter satisfaction in the northeast region included the number of deer, the number of mature bucks, and deer vehicle collisions. Results suggest that hunter satisfaction increases when the number of deer and number of mature bucks increase, and satisfaction decreases when the number of annual deer vehicle collisions increases.

Table 18. **Regression Models of Stakeholder Satisfaction with Deer and Deer-related Attributes**

Stakeholder Group	Hunter			Nonhunter		
Region	NW	NE	SW	NW	NE	SW
R-square	0.02	0.08	0.05	0.12	0.08	0.12
Deer Number coefficient (std. error)	0.4697 (0.5786)	2.2080 (0.5946)	1.6326 (0.5894)	0.9244 (0.6429)	1.3883 (0.6790)	1.6147 (0.5201)
Buck Number	2.3434 (1.2266)	2.0407 (1.2111)	-1.5254 (1.3225)			
Herd Health	0.0048 (0.0132)	-0.0076 (0.0133)	-0.0351 (0.0284)	-0.0288 (0.0151)	-0.1622 (0.0146)	-0.0293 (0.0257)
Deer Damage to Residential Property	-0.0103 (0.0132)	0.0092 (0.0123)	-0.0175 (0.0142)	-0.0102 (0.0149)	-0.0090 (0.0141)	-0.0142 (0.0129)
Deer Damage to Agriculture	-0.0140 (0.0722)	-0.1705 (0.1264)	0.1635 (0.1362)	-0.0833 (0.0798)	-0.2630 (0.1399)	0.0407 (0.1229)
Deer-vehicle Collisions	0.0001 (0.0001)	-0.0005 (0.0002)	-0.0003 (0.0001)	-0.0002 (0.0002)	-0.0002 (0.0002)	-0.0006 (0.0001)
Deer Browsing in the Forest	-0.0203 (0.0134)	-0.0021 (0.0132)	-0.0083 (0.0135)	-0.0107 (0.0151)	-0.0245 (0.0147)	-0.0070 (0.0124)
Education				-0.0659 (0.0189)		
Age			-0.0053 (0.0022)		-0.0042 (0.0021)	

Significant attributes of nonhunter satisfaction included the number of deer in the region, deer damage to agriculture, and age. These results suggest that nonhunter

satisfaction increases when the number of deer increases, and decreases when the amount of deer damage to agriculture increases.

Southwest Region

Significant attributes of hunter satisfaction in the southwest region included the number of deer in the region, deer vehicle collisions, and age. Results suggest that satisfaction increases when the number of deer increases. Similar to the northeast nonhunters, older nonhunters in the southwest region tend to be less satisfied than younger hunters. The sign on deer vehicle collisions is counter-intuitive, as it suggests that increases in the annual number of deer vehicle collisions increases satisfaction.

Significant attributes of nonhunter satisfaction included the number of deer and the number of deer-vehicle collisions. Results suggest that nonhunter satisfaction increases with increases in the number of deer, and decreases with increases in deer vehicle collisions.

Issue Activity Model Estimation

In addition to the satisfaction rating, respondents were asked if they would engage in certain types of "issue activity" if Scenario A (see Fig. 9) were the situation in their region. Types of issue activities respondents were asked about included (1) contact someone with authority to get the situation changed, or (2) take steps myself to change the situation. Respondents could also choose (3) do nothing because the situation would not be that bad, or (4) do nothing because it would not change the situation. As explained above, the experimental design used to determine the attribute levels for the

choice experiment resulted in *8*3 within each region for both hunters and non-hunters different "Scenario A's" for each type of choice set, thus respondents were questioned about engagement in issue activity for* 48 different deer situations. Item non-response was less than 6% for hunters and ranged between 7% and 9% for nonhunters. The dataset for the issue activity models was formed by combining ratings for increasing, decreasing, and marginal situations.

Issue activity models were estimated using maximum likelihood techniques for discrete choice data. The data on issue activity was coded as a 1 if respondents stated they would engage in issue activity (either 1 or 2 above) and a zero if respondents stated they would not engage in issue activity (3 or 4 above), given the particular deer situation. The models were estimated using LIMDEP 7.0. The models assume that respondent engagement in issue activity depends on the levels of the deer-related attributes in the scenario. Respondent characteristics variables were also included to determine their effect on satisfaction level; however, none of these variables were retained in the selected Issue Activity models as they generally confounded any significant effects of the deer-related attributes.

The only models containing any significant attributes were the northeast and southwest hunters and the southwest nonhunters. In the northeast the attribute deer numbers was significant ($p<0.01$), suggesting that as deer numbers decreased the likelihood of engaging in issue activity increased. In the southwest the attributes deer numbers and deer damage to agriculture were both significant ($p<0.02$ for both attributes). These results suggest that the likelihood of engaging in issue activity increases as deer numbers decrease and as deer damage to agriculture increases.

The nonhunter issue activity model in the southwest contained two significant attributes: deer damage to agriculture and deer vehicle collisions. While the interpretation for deer vehicle collisions is logical, e.g. the likelihood of engaging in issue activity increases when deer vehicle collisions increase, the coefficient on deer damage to agriculture has a negative sign, implying that the likelihood of issue activity increases as the amount of deer damage to agriculture decreases. Again the lack of qualitative research in developing these questions may be a factor in the poor model results and counter-intuitive sign.

Given the above results, it may be more beneficial to simply examine percentages rather than modeling stakeholder satisfaction and issue activity. For example, calculating the percentages of responses at each point of the agreement scale when the situation is one other than the status quo may be somewhat insightful in examining stakeholder satisfaction. Similarly, examining the percentage of respondents who would engage in issue activity if the situation were one other that the status quo may be more useful than modeling issue activity, particularly given the poor results of the models. This information is summarized in Table 19.

Table 19. **Satisfaction and Issue Activity Associated with Deer Population Changes**

Stakeholder Group	Hunter			Nonhunter		
Region	NW	NE	SW	NW	NE	SW
Satisfaction level and engagement in issue activity when deer numbers and externalities increase						
% **Extremely Satisfied**	7	9	13	5	3	5
% **Satisfied**	33	33	29	23	22	19
% **Neither Satisfied nor Dissatisfied**	25	25	23	23	27	29
% **Dissatisfied**	26	26	28	36	35	32
% **Extremely Dissatisfied**	9	7	7	13	12	15
% **Engage in issue activity when deer numbers and externalities increase**	35	30	34	32	29	33
Satisfaction level and engagement in issue activity when deer numbers and externalities decrease						
% **Extremely Satisfied**	7	4	8	12	13	12
% **Satisfied**	30	25	29	47	43	50
% **Neither Satisfied nor Dissatisfied**	20	21	17	26	22	19
% **Dissatisfied**	30	27	27	12	19	16
% **Extremely Dissatisfied**	13	23	19	3	3	3
% **Engage in issue activity when deer numbers and externalities decrease**	38	39	38	15	19	14

Results in Table 19 suggest that hunters are generally more satisfied than nonhunters when deer numbers and externalities increase, and about the same percentage of hunters and nonhunters in all regions would engage in issue activity in this type of situation. When deer numbers and externalities decrease nonhunters appear to be more satisfied than hunters, and for all regions the percentage of hunters engaging in issue activity is higher than the percentage of nonhunters. It is interesting to note that when

externalities and deer numbers increase, there are no significant differences between hunters and nonhunters in engagement in issue activity. However, when deer numbers and externalities decrease, hunters and nonhunters in each region differ significantly, with a larger percentage of hunters engaging in issue activity in this type of "decreasing" situation (Northwest $\chi^2 = 44.00$, $p < 0.01$; Northeast $\chi^2 = 35.14$, $p < 0.01$; Southwest $\chi^2 = 56.60$, $p < 0.01$). These results generally support previous findings presented in this chapter that suggest hunters want more deer than nonhunters and may be less concerned about deer-related externalities. In addition the results suggest that hunters may be more apt to engage in some level of issue activity when they are not satisfied with deer situations in their region.

CHAPTER 4. CHOICE MODEL ESTIMATION AND RESULTS

This chapter begins with a brief summary of the choice experiment framework presented in detail in Chapter 2. Results of the regionally aggregated models are then presented, followed by models for the regional level. The chapter concludes with a comparison of models estimated via different preference elicitation formats.

Background

CE's and the resulting choice models assume that people make choices based on the utility provided by different options. In the white-tailed deer CE, options (referred to as scenarios) consisted of different levels of deer-related attributes. The attributes included the number of deer, herd health, deer damage to residential property, deer damage to agriculture, deer-vehicle collisions, and deer browsing in the forest. Hunter surveys (from the MDNR sample only) contained an additional attribute - the number of mature bucks. Respondents were shown a choice set (Figure 10) and asked to choose which scenario they would prefer for their region.

Attribute levels for each alternative (except the status quo) are determined by an experimental design plan, but must be able to vary independently. This was a significant problem for the white-tailed deer CE, as independent variation created several counterfactual scenarios, e.g. deer numbers increase but deer vehicle collisions decrease, relative to the status quo. To overcome this problem three types of choice sets were presented to respondents: a choice set where attributes levels in each of two alternatives

	Current Situation	Scenario A	Scenario B
Number of deer in region	Current Number	20% more than current number	20% more than current number
Number of mature bucks in region	Current Number	15% more than current number	15% more than current number
Percent of deer in region with at least one characteristic of poor health	25%	30%	30%
Percent of residential properties in region experiencing some deer damage	30%	40%	35%
Deer damage per acre of cropland in region ($/acre)	$6	$8	$7
Annual number of deer-vehicle collisions in region	3,562	4,300	4,600
Percent of forest area in region experiencing heavy deer browsing	30%	35%	40%
Which do you prefer for your region? (Check one)	Current ❑	Scenario A ❑	Scenario B ❑

Figure 10. **Example of Choice Set**

increase relative to the status quo; a choice set where attribute levels in two alternatives decrease relative to the status quo; and a choice set where attribute levels in two alternatives increase or decrease relative to the status quo, but changes are small, referred to as the marginal choice set. All of these models can be referred to as 3-way models, as each choice set offers respondents three options - the status quo and two alternatives.

Respondents from the SOS sample were also given a choice set that contained the status quo, an increasing scenario, a decreasing scenario, and a marginal scenario, referred to as a 4-way choice set. Appendix A contains a complete survey instrument for the MDNR and SOS samples, illustrating each type of choice set.

Choice models were estimated by combining data from the increasing, decreasing, and marginal choice sets and estimating a separate model from the 4-way choice (SOS version only). In total, 12 different models were estimated from the data. Table 20 outlines the types of models estimated.

Multinomial logit (MNL) models, described in detail in Chapter 2, were estimated from the data. To begin the modeling process, the deer-related attributes and a dummy variable representing the status quo were entered as independent variables. When the data permitted, nested MNL models were estimated. Nested MNL models allow more flexible error structures by specifying an hierarchical choice setting and estimating additional parameters for each choice set partition. Figure 11 shows the hierarchical setting used for white-tailed deer. Using a nested MNL and partitioning the choice sets into respondents who chose a scenario other than the current situation, labeled "Change," and respondents who stayed with the current situation, labeled "No Change," allows the variance of the random components to vary across subsets of the partitions. This relaxes the independence assumption (for alternatives sharing a partition) as well as the identical distribution assumption between alternatives in different partitions (Louviere et al. 2000).

Table 20. **Types of Choice Models Estimated from Survey Data**

Model	No. of Obs.	Data Used for Estimation
Hunters - MDNR Sample		
Northwest Hunter	1,139	1
Northeast Hunter	1,202	1
Southwest Hunter	1,105	1
Statewide Hunter	3,446	2
Nonhunters - SOS Sample		
Northwest Nonhunter	683	3
Northeast Nonhunter	762	3
Southwest Nonhunter	892	3
Statewide Nonhunter	2,337	4
Northwest Nonhunter 4-way	221	5
Northeast Nonhunter 4-way	250	5
Southwest Nonhunter 4-way	300	5
Statewide Nonhunter 4-way	771	6

1 = Combined increasing, decreasing, marginal choice sets
2 = Combined increasing, decreasing, marginal choice sets from all regions
3 = Combined increasing, decreasing, marginal choice sets from nonhunter respondents
4 = Combined increasing, decreasing, marginal choice sets from nonhunter respondents from all regions
5 = 4-way choice set from nonhunter respondents
6 = 4-way choice set from nonhunter respondents from all regions

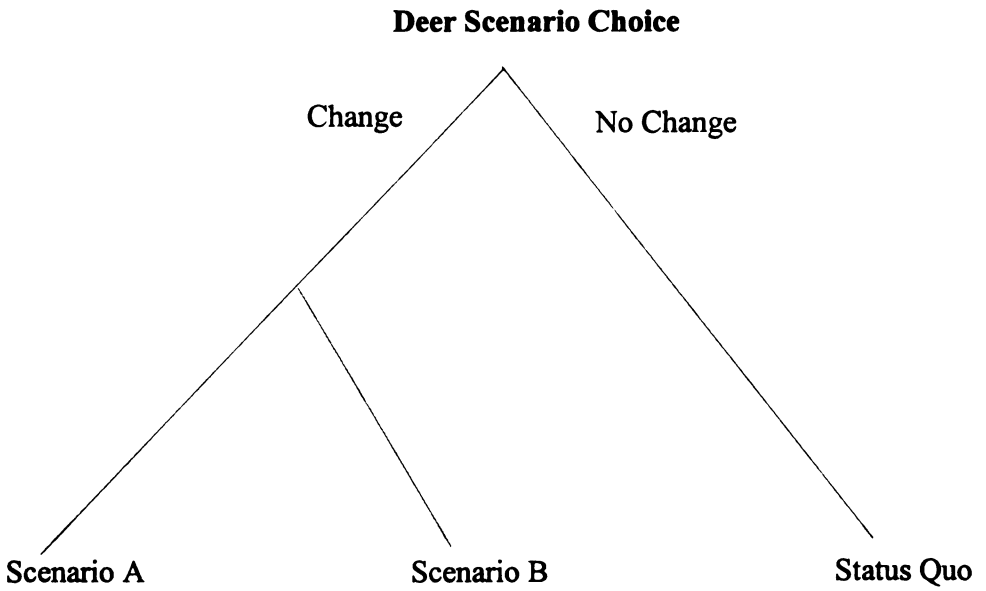


Figure 11. **Schematic of Nested Multinomial Logit**

Nesting results in the estimation of an inclusive value parameter for the choice set partition (change or no change). For all nested models the inclusive value parameters for change and no change were constrained to be equal. The interpretation of parameter estimates is that inclusive value parameters not significantly different than one suggest that the nesting specification could be collapsed into a non-nested model (Louviere et al. 2000).

During the modeling process additional variables were interacted with the dummy variable and entered into the model in an effort to improve model results. These variables

included respondent demographic characteristics, respondent experience with deer-related externalities, and likert scores from several of the belief statements. Because these variables were interacted with the dummy variable for the status quo, their interpretation concerns only the likelihood of changing from the status quo. For example, a negative sign on a belief statement coefficient would indicate that the higher a respondent's score is on the belief scale, the more likely they are to change from the status quo. While a handful of these variables were significant in the models, they generally (1) confounded the effects of the deer-related attributes, and (2) precluded the use of a nested model (nested models always improved the overall model results). Therefore, these variables were dropped, and the final models included only the deer-related attributes and a status quo dummy.

All models were estimated using LIMDEP 7.0. Results are presented below, beginning with statewide models, followed by regional models and a comparison of 3-way and 4-way models for the nonhunters. Goodness of fit, as measured by the likelihood ratio index, for regional and statewide models ranged from 0.02 to 0.29. For all models that retained a nested structure, the nested version increased the value of the likelihood ratio index. It is important to note that this index does not have the same interpretation as an R-squared value from linear regression models. The likelihood ratio index, sometimes referred to as McFadden's R-squared, is the percent increase in the log likelihood function above the value taken when all parameters are zero (or the value of no model). However, the index can only be used to compare models estimated from the same data and the same set of alternatives, and cannot be used to compare models

estimated from different data sets. Although generally a model with a higher likelihood ratio index is said to fit the data better than a model with a lower index, the index has no intuitively interpretable meaning (Train 2003).

Statewide Choice Models

Statewide models are non-nested MNL models. The statewide hunter model contained 6 significant attributes: the number of deer, the number of mature bucks, herd health, deer-vehicle collisions, deer browsing, and the status quo dummy variable. Similar results were found for nonhunters, where significant attributes included the number of deer, herd health, deer-vehicle collisions, deer browsing, and the status quo dummy variable. For both hunters and nonhunters, deer damage to residential property and deer damage to agriculture were non-significant attributes. For both hunters and nonhunters, significant attributes had the expected sign, indicating that deer-related externalities have a negative effect on utility and deer numbers (and buck numbers for hunters) have a positive effect. Table 21 presents the results of the statewide hunter and nonhunter models.

Table 21. **Results of Statewide Choice Models**

	Hunters	**Nonhunters**
Number of deer (std. error)	2.6818 (0.5667)	2.1377 (0.8037)
Number of mature bucks	7.5800 (1.2365)	
Herd health	-0.0741 (0.0108)	-0.0496 (0.0150)
Deer damage to residential property	0.0076 (0.0110)	-0.0145 (0.0139)
Deer damage to agriculture	-0.0537 (0.0559)	-0.0583 (0.1087)
Deer-vehicle collisions	-0.0009 (0.0001)	-0.0019 (0.0002)
Deer browsing in forest	-0.0097 (0.0041)	-0.0310 (0.0156)
Status quo dummy	1.0895 (0.0475)	0.8340 (0.0521)
Log-L	-3361.9	-1889.7

These results suggest that, at a regionally aggregated level, hunters and nonhunters experience gains in utility when deer populations and buck populations (hunters only) increase, all else being equal. Because the units are the same, a direct comparison between deer number and buck number coefficients can be made for hunters. This comparison reveals that buck numbers has a much stronger effect on utility than do deer numbers. Both hunters and nonhunters suffer disutility when three of the five deer-related externalities increase: the percent of deer in poor health, the number of annual deer-vehicle collisions, and the percent of forest area that is heavily browsed by deer. Additionally, the significance of the dummy variable suggests that moving away from the

status quo would bring disutility to both hunters and nonhunters.

Utility Comparisons

Coefficients from CE models do not have the same interpretation as OLS coefficients in that they do not directly reveal the change in the dependent variable given a 1 unit change in an independent variable. However, they can be used to compare utilities of a variety of potential deer scenarios. From Chapter 2, the probability that an individual prefers (and thus chooses) one scenario over all other scenarios, assuming the scale parameter is 1, can be expressed as

$$\Pr \quad a|C = \exp(\beta X_a) / \sum_{j=1}^{C} \exp(\beta X_j)$$

Having estimates of β, potential X's can now be plugged into the model to determine choice probabilities for alternative scenarios. To illustrate, suppose the scenarios in Table 22 below are the outcomes of two potential management strategies for the aggregate region of the Northwest, Northeast, and Southwest regions.

Table 22. **Hypothetical Outcomes for Deer-related Attributes**

	Scenario A	**Scenario B**
Number of deer	10% increase	15% increase
Number of mature bucks	5% increase	1% increase
Percent of deer with a characteristic of poor health	20%	25%
Percent of properties experiencing deer damage	10%	10%
Deer damage per acre of cropland	5$	5$
Annual deer-vehicle collisions	3,500	3,000
Percent of forest area experiencing heavy deer browsing	30%	20%

Using the models to predict choice probabilities for Scenario's A and B shows that, for hunters

$$\text{Prob}(\mathbf{A}|C) = 0.97$$

$$\text{Prob}(\mathbf{B}|C) = 0.03$$

and for nonhunters

$$\text{Prob}(\mathbf{A}|C) = 0.25$$

$$\text{Prob}(\mathbf{B}|C) = 0.75$$

Given the hypothetical outcomes above, if a manager is considering only the human dimension of deer management, Scenario A provides greater utility for hunters and thus is the preferred scenario for the aggregate region, while Scenario B is the preferred scenario for the region for nonhunters. However, when no increases in the

number of mature bucks occurs in either Scenario A or B, the hunter choice probabilities become

$$\text{Prob}(\mathbf{A}|C) = 0.42$$

$$\text{Prob}(\mathbf{B}|C) = 0.58$$

The difference between the two sets of choice probabilities for hunters illustrates the importance hunters place on mature bucks. When there are no increases to the number of mature bucks, the management decision, if based on the wishes of the majority of each stakeholder group, becomes the same for both hunters and nonhunters, given the hypothetical scenarios A and B. It should be noted at this point that both hypothetical scenarios A and B involve increases to both deer and mature buck populations. Chapter 5 introduces two additional types of situations, situations where deer populations increase but mature bucks decrease, and situations where mature bucks increase but deer populations decrease.

Marginal Rates of Substitution

CE results can also be used to calculate the marginal rates of substitution among the deer-related attributes. Marginal rates of substitution (MRS) represent the ratio of the change in utility with respect to one attribute and the change in utility with respect to a second attribute. Stated another way, MRS is the rate at which individuals will substitute (changes in) one attribute for (changes in) a second attribute such that overall utility remains constant. From the CE results, this ratio is expressed by $-\beta_1/\beta_2$, for two attribute coefficients. MRS are relevant to deer management as they can reveal the amount of

externality changes stakeholders will trade-off for a given percent change in the number of deer or number of mature bucks. For example, hunters may be willing to accept, or tolerate, a decrease in the number of deer or mature bucks in order to see a decrease in the number of deer-vehicle collisions. Similarly, hunters may accept an increase in deer-vehicle collisions in order to have more deer or mature bucks. MRS defines the increase (decrease) in deer that is necessary to keep utility constant when deer-vehicle collisions, or other attributes, increase (decrease). MRS were calculated for all attributes to examine the trade-offs hunters and nonhunters would accept for a 1% increase in the deer and mature buck population, relative to the status quo (Table 23).

Table 23. **Marginal Rates of Substitution for Deer and Mature Bucks: Statewide**

	Acceptable trade-offs for a 1% increase in mature bucks	**Acceptable trade-offs for a 1% increase in deer**	
	Hunters	**Hunters**	**Nonhunters**
Percent of deer with a characteristic of poor health	1% more*	0.4% more*	0.4% more*
Percent of residential properties experiencing deer damage	10.0% more	3.5% more	1.5% more
Deer damage per acre of cropland	$1.41 more	$0.50 more	$0.37 more
Annual deer-vehicle collisions	84 more*	30 more*	11 more*
Percent of forest area experiencing heavy deer browsing	8% more*	3% more*	0.7% more*

* Indicates that the attribute is significant in the statewide choice model.

Results in Table 23 show that hunters will accept greater externality increases for increases in mature bucks than increases in deer, and will also accept greater increases in deer-vehicle collisions and deer browsing than will nonhunters for increases in the number of deer. Interestingly, hunters and nonhunters will accept about the same increase in poor herd health for an increase in deer.

In calculating MRS, it is possible to determine the trade-offs stakeholders would accept for large increases in deer or mature bucks by scaling the ratio, e.g. for a 100% increase in mature bucks hunters would accept approximately 8,400 more deer-vehicle collisions per year. It is most likely that hunters would not accept this many more deer-vehicle collisions, nor is it likely that mature bucks could increase by 100%. This is a problem with CE models that assume linear preferences and predictions outside the range of the data, as does the model for deer. However, more complex functional forms for preference models require larger sample sizes and more resources. Given the constraints of this CE, linear models seemed the most appropriate functional form. Further, research has demonstrated that within a certain range linear preferences predict well (Louviere et al. 2000), and thus, up to a subjective cut-off point, knowledge of MRS would be useful for deer management professionals.

In summary, results of the aggregated choice models show that, for both hunters and nonhunters, the externalities 'deer damage to residential property' and 'deer damage to agriculture' do not have a significant effect on utility, while the externailities poor herd health, deer-vehicle collisions, and deer browsing provide disutility to both groups. Hunters will generally trade-off greater increases in externalities for increases in deer than

nonhunters, and will accept larger externality increases for more mature bucks than for more deer.

Among all attributes, mature bucks seems to be a key attribute for hunters. Models were simulated using hypothetical management outcomes that increase and decrease deer and buck numbers, and the externalities, by various amounts. Generally, when outcomes included changes to buck numbers, choice probabilities for hunters and nonhunters were different. However, when there were no changes to buck numbers but all other changes were the same, both groups generally had similar probabilities. Chapter 5 expands on model simulation and presents an array of choice probabilities under different management outcomes for the statewide models as well as regional models.

The results above are based on pooling data from all three regions. In the following section model results are presented separately for the Northwest, Northeast, and Southwest, illustrating some differences when the data is disaggregated by region.

Regional Results

Northwest Region

Hunter and nonhunter models for the northwest region were estimated using the hierarchical scheme discussed above. Inclusive value parameters for hunters are significantly different from one at $p < 0.12$. For nonhunters, inclusive values are significantly different from one at $p < 0.01$. Although the nesting structure did not result in highly significant inclusive value parameters for hunters, the structure was retained due to larger log-likelihood values.

For hunters in the northwest mature bucks have a positive effect on utility and the externalities poor herd health, deer-vehicle collisions, and deer browsing have a negative effect. The dummy variable for the status quo is significant. The number of deer, residential damage, and agricultural damage are not significant for hunters. For nonhunters, all externality attributes with the exception of deer browsing are significant. The number of deer is not a significant attribute for nonhunters. The status quo dummy is significant for both hunters and nonhunters. Tables 24 and 25 show model results for hunters and nonhunters.

Northeast Region

Hunter and non-hunter models for the northeast region are non-nested models. For hunters, deer and mature bucks are both significant attributes, with percentage increases in mature bucks having almost twice the effect on utility as do deer. Significant externalities include poor herd health, deer damage to agriculture, and deer-vehicle collisions. The dummy variable for status quo is also significant. For nonhunters deer numbers is significant, as are the externalities deer damage to agriculture, deer-vehicle collisions, deer browsing, and the status quo dummy variable. (Tables 24 and 25).

Southwest Region

Hunter models for the southwest region were nested, with inclusive value parameters significantly different from one at $p < 0.01$. The nonhunter nested model failed to converge, thus the non-nested model was retained. For hunters, deer numbers

and buck numbers were both significant, and, similar to the northeast hunters, mature buck numbers have nearly twice the effect on utility as do deer numbers. The externalities poor herd health, deer-vehicle collisions, deer browsing, and the status quo dummy are also significant. For nonhunters the externalities poor health, deer damage to agriculture, deer-vehicle collisions, and the status quo dummy are significant (Tables 24 and 25). In the nonhunter model the sign on deer damage to agriculture is positive, suggesting that this externality has a positive effect on utility.

Table 24. **Results of Regional Choice Models: Hunters**

	Northwest	**Northeast**	**Southwest**
Number of deer (std. error)	1.2135 (2.3200)	4.7903 (1.0729)	8.1879 (3.0490)
Number of mature bucks	12.8086 (4.9232)	8.1711 (2.2068)	14.5112 (6.2176)
Herd health	-0.0891 (0.0252)	-0.0864 (0.0199)	-0.3046 (0.0720)
Deer damage to residential property	-0.0063 (0.0341)	0.0025 (0.0195)	-0.0181 (0.0299)
Deer damage to agriculture	-0.0621 (0.1669)	-0.6199 (0.1840)	-0.3845 (0.3455)
Deer-vehicle collisions	-0.0007 (0.0003)	-0.0012 (0.0003)	-0.0013 (0.0004)
Deer browsing in forest	-0.0110 (0.0039)	0.0182 (0.0203)	-0.0916 (0.0383)
Status quo dummy	1.2155 (0.2714)	1.0577 (0.0842)	1.8138 (0.4778)
Inclusive Value Parameters Change;No change	0.3429 (0.2167)		0.4224 (0.1650)
Log-L	-1144.3	-1165.3	-1023.9

Table 25. **Results of Regional Choice Models: Nonhunters**

	Northwest	Northeast	Southwest
Number of deer	1.7862	2.7995	1.5774
(std. error)	(5.6832)	(1.5355)	(1.3380)
Herd health	-0.0931	0.0022	-0.1710
	(0.0457)	(0.0254)	(0.0593)
Deer damage to residential	-0.1013	0.0145	-0.0107
Property	(0.0424)	(0.0070)	(0.0229)
Deer damage to agriculture	-1.0740	-0.8768	0.5356
	(0.4525)	(0.2465)	(0.2557)
Deer-vehicle collisions	-0.0047	-0.0024	-0.0021
	(0.0009)	(0.0004)	(0.0002)
Deer browsing in forest	-0.1880	-0.0507	-0.0276
	(0.0517)	(0.0268)	(0.0257)
Status quo dummy	0.9118	0.8263	0.8143
	(0.3521)	(0.0268)	(0.0879)
Inclusive Value Parameters	0.2791		
Change;No change	(0.0918)		
Log-L	-531.9	-639.2	-689.2

As in the statewide model, significant attributes for hunters in all regions include the number of mature bucks, herd health, and deer-vehicle collisions. However, the regional models show some differences from the aggregate model. For example, deer are significant in the northeast and southwest but not in the northwest. This finding is consistent with the results of other questions in the survey that demonstrate that while 21% of hunters in the northwest would prefer less deer than last year for their region, only 10% of hunters in the northeast and 15% of southwest hunters prefer less deer than last year. Additionally, anecdotal evidence from pretest respondents in the northwest indicated that, although abundant, deer in this region are relatively small, which supports

both the insignificant coefficient on deer and the strong effect mature bucks have on utility.

Other regional differences include the significance of deer browsing in the northwest and southwest and the significance of deer damage to agriculture in the northeast. The latter is interesting as deer damage to agriculture is not significant in the statewide model, and only 12.9% of hunters in the northeast stated they would be very concerned with increases in deer damage to agriculture, compared to 21.5% and 18.7% of hunters in the northwest and southwest regions. Additionally, a greater proportion of hunters in the northeast than in the northwest or southwest said they would be "not concerned at all" with an increase (see Chapter 3). However, these questions were posed without constraints, e.g. there were no trade-offs involved. In the choice scenarios respondents were indirectly making trade-offs among changes in deer damage to agriculture and changes in other externalities (and deer and buck numbers), thus introducing some additional variables into the decision-making process.

Nonhunter models vary by region, and generally differ from the statewide model to a greater extent than the hunter models do. Deer-vehicle collisions and deer damage to agriculture are significant for all regional nonhunter models. Deer damage to residential properties, which is not significant in any other model, is significant for northwest nonhunters. Subjectively, this result is consistent with qualitative research conducted during the survey development phase, as discussions with private landscaping and tree nursery companies in the northwest indicated that deer damage was a problem for the region.

Deer numbers are significant in the northeast but not in the northwest or southwest, a finding consistent with other parts of the survey. For example, in both the northwest and southwest regions slightly over 30% of respondents stated they would prefer less deer in their region than they had last year, while only 25% of respondents in the northeast felt this way. Additionally, a greater percentage of nonhunters in the northeast (24%) preferred more deer for their region than did nonhunters in the northwest (15%) or southwest (10%).

An underlying reason for these attitudes may be, at least in part, the presence of bovine tuberculosis in the northeast. Due to bovine TB, liberal deer harvest policies have been in place over the last several years in the northeast, in an effort to eradicate the disease. During the qualitative research period people frequently discussed their concern over decreasing deer numbers and the liberal harvest policies in the region. While the perception of deer population declines was evident in the northeast, deer population decreases were generally not a concern in the northwest and southwest. This anecdotal evidence is borne out by other survey questions indicating that 47% of nonhunters in the northeast would be concerned or very concerned if the deer population decreased in their region, while only about 39% and 30% of nonhunters in the northwest and southwest felt this way.

Marginal Rates of Substitution

For comparison with the statewide model, MRS were calculated for regional hunter and nonhunter models, although the number of deer was not significant in each

case (Tables 26 and 27). Theoretically MRS can be calculated to determine trade-offs among externalities, e.g. acceptable trade-offs between deer browsing and deer-vehicle collisions. Since the focus of this chapter is on trade-offs between changes in the deer and buck populations and changes in externalities, the full set of MRS among all attributes is not displayed.

Table 26. **Hunter Marginal Rates of Substitution for Deer and Mature Bucks: Regional**

Acceptable **trade-offs for a 1% increase in deer**			
	Northwest Hunters	**Northeast Hunters**	**Southwest Hunters**
Percent of deer with a characteristic of poor health	0.1% more*	0.5% more*	0.2% more*
Percent of residential properties experiencing deer damage	1.9% more	19.0% less	4.5% more
Deer damage per acre of cropland	$0.19 more	$0.07 more*	$0.21 more
Annual number of deer-vehicle collisions	17 more*	40 more*	63 more*
Percent of forest area experiencing heavy deer browsing	1% more*	2.6% less	0.9% more*
Acceptable trade-offs for a 1% increase mature bucks			
Percent of deer with a characteristic of poor health	1.4% more*	0.9% more*	0.5% more*
Percent of residential properties experiencing deer damage	20.3%	32.6% less	8.0% more
Deer damage per acre of cropland	$2.06	$0.13 more*	$0.38 more
Annual number of deer-vehicle collisions	183 more*	68 more*	111 more*
Percent of forest area experiencing heavy deer browsing	12% more*	4.4% less	1.6% more*

* Indicates that the attribute is significant in the regional choice model.

Table 27. **Nonhunter Marginal Rates of Substitution for Deer: Regional**

	Acceptable trade-offs for a 1% increase deer		
	Northwest Nonhunters	**Northeast Nonhunters**	**Southwest Nonhunters**
Percent of deer with a characteristic of poor health	0.2% more*	12.7% more	.1% more*
Percent of residential properties experiencing deer damage	0.2% more*	1.9% more	1.5% more
Deer damage per acre of cropland	$0.01 more*	$0.03 more*	$0.03 less*
Annual number of deer-vehicle collisions	4 more*	11 more*	8 more*
Percent of forest area experiencing heavy deer browsing	0.1% more	0.5% more*	0.6% more

* Indicates that the attribute is significant in the regional choice model.

Comparing MRS for hunters shows that hunters in the northwest will trade-off fewer deer in poor health and fewer deer-vehicle collisions for an increase in the number of deer than will hunters in the northeast or southwest. However, for increases in the number of mature bucks northwest hunters will accept more of all significant externalities than will northeast or southwest hunters, illustrating the preference northwest hunters have for mature bucks relative to deer and deer-related externalities. For hunters in the northwest and southwest the acceptable externality trade-offs are considerably greater for mature bucks than for deer, though in the northeast this relationship is not as strong. As discussed previously, bovine TB is present in the northeast region, and liberal harvest quotas may elevate the overall importance of increasing the deer population relative to

increasing the number of mature bucks. Comparing the northeast hunters to northeast nonhunters shows that the acceptable externality trade-offs for nonhunters are lower than those for hunters. This preference difference is consistent with results presented in Chapter 3, where descriptive results show that nonhunters are generally more concerned with increases in deer-related externalities than are hunters.

In summary, the regional hunter models are more consistent with the aggregate statewide hunter model than are regional nonhunter models. For hunters, mature bucks, herd health, and deer-vehicle collisions are significant in all regional models, while the significance of deer numbers, deer damage to agriculture, and deer browsing vary by region. Hunters have stronger preferences for mature bucks than for deer in all regions, though this relationship is strongest in the northwest and southwest. For nonhunter regional models deer damage to agriculture and deer-vehicle collisions are significant in all regions, while the significance of other attributes varies by region. For both hunter and nonhunters in all regions the status quo dummy variable is significant, indicating that people tend to prefer the current situation in their region to potential changes.

Comparison of Preference Elicitation Formats

In addition to the three 3-way choice sets (increasing, decreasing, and marginal), the SOS versions of the survey contained an additional choice set which included a 4-way choice among the current situation, a situation where all attributes increase, a situation where all attributes decrease, and a situation with small attribute changes in either direction (see Chapter 2 for a detailed description). Using this design, two separate

choice models can be estimated: a model pooling the increasing, decreasing, and marginal scenarios and a second model using data from the 4-way choice.

The pooled model is the statewide nonhunter model presented above in Table 21. The 4-way model was estimated separately using data on the 4-way choice, and comparisons of the two models are presented below. One important distinction between the two types of models concerns the number of alternative scenarios in each choice set. As previously discussed, the pooled model is based on pooling choices from increasing, decreasing, and marginal sets, each of which contained 3 scenarios in the choice set. Thus respondents had to evaluate three alternatives before making a choice. In the 4-way choice model, respondents evaluated four scenarios before making a choice, which may be a slightly more complex task. On the other hand, the 4-way choice was presented near the end of the survey, and at this point respondents may have become familiar with the choice experiment format and may have even devised heuristic tools to help them answer choice questions, thus the addition of a fourth scenario would not add significantly to the task complexity. Several authors have demonstrated a learning effect in repeated measures experiments (Morrison 2000; Bradley and Daly 1994) though generally more than three choice tasks were required to reveal evidence of a learning effect.

A comparison of the pooled and 4-way model was conducted to test the hypothesis that different preference elicitation formats over the same range of attributes and attribute levels will result in similar preference structures. An informal hypothesis test was conducted by using the coefficients of the pooled model as starting values for the 4-way model, constraining the model to zero iterations, and conducting a log-likelihood

ratio test on the likelihood functions of the pooled and 4-way models. Results of this informal test show that the models are significantly different ($\chi^2 = 25.23$, $p < 0.01$). Results of pooled and 4-way statewide models are presented in Table 28. MRS are not compared between the two models as deer was not significant in the 4-way model.

Table 28. **Results of Pooled versus Four-way Choice Model**

	Pooled	**4-way**
Number of deer (std. error)	2.1377 (0.8037)	0.9590 (1.1540)
Herd health	-0.0496 (0.0150)	-0.0579 (0.0220)
Deer damage to residential property	-0.0145 (0.0139)	-0.0465 (0.0244)
Deer damage to agriculture	-0.0583 (0.1087)	-0.1927 (0.1624)
Deer-vehicle collisions	-0.0019 (0.0002)	-0.0011 (0.0002)
Deer browsing in forest	-0.0310 (0.0156)	-0.0406 (0.0247)
Status quo dummy	0.8340 (0.0521)	0.6803 (0.1180)
Log-L pseudo R^2	-1889.7 0.26	-690.3 0.35

Results demonstrate that there are differences in the significant attributes from each model. For example, residential damage is significant in the 4-way model but non-significant in the pooled model, while the opposite pattern holds for deer browsing. Further, the number of deer is not significant in the 4-way model. Deer-vehicle collisions, herd health, and the status quo are significant in both models.

Full results are not presented for the regional comparisons. However, regional 4-

way models generally showed a fewer number of significant attributes, and those that were significant had larger p-values than the pooled model, as expected given the larger sample size. The same informal hypothesis tests were conducted on pooled and 4-way regional model and similar results to the statewide tests were obtained at the regional level.

Both statewide and regional comparisons between pooled and 4-way models suggest that different elicitation formats result in different preference structures. One reason for this may be differences in choice complexity of the pooled and 4-way choice. In the 4-way choice respondents evaluated the current situation and three alternative scenarios, each of which was moving in a different direction relative to the status quo. This may have been a more difficult task than the choices from the pooled model, where respondents evaluated fewer alternatives per choice set (the current situation and two alternatives), both of which were moving in the same direction relative to the status quo. On the other hand, it is possible that, for some respondents, the 4-way choice was easier, as they may have been looking at the way the attributes move in making their decision. For example, respondents who were looking for decreases may have had an easier time choosing in the 4-way choice because only one scenario was decreasing. In the 3-way model, even if respondents knew they wanted a decrease in the attributes, they still had to compare two decreasing alternatives before making a choice. Further, the alternatives in the 3-way choice set contained identical changes in deer numbers, in an effort to encourage those respondents who tend to make choices based solely on the number of deer to consider all the attributes before making a choice. Survey questions do not

provide insight as to which type of choice was more complex for whom; however, if choice task complexity was different between the pooled and 4-way models this may affect the respondent's decision process and thus the model results.

Status quo choices were examined in each of the increasing, decreasing, marginal, and 4-way choice sets in the survey. In each of the increasing, decreasing, and marginal choice sets the status quo made up a larger percentage of choices than in the 4-way choice. For example, in the increasing, decreasing, and marginal choice set, 84%, 32%, and 44% of choices were for the status quo, respectively. Note that these choice sets are constrained, e.g. a respondent may want fewer deer, but in the increasing choice set they are not offered that choice, thus they default to the status quo. When all choice sets were pooled, the status quo represented 53% of the choices made. In contrast, in the 4-way choice set only 23% of the choices were the status quo. In the 4-way choice set respondents did not have constraints on their choice, e.g. if they wanted fewer deer they could choose that option from the choice set rather than defaulting to the status quo. Thus, in addition to choice task complexity, it is possible that the different constraints respondents faced at each choice set may also affect the results of the pooled and 4-way model.

CHAPTER 5. CONCLUSIONS AND MANAGEMENT IMPLICATIONS

This chapter begins with a discussion of preferences for deer and deer-related externalities, based on the results of the choice experiment and other survey components. This discussion is followed by describing the general limitations of the research and a retrospective examination of issues that are specific to the use of a choice experiment survey format. The chapter concludes with a discussion of the big picture for deer management.

Preferences for Deer and Deer-related Externalities

The purpose of this research was to examine and quantify stakeholder preferences, with the intention of informing management about preferences, trade-offs, satisfaction, and issue activity related to changes in the deer population and related externalities. Results of both the CE and other survey components demonstrate that people in Michigan care about the deer population and many of the externalities associated with the population, and are willing to make trade-offs for increases or decreases in the number of deer and the level of particular externalities. To a large extent the research was able to quantify these trade-offs and provide management with guidance and recommendations, though the preference information is not perfectly consistent (see Limitations in this chapter).

In general, choice model results show that the number of deer and the number of mature bucks both have a positive effect on utility, although there are some regional differences. Further, all significant externalities, with the exception of deer damage to

agriculture in the southwest nonhunter model, have a negative effect on utility. The externalities herd health and deer vehicle collisions are generally significant across regions and stakeholder groups, and appear to be the externalities respondents are most concerned about.

In Chapter 1, four research questions were introduced. These questions are now examined using a synthesis of the results presented in Chapters 3 and 4.

Question (1): How does the relative importance of deer and deer-related externalities differ among different stakeholder groups?

At the statewide level, the relative importance of deer and deer-related externalities are similar for hunters and non-hunters. Both groups have positive utility for deer, and negative utility for externalities. Additionally, neither deer damage to residential property nor deer damage to agriculture was a significant attribute for either group, suggesting that respondents are least concerned with these externalities relative to the other externalities described in the survey. The hunter choice model shows that, at the statewide level, mature bucks provide about three times more utility for hunters than do deer.

Choice model results show that hunters in all regions place relatively more importance on having more mature bucks in their region than on having more deer. Another consistency across hunters in each region is the importance placed on the externalities herd health and deer-vehicle collisions, both of which have negative and significant coefficients in all regions. None of the regional hunter models show significant coefficients on the residential property damage coefficient, suggesting that, for

hunters, it is a relatively unimportant externality associated with the deer population.

Similar to the hunter models, all nonhunter models have significant and negative coefficients on deer-vehicle collisions, suggesting that nonhunters also place relatively high importance on this externality. Also similar to the hunter models, the attribute herd health appeared to be relatively important to nonhunters, though only in the northwest and southwest regions. Deer damage to residential property also appeared to be relatively unimportant to nonhunters as a group. In contrast to hunters, the deer numbers coefficient was only marginally significant in one region (northeast), suggesting that nonhunters place less importance on the number of deer in the region than do hunters.

At the regional level there are some differences among hunters and among nonhunters. For example, in the northwest and southwest, deer browsing in the forest appears to be an externality that hunters feel is relatively important, whereas hunters in the northeast place relatively more importance on deer damage to agriculture. Among nonhunters, deer damage to residential property was significant only in the northwest model, and deer browsing in the forest was marginally significant in the northeast. Deer damage to agriculture was significant and brought disutility in the northwest and northeast, though in the southwest the coefficient sign implied that deer damage to agriculture has a significant positive effect on utility. Searching for data coding errors and re-examining the experimental design for errors did not shed any insight as to why deer damage to agriculture would have an unexpected sign.

As discussed in Chapters 2 and 3, the survey also contained questions that asked respondents to express their level of concern over changes in the attribute levels.

Although the format of these questions is different than the choice experiment in that respondents do not evaluate a bundle of attributes and make trade-offs among them, many responses to the concern questions generally support the choice model results. For example, when asked to express concern about a decrease in the number of deer, more than 60% of hunters in each region stated they would be concerned or very concerned, while 45% or less of nonhunters in each region expressed this level of concern. This finding is generally consistent with the significance of the deer number attribute from the choice models. Over 70% of each stakeholder group in each region stated they would be concerned or very concerned if herd health decreased, and approximately 60% or more of respondents in each stakeholder group, with the exception of the northeast hunters, would be concerned or very concerned with an increase in deer-vehicle collisions. These results generally support the significance of herd health and deer-vehicle collisions in five of the six choice models. The majority of hunters and nonhunters in all regions stated that it was 'somewhat important' or 'not important at all' to decrease the amount of deer damage to residential property, though the split between somewhat important/not important at all and important/very important was closest for the northwest nonhunters. Similar results are demonstrated from the choice models, where deer damage to residential property was a non-significant attribute in all regional models except the northwest nonhunters.

Other components of the survey support the conclusion that preferences for deer and deer-related externalities differ among hunter and nonhunter stakeholder groups. For example, cross tabulation analysis with Chi-square test of significance suggest that, in all

regions, hunters tend to prefer more deer and tend to be more concerned with deer decreases than nonhunters. In general, cross tabulations also suggest that hunters tend to be more concerned than nonhunters with herd health, and nonhunters tend to be more concerned with deer damage to agriculture and residential properties, deer-vehicle collisions, and deer browsing in the forest.

The sample population was segmented by other socioeconomic strata to determine whether respondent characteristics other than hunter or nonhunter are correlated with preferences for deer and deer-related externalities. Few conclusions can be drawn from this analysis, as most of the significant correlations were weak (Pearson correlation coefficients < 0.12). Several of the "stronger" correlations suggest that, in all regions, respondents with more years of hunting tend to place more importance on decreasing deer damage to residential property, and respondents with less education tend to be more concerned about decreases in the number of deer. However, none of the correlation coefficients is greater than 0.12, thus the usefulness of segmenting respondents by strata other than hunter/nonhunter or region may be limited.

The respondent population was also segmented by their experience with deer-related externalities. Respondent experience with the externalities varied by group and by regions, and cross tabulation analyses suggest that respondents with experience with deer damage to residential property, agriculture, and deer browsing in the forest tend to prefer less deer for their region than respondents without this experience. Over 74% of respondents in each group and each region had either themselves or someone in their immediate family experienced a deer-vehicle collision, which may be a reason for the

significance of the deer-vehicle collision coefficient in all of the choice models.

In summary, there are differences and similarities among regions, between stakeholders, and among various segments of the respondent population in the relative importance placed on deer and deer-related attributes. This situation precludes a succinct list of definitive conclusions concerning each specific attribute; however, the list below, drawing from all components of the survey, summarizes the general conclusions pertaining to research question (1).

- Deer and deer-related externalities are important to respondents, though their relative importance varies among regions and between stakeholder groups.
- For hunters, deer and mature bucks generally have a significant and positive effect on utility, while for nonhunters deer generally have a non-significant positive effect.
- Hunters prefer more deer for their region than do nonhunters
- Hunters place more importance on the number of mature bucks than on deer numbers
- When statistically significant, deer-related externalities generally have a negative effect on utility.
- Deer-vehicle collisions and herd health appear to be important to the majority of respondents.
- Residential property damage appears to be least important to the majority of respondents .
- Respondents with experience with deer-related externalities tend to prefer less deer for their region than respondents without this experience.

Satisfaction and Issue Activity Related to Deer and Externality Levels

The conclusions in the section above are consistent with previous research documenting both positive attitudes towards deer in general and the importance of deer-related externalities. However, in addition to examining the relative importance of deer and deer-related attributes, this research addresses additional questions concerning satisfaction and issue activity when the level of deer and deer-related attributes change, which may be useful in making management decisions.

Research Question (2): What kinds of changes in deer populations and associated externalities are most likely to satisfy different stakeholder groups?

Satisfaction models that regressed attribute levels in the choice experiment on a likert satisfaction rating were estimated at the statewide and regional level. The models generally have low R-square values (< 0.13) and few significant coefficients, perhaps due, in part, to the limited amount of qualitative research devoted to the satisfaction questions. It is also possible that there is not sufficient variance in the independent variables to treat them as linear variables in the regression. Generally, the models suggest that satisfaction increases when the number of deer or mature bucks increase, and satisfaction decreases when externalities increase, though there is a counter-intuitive sign on deer-vehicle collisions in the southwest hunter model.

The usefulness of the satisfaction models in explaining variance is relatively limited. However, if the concept of utility, a central concept in addressing research question (3), can act as an indicator of satisfaction, then marginal rates of substitution and utility scenario predictions can be used to address respondent satisfaction when attribute

levels change.

Research Question (3): What types of externality increases will stakeholders accept for increases in the deer population, and conversely, what types of externality decreases will compensate stakeholders for decreases in the deer population?

The marginal rate of substitution (MRS) is the rate at which individuals will substitute changes in one attribute for changes in a second attribute such that their overall level of utility remains constant. As applied to preferences for and satisfaction with deer and deer-related externalities, MRS can illustrate the increases in externality levels that respondents will accept for increases in the deer population, and similarly, the externality decreases needed to compensate respondents for deer population decreases. When comparing hunter and nonhunter MRS at the statewide level, results suggest that for an increase in the deer population, hunters will accept (utility will remain constant) 2.5 to 3 times the increases in deer-vehicle collisions and the percent of heavily browsed forest area than nonhunters; however, the two groups will accept about the same increase in the percent of deer in poor health. Both hunters and nonhunters would accept larger increases in the percent of heavily browsed forest area than in poor health and deer-vehicle collisions.

At the statewide level, increases in mature bucks provide more utility than do increases in deer, as hunters will accept 2.5 to 3 times the externality increases for increases in mature bucks versus increases in deer. There are some differences at the regional level, however. For example, in general hunters in the northeast and southwest will accept larger externality increases for increases in deer than will hunters in the

northwest. For increases in mature bucks, the reverse is true. Hunters in the northwest will accept larger increases - more than twice as much for some externalities - for an increase in mature bucks than hunters in the northeast and southwest.

As discussed in Chapter 4, choice models can also be used to predict choice probabilities for different deer scenarios. Higher choice probabilities indicate higher utility levels associated with a given scenario, and may also indicate higher satisfaction levels. Utility scenario predictions were made for the four deer scenarios below, to examine the extent to which choices would vary between stakeholders. The deer scenarios are relative to the status quo of the region, and represent hypothetical changes for analytical purposes. Other scenarios can be constructed based on different predictions of management outcomes.

Using the choice models to predict choice probabilities for each scenario shows that, when changes to bucks occur, for hunters and nonhunters in each region the highest probabilities are associated with Scenario D and the lowest with Scenario B, with the exception of nonhunters in the northeast, where Scenarios A and D were equally high, and Scenarios B and C were equally low. One reason for these results may be that Scenario D has the largest increase in buck numbers, which is important for hunters, but also the largest decreases in externality levels, which may be important to the nonhunters. When the hypothetical management outcomes do not include changes to buck numbers, hunters in the northeast and northwest tend to prefer Scenarios B, while hunters in the southwest tend to prefer Scenarios A and B with about the same probabilities.

	A	B	C	D
Number of deer	5% more	8% more	5% less	8% less
Number of mature bucks	3% less	5% less	3% more	5% more
Percent of deer in poor health	3% more	8% more	3% less	8% less
Percent of residential properties experience deer damage	3% more	10% more	3% less	10% less
Deer damage per acre of cropland	1% more	3% more	1% less	3% less
Annual deer-vehicle collisions	2% more	4% more	2% less	4% less
Percent of forest area experiencing heavy deer browsing	3% more	6% more	3% less	6% less
Hunter Choice Probability				
Northwest	0.2066	0.1792	0.2852	0.3289
Northeast	0.2133	0.1896	0.2810	0.3161
Southwest	0.2022	0.1729	0.2881	0.3369
Hunter Choice Probability when no buck changes occur				
Northwest	0.2664	0.2689	0.2334	0.2313
Northeast	0.2718	0.2812	0.2273	0.2197
Southwest	0.2626	0.2613	0.2374	0.2386
Nonhunter Choice Probability				
Northwest	0.2411	0.2227	0.2574	0.2787
Northeast	0.2538	0.2464	0.2462	0.2536
Southwest	0.2313	0.2066	0.2652	0.2969

This analysis demonstrates that, for the magnitude and direction of the changes proposed, hunters and nonhunters prefer the same management scenarios when changes to bucks occur. However, without changes to buck numbers hunters tend to pick scenarios with more deer and externality increases while nonhunters tend to choose scenarios with less deer and externality decreases.

In summary, several conclusions can be drawn in relation to research questions (2) and (3):

- For a deer population increase, hunters will generally accept larger increases in externality levels than will nonhunters. Herd health is an exception, and hunters and nonhunters will generally accept about the same decrease in herd health for an increase in the deer population.
- Hunters prefer to have more mature bucks than more deer, and will accept larger externality increases for increases in mature bucks. This pattern exists in each region, though it is strongest in the northwest.
- Generally, increases in the annual number of deer-vehicle collisions and increases in herd health are the least acceptable type of externality increase, followed by deer browsing in the forest.
- Based on hypothetical management outcomes which increase and decrease attribute levels, hunters tend to prefer scenarios which increase mature bucks even when the deer numbers decrease. Nonhunters tend to prefer scenarios which decrease externality levels, even when deer numbers decrease.

Question (4): What kinds of changes in deer populations and associated externalities are most likely to induce different stakeholder groups to engage in issue activity?

Similar to the satisfaction models, the models of issue activity based on the levels of deer and deer-related attributes performed poorly, perhaps due in part to lack of qualitative research devoted to the questions concerning issue activity. As suggested in Chapter 3, it may be more informative to examine the percentages of respondents who state they would engage in some form of issue activity when situations change from the status quo. For example, when deer and externalities increase, about 30% of hunters and nonhunters in a region would engage in some form of issue activity, with no significant differences between the two groups. However, hunters and nonhunters differ

significantly when deer and externalities decrease, with hunters being more likely to engage in issue activity. Approximately 40% of hunters in each region would engage in issue activity when deer, mature bucks, and externalities decrease (decreases were between 0 -5% for mature bucks and 10 -20% for deer).

Limitations of the Research

In collecting preference information, survey respondents were provided with the status quo levels of deer-related attributes and then asked to make a choice about different deer scenarios for their region. It is assumed that respondents perceive the status quo information as credible, and make an informed choice using this information. It is worth noting that, on average, less than 25% of respondents did not disagree with information provided about the status quo. Further, if the respondents from the northeast are removed the figure drops to less than 20%. Some respondents in this region may be more skeptical of any information related to deer due to a somewhat unstable relationship with deer management professionals in recent years. Though in general the level of skepticism seems limited, any skepticism at all can affect decision-making. For example, it is possible that a respondent may be concerned about an attribute but, because the information presented is perceived as incorrect, they disregard the attribute altogether when making choices. This could render attribute parameters insignificant. For this survey, the best available information concerning deer-related attributes was presented to respondents; however, respondents were cautioned that, in some cases, the information was an estimated average for a three or four county region. More precise estimates, if

they existed, might improve credibility in the survey and subsequently increase the validity of survey results. In the future, any information managers and educators can provide concerning deer and deer-related attributes will improve efforts to examine stakeholder preferences.

Generally, when survey results are applied for management purposes, response bias should be considered. Time and resources did not allow for any formal examination of response bias; however, for this survey, the effects of response bias may be mitigated by two factors. First, the response rates were relatively high (62% for the general public and 66% for hunters), particularly given that the first mailing occurred on September 11, 2001. Second, because approximately 40% of public respondents stated that they had hunted deer, two distinct groups, hunters and nonhunters, were created to reduce bias by hunters on the public responses. It is possible that responses are biased by other characteristics. One obvious characteristic would be that only respondents with an overt interest in deer or experience with deer-related attributes returned the survey. Generally this does not appear to be the case. For example, only about 29% of hunters and 10% of nonhunters stated that they frequently took a drive or walk to view deer, and less than 50% of respondents had experience with deer damage to residential property, deer damage to agriculture, or deer browsing in the forest.

The survey has demonstrated preference inconsistencies across different elicitation formats, e.g. the 4-way versus the pooled nonhunter choice models. These differences, described in detail in Chapter 4, may be due to the difference in choice complexity or the difference in the number of observations used to estimate each model.

The pooled model was estimated from 2,337 observations, while the 4-way model had only 771 observations. The difference in observations is a function of survey design (and not item non-response), and it may, in part, be responsible for the preference inconsistencies.

Deer management should be cautious in generalizing the precise choice model results outside of the study regions. The statewide model is based only on the aggregate of observations from the three regions. Each of these regions is fairly unique, and relatively rural - particularly the northeast and northwest regions. Further, preferences differed, at times considerably, among regions. Noting this, the use of exact parameter estimates for analyses outside of the study regions may be inappropriate; however, using results as general guidance outside of the study area may be suitable in some situations.

The Survey Instrument and Choice Experiment Format

In developing the choice experiment survey instrument, a fairly extensive qualitative research phase was undertaken, consisting of three focus groups and sixty two in-person pretests. The qualitative research was vital in identifying problems in the survey instrument, and the strength of this phase ultimately led to a credible survey instrument. This section describes the insight gained during the qualitative research and presents some of the issues related to the survey instrument that emerged after the CE data was analyzed.

Some CE's ask respondents to make choices among attributes with which they are relatively familiar. In other CE's respondents' knowledge of the attributes in question

may be limited, or the way in which the attributes are quantified may be unfamiliar. The latter was the case in the white-tailed deer CE. Qualitative research suggested that, while people generally had a conceptual understanding of most of the attributes, choosing a metric to express different levels of the attributes presented a challenge. Feedback during the survey development phase proved crucial in identifying and describing a metric to quantify attribute level changes.

In addition to the above, the qualitative research phase identified problems that occurred when all attributes were allowed to vary independently, e.g. the creation of counterfactual situations, and the problem of respondents choosing a scenario based only on the number of deer. Feedback from focus groups and pretest interviews induced, in part, the experimental design plan, which divided the choice sets into "increasing," "decreasing," and "marginal" sets and added a third alternative to each set. Thus in keeping with other researchers who stress the importance of a qualitative phase, the attention given to qualitative research in the white-tailed deer CE was critical in developing a credible survey instrument.

Given the scope of the research project and the time and resource constraints, the qualitative research phase was relatively extensive, and was used to obtain feedback on issues that were critical to the choice experiment. However, there are several survey items that may have benefitted from more attention during qualitative research, including endpoint levels for attributes, and satisfaction and issue activity questions. For example, endpoint levels for changes to the deer population were set at 20% and 30% more or less for increasing and decreasing scenarios. It is possible that these changes are not dramatic

enough to induce people to consider the attribute when making choices, and thus deer numbers was not a significant attribute in several of the regional models. The same may be true for other nonsignificant attributes. Questions concerning the magnitude of attribute level changes were not formally incorporated into the qualitative research, and more feedback from focus group and pretest participants would have been useful. Additionally, the questions concerning satisfaction and issue activity, which followed choice questions but are not directly related to the CE, needed further development. This is evidenced in part by the poorly performing satisfaction and issue activity models. Admittedly neither the satisfaction nor issue activity scales were given much attention in the qualitative research.

An additional issue for discussion in focus groups or pretest interviews concerns a mechanism for attribute level changes. In the survey respondents were given limited information on how the changes to the status quo might occur in the alternative scenarios, with a caveat that... "alternative scenarios may not always seem logical, but they are projections of possible deer scenarios..." Explanations or mechanisms for how the changes may arise could be tested to see if they enhance the credibility of the alternative scenarios. On the other hand, information of this type may result in respondents valuing a mechanism for change, and not necessarily the attributes themselves. Given additional time and resources, qualitative research may have provided insight into this issue.

The survey format was the same for all respondents in that each choice scenario contained the status quo and two or three alternatives, depending on whether a respondent received the SOS or MDNR survey version. In either case, the current situation, or status

quo, was always presented in the first (left-most) column, followed by the two or three alternatives. Ordering problems may arise from this positioning. For example, respondents may simply choose the first scenario available, which in this case would always be the current situation. The white-tailed deer CE data do not support this, however, as the current situation was chosen most frequently (by the SOS respondents) when the alternatives were increasing, but not when alternatives were decreasing. When the alternatives involved marginal changes, the current situation and an alternative were chosen with similar frequencies. However, what does appear to occur due to this ordering is that, for those respondents who chose other than the status quo, the majority of them always chose the first alternative presented. This could suggest that respondents who already know they do not want the status quo simply choose the first available alternative. Focus groups and/or pretest interviews could be conducted to determine whether the ordering of scenarios appears to have an effect on choices, or alternatively, the survey sample could be split to test for an "ordering" effect. However, the latter requires a larger number of survey versions to be developed and adds considerably to printing and coordination costs.

In summary, the survey instrument benefitted from an extensive qualitative research phase, given time and financial constraints, and the importance of the qualitative phase should not be underestimated.

The Big Picture for Deer Management

At the most general level, this research has demonstrated two very important points for deer management. First, management should consider the preferences of more than just deer hunters when developing policies, as deer provide positive utility to both hunters and nonhunters. Second, while hunters do care about deer, they also care about the externalities associated with deer, and neither hunters nor nonhunters want increases in the deer population at any cost (e.g. more deer-vehicle collisions, more deer browsing in the forest, etc...). Two of the costs that are least acceptable to both hunters and nonhunters are deer-vehicle collisions and poor herd health, while residential property damage appears to be the most acceptable cost associated with deer.

As expected, hunters generally want more deer than nonhunters, but they are also willing to accept higher (but not unlimited) costs, with one exception. Results show that nonhunters are just as concerned with herd health as are hunters, and both groups are willing to make similar trade-offs between herd health and increases in deer populations - for a 1% increase in deer numbers both groups could incur about 0.4% more deer in poor health without a change in utility. If management seeks to reduce deer populations, this finding emphasizes the importance of demonstrating the relationship between herd health and population size to the public.

Another finding that should be of interest to management is the importance hunters place on mature bucks. Choice model results show that hunters will incur 2.5 to 3 times the cost, in terms of increased externalities, for increases in mature bucks than for increases in deer. Further, hunters are most likely to choose deer scenarios with the

largest increase to mature bucks for their region, even if the number of deer decrease. It is interesting to compare these results with the results of MDNR surveys concerning Quality Deer Management (QDM) (Frawley 2003). As stated by the MDNR, the goals of QDM include maintaining a balanced sex ratio in the deer herd, keeping the herd in balance with the habitat, and increasing the number of older-aged bucks. QDM survey results suggest that, in 5 out of 6 deer management units surveyed, there is insufficient support to recommend QDM for implementation, or for continued antler point restrictions in harvest. One reason for the disparity between the choice model and QDM survey results may be the lack of information provided in the choice experiment survey addressing how a region will get more mature bucks. While the CE survey does not describe this mechanism, the QDM surveys discuss specific mechanisms for attaining goals, most of which pertain to harvest restrictions. The different survey formats and results may suggest that, while hunters would like more mature bucks, they do not want to incur additional harvest restrictions to get them. However, if an increased number of mature bucks is a management goal, it may be possible to use the strong preferences for herd health to gain support for QDM. For example, the QDM surveys do not specifically discuss the overall health of the herd in relation to QDM. Emphasizing any relationships between improved herd health and QDM may generate increased support for the management concept.

The survey instrument produced consistent results across most types of measurement. For example, when respondents were asked how many deer they would like in their region, hunters wanted about 25% more than last year and nonhunters wanted

about the same as last year. This finding is consistent with the choice model results indicating that deer provide positive utility to both stakeholder groups. Further, attitude questions indicate that respondents are less concerned about deer damage to agriculture and residential property than they are about deer browsing in the forest, deer-vehicle collisions, and herd health, a finding borne out by the choice models as well. When models were estimated at the regional level, the significance of the attributes varied by region. For example, choice models suggest that deer browsing in the forest is not significant to hunters in the northeast but significant to hunters in the other two regions. This finding is consistent with the fact that more hunters in the southwest and northwest agreed with the statement that 'the effects of deer browsing in the forest are significant' than did hunters in the northeast. Also, more nonhunters in the northwest agreed with the statement that 'there is a significant amount of deer damage to residential properties' than did nonhunters in the other regions, a finding supported by the significance of that attribute in the nonhunter northwest regional choice model. The consistency across different types of preference measurement underscores the credibility of the survey results and the management implications derived from the results.

In addition to knowledge of preferences for deer and deer-related attributes, deer managers may need to know what types of changes are likely to produce issue activity, and subsequently, the cultural carrying capacity for deer (see Chapter 1). Although the issue activity models from Chapter 4 performed poorly, using other components of the survey some conclusions about issue activity and cultural carrying capacity can be drawn:

- Generally, nonhunter issue activity is limited to situations when deer and externalities increase, while hunters tend to engage in issue activity when deer numbers decrease and when externalities increase. However, the largest amount of total issue activity (combining hunters and nonhunters in all regions) arises when deer, bucks, and externalities increase.

- Among all externalities, decreases in the percent of deer in poor health and the number of deer-vehicle collisions would provide the strongest "compensation" for a decrease in the deer population, while a decrease in deer damage to residential property would likely provide the weakest "compensation."

- Based on the hypothetical outcomes used to simulate the choice models, a win-win deer scenario for hunters and public is a scenario that decreases the number of deer and the level of deer-related externalities but increases the number of mature bucks. Given the magnitude of the mature bucks coefficient it seems reasonable that additional simulations, based on a realistic range of attribute outcomes, will produce similar results.

In conclusion, using all components of the survey, several management recommendations are presented below:

- Consider the preferences of both hunters and nonhunters when setting deer management goals. Results suggest that, all else equal (e.g. externalities remain at the status quo level), more deer will increase the well-being of both groups.

- Recognize that hunters as well as nonhunters do not want more deer at any cost, and both groups can make trade-offs between deer population size and externalities.

- Preference differences among regions reinforce the existing design of small deer management units, and illustrate the need for the human as well as biological aspects of deer management to be incorporated at small scales.

- Outreach and education efforts would be well spent demonstrating the relationship between herd health and deer population size. It may also be useful to direct some effort at minimizing deer-vehicle collisions.

- Hunters appear to be more likely than nonhunters to engage in issue activity. However, the least amount of issue activity is undertaken when mature bucks increase and deer-related externalities decrease, even if the overall size of the deer population decreases.

Because deer and deer-related externalities matter to the public, future research concerning cultural carrying capacity as defined in Chapter 1 may want to explore mechanisms to better link deer and externalites to the concept of issue activity. Further research could be undertaken concerning the scale used to measure issue activity, the changes required to induce an individual to engage in some form of issue activity, and other unexplored variables that may affect the likelihood of issue activity. In addition, the relationship between respondent characteristics, experience/attitudes, and preferences for deer populations could be examined.

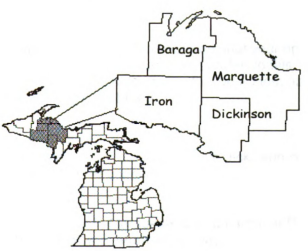
Stated choice techniques are becoming increasing popular as a method to incorporate a human dimension into natural resource management. The format places individuals in situations where trade-offs must be made, a common situation that many resource managers face. This research shows that choice experiment surveys can generate a significant amount of information, not only from the choice models themselves but from the additional survey components provided to help people make an informed decision.

APPENDIX A

SURVEY INSTRUMENTS

LIVING WITH DEER IN THE NORTHWESTERN UPPER PENINSULA OF MICHIGAN

A Survey Conducted by Michigan State University



Marquette, Baraga, Iron, and Dickinson counties.
Region 1

Michigan State University is conducting surveys about deer management in many areas of Michigan.

We are asking you about deer management in the region of Marquette, Baraga, Iron, and Dickinson counties.

These four counties are referred to as the Northwest (NW) region.

Deer management in the NW region affects ***YOU*** because these decisions affect issues such as the number of deer in the region available for viewing and hunting, deer-vehicle collisions, or deer damage to forestry and agriculture.

Because these issues affect you, it is important that your opinions and concerns are heard by state deer management professionals. Taking a few minutes to fill out this survey will help ensure that your input about deer management in the NW region is heard.

Please complete this survey if:

- you live in Marquette, Baraga, Iron, or Dickinson county OR hunt deer in any of these counties

If you do not live or hunt deer in Marquette, Baraga, Iron, or Dickinson county please check the box below and return the survey.

❑ I am not a current resident and do not hunt deer in Marquette, Baraga, Iron, or Dickinson county.

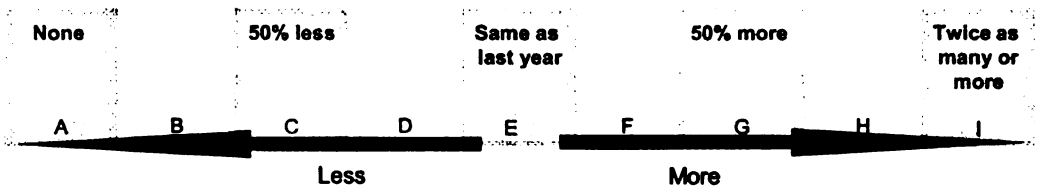
Section I. Aspects of the Deer Herd

1. During the last year, approximately how often did you . . . (circle only one)

....See deer in your own yard or in your neighborhood	**Never**	**Rarely**	**Sometimes**	**Frequently**
....Take a drive or a walk for the specific purpose of viewing deer	**Never**	**Rarely**	**Sometimes**	**Frequently**

NUMBER OF DEER

2. In the diagram below, the letter E represents the number of deer last year in the NW region. Please circle the letter that best represents the number of deer that you would like to have in future years in the NW region. (Circle one letter below. If you are not sure or don't care, check the appropriate box below).



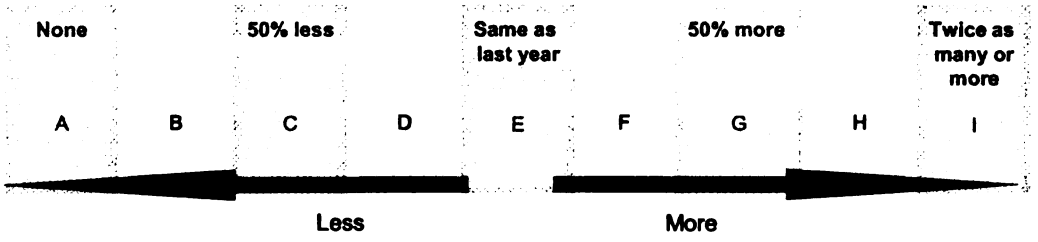
- ❑ I am unsure
- ❑ I don't care

3. How concerned would you be if the number of deer in the NW region decreased in future years by 20%? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

NUMBER OF MATURE BUCKS

4. In the diagram below, the letter E represents the number of mature bucks in the NW region that are two and a half years or older and have at least four antler points on one side. Please circle the letter that best represents the number of mature bucks that you would like to have in future years in the NW region. (Circle one letter below. If you are not sure or don't care, check the appropriate box below).



- ❑ I am unsure
- ❑ I don't care

5. How concerned would you be if the number of mature bucks in the NW region decreased in future years by 20%? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

INFORMATION ABOUT HERD HEALTH

Herd health refers to the physical well-being of the deer herd.

- The health of a deer herd may be considered excellent, even though a few individual deer may be in poor health.
- When the number of deer in poor health increases, the health of the deer herd decreases.

When a deer is in **POOR HEALTH** it may have **AT LEAST ONE** of these characteristics:

- Smaller body size than expected
- Low reproductive success
- Disease
- Lower chance of surviving long winters

The percent of deer in the herd that have **AT LEAST ONE** of the characteristics of poor health varies, depending on the region of the state. There are no **EXACT** figures, but professionals **ESTIMATE** that:

- In Michigan the percent of deer with **AT LEAST ONE** of the characteristics of poor health ranges from 5% to 50%.
- In the NW region ***approximately 25%*** of the deer have **AT LEAST ONE** of the characteristics of poor health.

6. How concerned would you be if the percent of deer in poor health in the NW region increased from the current level of 25% to 35% in future years? (Check only one)

   ❑ Very concerned

   ❑ Concerned

   ❑ Somewhat concerned

   ❑ Not concerned at all

7. Based on your own opinion and experience with deer, how would you rate the health of the deer herd in the NW region? (Check only one)

   ❑ Excellent ❑ Fair ❑ Good ❑ Poor

   ❑ I am unsure

INFORMATION ABOUT DEER DAMAGE TO RESIDENTIAL PROPERTY

Residential property damage is caused by deer feeding on plants, trees, and shrubs that people plant in their yards.

- Professionals **ESTIMATE** that ***approximately 30%*** of the residential properties in the NW region experience some deer damage.
- This is an **ESTIMATED AVERAGE** for the entire region. Damage may be *higher in areas where there are more deer* and *lower in areas with less deer.*

8. Have you experienced residential property damage from deer?

❑ Yes → **8a.** **If Yes**, has the deer damage caused you to change the types of plants in your yard?

- ❑ Yes
- ❑ No
- ❑ I am unsure

❑ No

9. How important would it be to you if the percent of residential properties in the NW region experiencing some deer damage decreased from the current level of 30% to 10% in future years? (Check only one)

- ❑ Very important
- ❑ Important
- ❑ Somewhat important
- ❑ Not important at all

INFORMATION ABOUT DEER DAMAGE TO AGRICULTURAL CROPS

Deer damage to agriculture is caused by deer feeding on agricultural crops.

- There are approximately 47,000 acres of cropland in the NW region.
- Professionals **ESTIMATE** that deer cause ***approximately $6 of damage per acre of cropland*** in the NW region.
- This is an **ESTIMATED AVERAGE** for all crops in the entire region. Damage may be *higher for certain crops* and *lower for others.* Damage may also be *higher in areas where there are more deer* and *lower in areas with less deer.*

10. Have you or has someone you know in the NW region experienced deer damage to agricultural crops?

- ❑ Yes → **10a. If Yes,** has the damage resulted in: (Check only one)
  - ❑ Major economic loss
  - ❑ Moderately important economic loss
  - ❑ Relatively unimportant economic loss
  - ❑ I am unsure
- ❑ No

11. How concerned would you be if the average amount of deer damage to agricultural crops in the NW region increased from the current level of $6 per acre to $9 per acre in future years? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

INFORMATION ABOUT DEER-VEHICLE COLLISIONS

Deer-vehicle collisions refers to the number of reported collisions between deer and automobiles during a given time period.

- In 1999 in the STATE OF MICHIGAN there was a total of 67,669 reported deer-vehicle collisions in the state of Michigan.
- In the NW region there were 3,562 reported deer-vehicle collisions.
  - About 65% of the collisions in the NW region occurred on county or local roads.
  - About 35% of the collisions in the NW region occurred on Interstates, US Routes, or State Routes.

12. Before reading about deer-vehicle collisions, did you know that the majority of reported deer-vehicle collisions in the NW region occurred on county or local roads?

- ❑ Yes
- ❑ No
- ❑ I am unsure

13. Have you or anyone in your immediate family been involved in a deer-vehicle collision?

- ❑ Yes
- ❑ No
- ❑ I am unsure

14. How important would it be to you if the annual number of reported deer-vehicle collisions in the NW region decreased from the 1999 level of 3,562 to 2,000 collisions in future years? (Check only one)

- ❑ Very important
- ❑ Important
- ❑ Somewhat important
- ❑ Not important at all

INFORMATION ABOUT DEER AND THE FOREST

In a forest, deer generally feed, or browse, on the plants, shrubs, and tree seedlings. Over time, deer browsing may change the types of plants, trees, and animals that live in the forest. The extent of the changes depends on how much browsing occurs in the forest.

In forest areas that experience *heavy deer browsing* for 5 - 10 years:

- Some types of wildflowers may be eliminated, while some grasses and ferns may increase.
- Some trees, like white cedar and maples, may be eliminated, while trees like spruce and fir may increase.
- The elimination of certain kinds of trees may cause losses in the commercial forest industry.
- Some birds, like warblers may be eliminated, while cardinals and bluejays may increase.
- In general, the habitat will support fewer *kinds* of plants and wildlife.

Besides the changes described above, many scientists believe that changes in the forest may also cause the forest to function differently in the long-term, with uncertain consequences. For example, the forest may be less able to adjust to events like fires and floods.

15. Have you seen any examples of heavy deer browsing in the NW region?

- ❑ Yes
- ❑ No
- ❑ I am unsure

- There are no **EXACT** figures, but professionals **ESTIMATE** that ***approximately 30%*** of forest areas in the NW region experience heavy deer browsing.
- This is an **ESTIMATED AVERAGE** for the entire region – damage may be *higher in areas where there are more deer* and *lower in areas with less deer.*

16. How concerned would you be if the percent of forest area in the NW region that experiences heavy deer browsing increased from the current level of 30% to 40% in future years? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

17. For each of the following statements, please circle the response that comes closest to your point of view.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a. I am concerned about heavy deer browsing in the forest because of the changes to wildlife	SA	A	N	D	SD
b. I am concerned about heavy deer browsing in the forest because of the potential long-term effects to the forest	SA	A	N	D	SD
c. I am concerned about heavy deer browsing in the forest because of the losses to commercial forestry	SA	A	N	D	SD

Section III. Deer Scenarios

The main purpose of this survey is to find out what aspects of the deer herd are important to you. To do this we will show you scenarios and ask you to choose the one you prefer for the NW region.

The previous pages provided information about the *current* deer situation in the NW region. In the next few pages you will see the current deer situation and two *alternative* deer scenarios.

Here is an example of what you will see on the following pages:

Please Compare Deer Scenarios 1, 2, and the Current Deer Situation:

EXAMPLE

	Current Situation	Scenario 1	Scenario 2
Number of Deer	Current number	20% more than current number	20% more than current number
Number of Mature Bucks	Current number	10% more than current number	10% more than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	25%	25%
Percent of Residential Properties Experiencing Some Deer Damage	30%	30%	30%
Deer Damage per Acre of Cropland	$6	$7	$8
Number of Deer-Vehicle Collisions	3,562	3,700	3,600
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	30%	30%

Following each table, you will be asked which scenario you prefer for the NW region.

A series of these scenarios will be presented and the items in each scenario will vary. The *alternative* scenarios may not always seem logical, but they are projections of possible deer scenarios for the NW region.

It is very important that you carefully consider the scenarios as they are described when you make your choice. This will provide the best information to state deer management professionals to help them design deer management policies.

18. **Please** compare Deer Scenarios A, B, and the Current Deer Situation:

	Current Situation	Scenario A	Scenario B
Number of Deer	Current number	20% more than current number	20% more than current number
Number of Mature Bucks	Current number	10% more than current number	10% more than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	35%	30%
Percent of Residential Properties Experiencing Deer Damage	30%	40%	35%
Deer Damage per Acre of Cropland	$6.00	$7.00	$7.00
Number of Deer-Vehicle Collisions	3,562	4,300	4,600
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	40%	40%
Which of these do you prefer?	❑ Current	❑ A	❑ B

19. How satisfied would you be if Scenario **A** was the situation in the NW region? (Check only one)

❑ **Extremely Satisfied** ❑ **Somewhat Satisfied** ❑ **Neither Satisfied nor Dissatisfied** ❑ **Somewhat Dissatisfied** ❑ **Extremely Dissatisfied**

20. If Scenario **A** was the situation in the NW region, which of the following would you likely do? (Check all that apply)

❑ Do nothing because it would not change the situation

❑ Do nothing because the situation would not be that bad

❑ Contact someone with authority to get the situation changed

❑ **Take steps myself to change the situation**

21. Please compare Deer Scenarios C, D, and the Current Deer Situation:

	Current Situation	Scenario C	Scenario D
Number of Deer	Current number	30% less than current number	30% less than current number
Number of Mature Bucks	Current number	10% less than current number	10% less than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	15%	20%
Percent of Residential Properties Experiencing Deer Damage	30%	20%	20%
Deer Damage per Acre of Cropland	$6.00	$4.00	$4.00
Number of Deer-Vehicle Collisions	3,562	2,500	2,850
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	25%	20%
Which of these do you prefer?	❑ Current	❑ C	❑ D

22. How satisfied would you be if Scenario **C** was the situation in the NW region? (Check only one)

❑ Extremely Satisfied ❑ Somewhat Satisfied ❑ Neither Satisfied nor Dissatisfied ❑ Somewhat Dissatisfied ❑ Extremely Dissatisfied

23. If Scenario C was the situation in the NW region, which of the following would you likely do? (Check all that apply)

❑ Do nothing because it would not change the situation

❑ Do nothing because the situation would not be that bad

❑ Contact someone with authority to get the situation changed

❑ Take steps myself to change the situation

24. Please compare Deer Scenarios E, F, and the Current Deer Situation:

	Current Situation	Scenario E	Scenario F
Number of Deer	Current number	5% less than current number	5% less than current number
Number of Mature Bucks	Current number	5% more than current number	5% more than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	27%	23%
Percent of Residential Properties Experiencing Deer Damage	30%	28%	32%
Deer Damage per Acre of Cropland	$6.00	$5.75	$5.75
Number of Deer-Vehicle Collisions	3,562	3,750	3,750
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	28%	28%
Which of these do you prefer?	❑ Current	❑ E	❑ F

25. How satisfied would you be if Scenario **E** was the situation in the NW region? (Check only one)

❑ Extremely Satisfied ❑ Somewhat Satisfied ❑ Neither Satisfied nor Dissatisfied ❑ Somewhat Dissatisfied ❑ Extremely Dissatisfied

26. If Scenario **E** was the situation in the NW region, which of the following would you likely do? (Check all that apply)

❑ Do nothing because it would not change the situation

❑ Do nothing because the situation would not be that bad

❑ Contact someone with authority to get the situation changed

❑ Take steps myself to change the situation

27. For each of the following statements, please circle the response that comes closest to your point of view.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a. When deer-vehicle collisions increase in an area, car insurance rates usually increase.	SA	A	N	D	SD
b. People can avoid most deer-vehicle collisions.	SA	A	N	D	SD
c. Deer browsing can prevent some types of trees from reproducing in the forest	SA	A	N	D	SD
d. The effects of deer browsing in the forest are significant in the NW region of Michigan.	SA	A	N	D	SD
e. When comparing scenarios, I accepted that 30% of the forest areas in the NW region of Michigan experience heavy deer browsing.	SA	A	N	D	SD
f. A deer with at least one characteristic of poor health has a disease.	SA	A	N	D	SD
g. When comparing scenarios, I accepted that 25% of the deer in the NW region of Michigan have at least one characteristic of poor health.	SA	A	N	D	SD
h. There is a significant amount of deer damage to agricultural crops in the NW region of Michigan.	SA	A	N	D	SD
i. There is a significant amount of deer damage to residential properties in the NW region of Michigan.	SA	A	N	D	SD
j. When comparing scenarios, I accepted that 30% of residential properties in the NW region of Michigan experience some deer damage.	SA	A	N	D	SD
k. The number of bucks can increase in a deer herd even if the total number of deer stays the same.	SA	A	N	D	SD

Section V. Background Information

In this section we ask a few questions about your background so that we can compare our results to the state population. Your responses are completely confidential and will not be linked to your name in any way.

28. How many years have you lived in the NW region (Marquette, Baraga, Iron, or Dickinson county)?

_____ years

29. Which best describes the area where you live? (Check only one)

- ❑ Many neighborhoods in a town or city
- ❑ Scattered neighborhoods outside the town
- ❑ Few neighborhoods in a rural area

30. How many years have you lived in the state of Michigan?

_____ years

31. Do you hunt deer in the NW region (Marquette, Baraga, Iron, or Dickinson counties)?

- ❑ No (**If No**, Please skip to question 34)
- ❑ Yes ➡ **If Yes**, which counties _____

32. Approximately how many years have you hunted deer in these counties ?

_____ years

33. About how many days did you spend hunting deer in these counties last year?

_____ days

34. Do you own property in the NW region (Marquette, Baraga, Iron, or Dickinson county)?

❑ No **(If No, please skip to question 36)**

❑ Yes ➡ **If Yes**, approximately how many acres? _____

35. What are the uses of your property? (Check all that apply)

❑ Primary residence
❑ Recreational residence
❑ Farming
❑ Forest products
❑ Hunting
❑ Other _____
❑ Wildlife viewing

36. What was your gross household income in 2000? (Check only one)

❑ $0 to $14,999
❑ $35,000 - $49,999
❑ $15,000 - $24,999
❑ $50,000 - $74,999
❑ $25,000 - $34,999
❑ Over $75,000

37. Is any of your income derived from the activities below? (Check all that apply)

❑ Farming ❑ Forestry ❑ Tourism ❑ None of these

38. What is the highest level of formal education that you have completed? (Check only one)

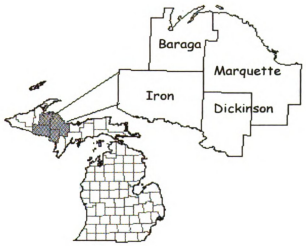
❑ Some high school
❑ Associates Degree (2 year degree)
❑ High School Graduate or equivalent
❑ College graduate (Bachelors or 4 year degree)
❑ Trade or Vocational School
❑ Graduate or Professional degree
❑ Some college

Thank you for helping us with this project. That completes the survey, but if there is anything else you would like to share with us concerning deer management please use the remainder of this page, or feel free to attach additional sheets to this survey.

Please use the enclosed sticker to seal your completed survey, and drop the survey in the mail. Postage has already been paid.

LIVING WITH DEER IN THE NORTHWESTERN UPPER PENINSULA OF MICHIGAN

A Survey Conducted by Michigan State University

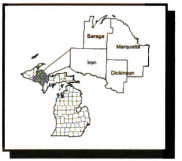


Marquette, Baraga, Iron, and Dickinson counties.
Region 25

Michigan State University is conducting surveys about deer management in many areas of Michigan.

We are asking you about deer management in the region of Marquette, Baraga, Iron, and Dickinson counties.

These four counties are referred to as the Northwest (NW) region.



Deer management in the NW region affects ***YOU*** because these decisions affect issues such as the number of deer in the region available for viewing and hunting, deer-vehicle collisions, or deer damage to forestry and agriculture.

Because these issues affect you, it is important that your opinions and concerns are heard by state deer management professionals. Taking a few minutes to fill out this survey will help ensure that your input about deer management in the NW region is heard.

Please complete this survey if:

- you live in Marquette, Baraga, Iron, or Dickinson county OR hunt deer in any of these counties

If you do not live or hunt deer in Marquette, Baraga, Iron, or Dickinson county please check the box below and return the survey.

❑ I am not a current resident and do not hunt deer in Marquette, Baraga, Iron, or Dickinson county.

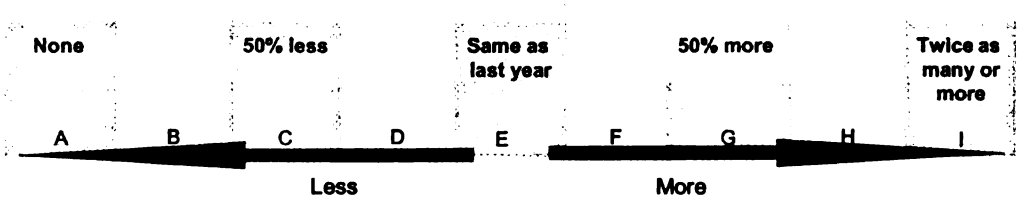
Section I. Aspects of the Deer Herd

1. During the last year, approximately how often did you . . . (circle only one)

....See deer in your own yard or in your neighborhood	**Never**	**Rarely**	**Sometimes**	**Frequently**
....Take a drive or a walk for the specific purpose of viewing deer	**Never**	**Rarely**	**Sometimes**	**Frequently**

NUMBER OF DEER

2. In the diagram below, the letter E represents the number of deer last year in the NW region. Please circle the letter that best represents the number of deer that you would like to have in future years in the NW region. (Circle one letter below. If you are not sure or don't care, check the appropriate box below).



- ❑ I am unsure
- ❑ I don't care

3. How concerned would you be if the number of deer in the NW region decreased in future years by 20%? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

INFORMATION ABOUT HERD HEALTH

Herd health refers to the physical well-being of the deer herd.

- The health of a deer herd may be considered excellent, even though a few individual deer may be in poor health.
- When the number of deer in poor health increases, the health of the deer herd decreases.

When a deer is in **POOR HEALTH** it may have **AT LEAST ONE** of these characteristics:

- Smaller body size than expected
- Low reproductive success
- Disease
- Lower chance of surviving long winters

The percent of deer in the herd that have **AT LEAST ONE** of the characteristics of poor health varies, depending on the region of the state. There are no **EXACT** figures, but professionals **ESTIMATE** that:

- In Michigan the percent of deer with **AT LEAST ONE** of the characteristics of poor health ranges from 5% to 50%.
- In the NW region ***approximately 25%*** of the deer have **AT LEAST ONE** of the characteristics of poor health.

4. How concerned would you be if the percent of deer in poor health in the NW region increased from the current level of 25% to 35% in future years? (Check only one)

   ❑ Very concerned

   ❑ Concerned

   ❑ Somewhat concerned

   ❑ Not concerned at all

5. Based on your own opinion and experience with deer, how would you rate the health of the deer herd in the NW region? (Check only one)

   ❑ Excellent ❑ Fair ❑ Good ❑ Poor

   ❑ I am unsure

INFORMATION ABOUT DEER DAMAGE TO RESIDENTIAL PROPERTY

Residential property damage is caused by deer feeding on plants, trees, and shrubs that people plant in their yards.

- Professionals **ESTIMATE** that ***approximately 30%*** of the residential properties in the NW region experience some deer damage.
- This is an **ESTIMATED AVERAGE** for the entire region. Damage may be *higher in areas where there are more deer* and *lower in areas with less deer.*

6. Have you experienced residential property damage from deer?

   ❑ Yes → **6a. If Yes**, has the deer damage caused you to change the types of plants in your yard?

   ❑ No

   ❑ Yes

   ❑ No

   ❑ I am unsure

7. How important would it be to you if the percent of residential properties in the NW region experiencing some deer damage decreased from the current level of 30% to 10% in future years? (Check only one)

   ❑ Very important

   ❑ Important

   ❑ Somewhat important

   ❑ Not important at all

INFORMATION ABOUT DEER DAMAGE TO AGRICULTURAL CROPS

Deer damage to agriculture is caused by deer feeding on agricultural crops.

- There are approximately 47,000 acres of cropland in the NW region.
- Professionals **ESTIMATE** that deer cause ***approximately $6 of damage per acre of cropland*** in the NW region.
- This is an **ESTIMATED AVERAGE** for all crops in the entire region. Damage may be *higher for certain crops* and *lower for others*. Damage may also be *higher in areas where there are more deer* and *lower in areas with less deer*.

8. Have you or has someone you know in the NW region experienced deer damage to agricultural crops?

- ❑ Yes → **8a.** **If Yes**, has the damage resulted in: (Check only one)
  - ❑ Major economic loss
  - ❑ Moderately important economic loss
  - ❑ Relatively unimportant economic loss
  - ❑ I am unsure
- ❑ No

9. How concerned would you be if the average amount of deer damage to agricultural crops in the NW region increased from the current level of $6 per acre to $9 per acre in future years? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

INFORMATION ABOUT DEER-VEHICLE COLLISIONS

Deer-vehicle collisions refers to the number of reported collisions between deer and automobiles during a given time period.

- In 1999 in the STATE OF MICHIGAN there was a total of 67,669 reported deer-vehicle collisions in the state of Michigan.
- In the NW region there were 3,562 reported deer-vehicle collisions.
  - About 65% of the collisions in the NW region occurred on county or local roads.
  - About 35% of the collisions in the NW region occurred on Interstates, US Routes, or State Routes.

10. Before reading about deer-vehicle collisions, did you know that the majority of reported deer-vehicle collisions in the NW region occurred on county or local roads?

- ❑ Yes
- ❑ No
- ❑ I am unsure

11. Have you or anyone in your immediate family been involved in a deer-vehicle collision?

- ❑ Yes
- ❑ No
- ❑ I am unsure

12. How important would it be to you if the annual number of reported deer-vehicle collisions in the NW region decreased from the 1999 level of 3,562 to 2,000 collisions in future years? (Check only one)

- ❑ Very important
- ❑ Important
- ❑ Somewhat important
- ❑ Not important at all

INFORMATION ABOUT DEER AND THE FOREST

In a forest, deer generally feed, or browse, on the plants, shrubs, and tree seedlings. Over time, deer browsing may change the types of plants, trees, and animals that live in the forest. The extent of the changes depends on how much browsing occurs in the forest.

In forest areas that experience *heavy deer browsing* for 5 - 10 years:

- Some types of wildflowers may be eliminated, while some grasses and ferns may increase.
- Some trees, like white cedar and maples, may be eliminated, while trees like spruce and fir may increase.
- The elimination of certain kinds of trees may cause losses in the commercial forest industry.
- Some birds, like warblers may be eliminated, while cardinals and bluejays may increase.
- In general, the habitat will support fewer *kinds* of plants and wildlife.

Besides the changes described above, many scientists believe that changes in the forest may also cause the forest to function differently in the long-term, with uncertain consequences. For example, the forest may be less able to adjust to events like fires and floods.

13. Have you seen any examples of heavy deer browsing in the NW region?

- ❑ Yes
- ❑ No
- ❑ I am unsure

- There are no **EXACT** figures, but professionals **ESTIMATE** that ***approximately 30%*** of forest areas in the NW region experience heavy deer browsing.
- This is an **ESTIMATED AVERAGE** for the entire region – damage may be *higher in areas where there are more deer* and *lower in areas with less deer.*

14. How concerned would you be if the percent of forest area in the NW region that experiences heavy deer browsing increased from the current level of 30% to 40% in future years? (Check only one)

- ❑ Very concerned
- ❑ Concerned
- ❑ Somewhat concerned
- ❑ Not concerned at all

15. For each of the following statements, please circle the response that comes closest to your point of view.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a. I am concerned about heavy deer browsing in the forest because of the changes to wildlife	SA	A	N	D	SD
b. I am concerned about heavy deer browsing in the forest because of the potential long-term effects to the forest	SA	A	N	D	SD
c. I am concerned about heavy deer browsing in the forest because of the losses to commercial forestry	SA	A	N	D	SD

Section III. Deer Scenarios

The main purpose of this survey is to find out what aspects of the deer herd are important to you. To do this we will show you scenarios and ask you to choose the one you prefer for the NW region.

The previous pages provided information about the *current* deer situation in the NW region. In the next few pages you will see the current deer situation and two *alternative* deer scenarios.

Here is an example of what you will see on the following pages:

Please Compare Deer Scenarios 1, 2, and the Current Deer Situation:

EXAMPLE

	Current Situation	Scenario 1	Scenario 2
Number of Deer	Current number	20% more than current number	20% more than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	25%	25%
Percent of Residential Properties Experiencing Some Deer Damage	30%	30%	30%
Deer Damage per Acre of Cropland	$6	$7	$8
Number of Deer-Vehicle Collisions	3,562	3,700	3,600
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	30%	30%

Following each table, you will be asked which scenario you prefer for the NW region.

A series of these scenarios will be presented and the items in each scenario will vary. The *alternative* scenarios may not always seem logical, but they are projections of possible deer scenarios for the NW region.

It is very important that you carefully consider the scenarios as they are described when you make your choice. This will provide the best information to state deer management professionals to help them design deer management policies.

16. Please compare Deer Scenarios A, B, and the Current Deer Situation:

	Current Situation	Scenario A	Scenario B
Number of Deer	Current number	20% more than current number	20% more than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	35%	30%
Percent of Residential Properties Experiencing Deer Damage	30%	40%	35%
Deer Damage per Acre of Cropland	$6.00	$7.00	$7.00
Number of Deer-Vehicle Collisions	3,562	4,300	4,600
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	40%	40%
Which of these do you prefer?	❑ Current	❑ A	❑ B

17. How satisfied would you be if Scenario **A** was the situation in the NW region? (Check only one)

❑ Extremely Satisfied ❑ Somewhat Satisfied ❑ Neither Satisfied nor Dissatisfied ❑ Somewhat Dissatisfied ❑ Extremely Dissatisfied

18. If Scenario **A** was the situation in the NW region, which of the following would you likely do? (Check all that apply)

❑ Do nothing because it would not change the situation

❑ Do nothing because the situation would not be that bad

❑ Contact someone with authority to get the situation changed

❑ Take steps myself to change the situation

19. Please compare Deer Scenarios C, D, and the Current Deer Situation:

	Current Situation	Scenario C	Scenario D
Number of Deer	Current number	30% less than current number	30% less than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	15%	20%
Percent of Residential Properties Experiencing Deer Damage	30%	20%	20%
Deer Damage per Acre of Cropland	$6.00	$4.00	$4.00
Number of Deer-Vehicle Collisions	3,562	2,500	2,850
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	25%	20%
Which of these do you prefer?	❑ Current	❑ C	❑ D

20. How satisfied would you be if Scenario **C** was the situation in the NW region? (Check only one)

❑ **Extremely Satisfied** ❑ **Somewhat Satisfied** ❑ **Neither Satisfied nor Dissatisfied** ❑ **Somewhat Dissatisfied** ❑ **Extremely Dissatisfied**

21. If Scenario C was the situation in the NW region, which of **the following would you likely do?** (Check all that apply)

❑ **Do nothing because it would not change the situation**

❑ **Do nothing because the situation would not be that bad**

❑ **Contact someone with authority to get the situation changed**

❑ **Take steps myself to change the situation**

22. Please compare Deer Scenarios E, F, and the Current Deer Situation:

	Current Situation	Scenario E	Scenario F
Number of Deer	Current number	5% less than current number	5% less than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	27%	23%
Percent of Residential Properties Experiencing Deer Damage	30%	28%	32%
Deer Damage per Acre of Cropland	$6.00	$5.75	$5.75
Number of Deer-Vehicle Collisions	3,562	3,750	3,750
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	28%	28%
Which of these do you prefer?	❑ Current	❑ E	❑ F

23. How satisfied would you be if Scenario **E** was the situation in the NW region? (Check only one)

❑ Extremely Satisfied ❑ Somewhat Satisfied ❑ Neither Satisfied nor Dissatisfied ❑ Somewhat Dissatisfied ❑ Extremely Dissatisfied

24. **If Scenario E was the situation in the NW region, which of the following would you likely do? (Check all that apply)**

- ❑ **Do nothing because it would not change the situation**
- ❑ **Do nothing because the situation would not be that bad**
- ❑ **Contact someone with authority to get the situation changed**
- ❑ Take steps myself to change the situation

25. Please compare Deer Scenarios A, C, E, and the Current Deer Situation:

	Current Situation	Scenario A	Scenario C	Scenario E
Number of Deer	Current number	20% more than current number	30% less than current number	5% less than current number
Percent of Deer With At Least One Characteristic of Poor Health	25%	35%	15%	27%
Percent of Residential Properties Experiencing Deer Damage	30%	40%	20%	28%
Deer Damage per Acre of Cropland	$6.00	$7.00	$4.00	$5.75
Number of Deer-Vehicle Collisions	3,562	4,300	2,500	3,750
Percent of Forest Areas Experiencing Heavy Deer Browsing	30%	40%	25%	28%
Which of these do you prefer?	❑ Current	❑ A	❑ C	❑ E

26. For each of the following statements, please circle the response that comes closest to your point of view.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a. When deer-vehicle collisions increase in an area, car insurance rates usually increase.	SA	A	N	D	SD
b. People can avoid most deer-vehicle collisions.	SA	A	N	D	SD
c. Deer browsing can prevent some types of trees from reproducing in the forest	SA	A	N	D	SD
d. The effects of deer browsing in the forest are significant in the NW region of Michigan.	SA	A	N	D	SD
e. When comparing scenarios, I accepted that 30% of the forest areas in the NW region of Michigan experience heavy deer browsing.	SA	A	N	D	SD
f. A deer with at least one characteristic of poor health has a disease.	SA	A	N	D	SD
g. When comparing scenarios, I accepted that 25% of the deer in the NW region of Michigan have at least one characteristic of poor health.	SA	A	N	D	SD
h. There is a significant amount of deer damage to agricultural crops in the NW region of Michigan.	SA	A	N	D	SD
i. There is a significant amount of deer damage to residential properties in the NW region of Michigan.	SA	A	N	D	SD
j. When comparing scenarios, I accepted that 30% of residential properties in the NW region of Michigan experience some deer damage.	SA	A	N	D	SD
k. The number of bucks can increase in a deer herd even if the total number of deer stays the same.	SA	A	N	D	SD

Section V. Background Information

In this section we ask a few questions about your background so that we can compare our results to the state population. Your responses are completely confidential and will not be linked to your name in any way.

27. How many years have you lived in the NW region (Marquette, Baraga, Iron, or Dickinson county)?

_____ years

28. Which best describes the area where you live? (Check only one)

- ❑ Many neighborhoods in a town or city
- ❑ Scattered neighborhoods outside the town
- ❑ Few neighborhoods in a rural area

29. How many years have you lived in the state of Michigan?

_____ years

30. Do you hunt deer in the NW region (Marquette, Baraga, Iron, or Dickinson counties)?

- ❑ No (**If No**, Please skip to question 33)
- ❑ Yes ➡ **If Yes**, which counties _____

31. Approximately how many years have you hunted deer in these counties ?

_____ years

32. About how many days did you spend hunting deer in these counties last year?

_____ days

33. Do you own property in the NW region (Marquette, Baraga, Iron, or Dickinson county)?

❑ No (**If No**, please skip to question 35)

❑ Yes ➡ **If Yes**, approximately how many acres? _____

34. What are the uses of your property? (Check all that apply)

❑ Primary residence
❑ Recreational residence
❑ Farming
❑ Forest products
❑ Hunting
❑ Other _____
❑ Wildlife viewing

35. What was your gross household income in 2000? (Check only one)

❑ $0 to $14,999
❑ $35,000 - $49,999
❑ $15,000 - $24,999
❑ $50,000 - $74,999
❑ $25,000 - $34,999
❑ Over $75,000

36. Is any of your income derived from the activities below? (Check all that apply)

❑ Farming ❑ Forestry ❑ Tourism ❑ None of these

37. What is the highest level of formal education that you have completed? (Check only one)

❑ Some high school
❑ Associates Degree (2 year degree)
❑ High School Graduate or equivalent
❑ College graduate (Bachelors or 4 year degree)
❑ Trade or Vocational School
❑ Graduate or Professional degree
❑ Some college

Thank you for helping us with this project. That completes the survey, but if there is anything else you would like to share with us concerning deer management please use the remainder of this page, or feel free to attach additional sheets to this survey.

Please use the enclosed sticker to seal your completed survey, and drop the survey in the mail. Postage has already been paid.

APPENDIX B

SURVEY CORRESPONDANCE

MICHIGAN STATE
UNIVERSITY

Name
Address

Date, 2001

In a few days you will be receiving a questionnaire for a research project at Michigan State University. It will ask you about deer management issues that affect you as a resident of Marquette, Baraga, Iron, or Dickinson county. Your opinion and concerns are important to ensure that deer are managed to meet the needs of your area.

We have found that many people like to know ahead of time that they will be receiving a questionnaire. As your time is valuable we will be enclosing a small token of our appreciation.

We look forward to receiving your completed questionnaire.

Sincerely,

Kristy Wallmo
Project Coordinator
Michigan State University

(printed on letterhead)

MICHIGAN STATE
UNIVERSITY

Name
Address

Date, 2001

We need your help with the enclosed survey about deer management in northwest Michigan. You may recall from a letter we sent you last week that the survey is part of an effort by Michigan State University to learn your opinions toward a variety of deer management issues.

Results of the survey will provide guidance to the Michigan Department of Natural Resources in developing deer management policies that address the needs and concerns of residents of many different areas of Michigan.

You might be wondering why we want your opinion, particularly if you are not a hunter or a wildlife enthusiast. Your input is vital because managing deer involves trade-offs that affect you.

We realize that it takes time out of your day to fill out this survey, and have enclosed three first class stamps as a way of saying thank you for your help.

Please take a few minutes to share your viewpoint by filling out this survey. All responses are completely confidential - **your name and address will never be connected to your responses in any way**. Rest assured, your privacy will be protected to the maximum extent allowable by law.

If you have any questions or comments about this study feel free to call me at 517-432-5037. If you have any further questions concerning your rights as a survey respondent please contact Dr. David Wright, Chair of the MSU Committee on Research Involving Human Subjects, at (517) 355-2180.

Thanks for participating in this study.

Sincerely,

Kristy Wallmo
Project Coordinator
Michigan State University

(printed on letterhead)

Dear Sir or Madam:

You were recently sent a questionnaire concerning deer management in your area. If you have returned the questionnaire, ***thank you***. If you have not yet completed the questionnaire, please take a few minutes to do so now. Your input is important to ensure that deer are managed to meet the needs of your area.

Sincerely,

Kristy Wallmo
Project Coordinator
Michigan State University
wallmokr@msu.edu
(517) 432-5037

MICHIGAN STATE
UNIVERSITY

Name
Address

Date, 2001

We recently sent you a survey about deer management in your area of Michigan. Although we have received completed surveys from many of the residents that were selected from your area, to date we have not heard from you.

I am writing to you again because **your** input is vital! Managing deer involves trade-offs that affect you and the people in your community. As a member of our scientifically designed study, we need to hear from you to make sure that our results are truly representative of residents in your area.

Results of the survey will provide guidance to the Michigan Department of Natural Resources in developing deer management policies that address the needs and concerns of residents of many different areas of Michigan.

Please take a few minutes to share your viewpoint by filling out this survey. We remind you that all responses are completely confidential - your name and address will never be connected to your responses. Rest assured, your privacy will be protected to the maximum extent allowable by law.

If you have any questions or comments about this study feel free to call me at 517-432-5037. If you have any further questions concerning your rights as a survey respondent please contact Dr. David Wright, Chair of the MSU Committee on Research Involving Human Subjects, at (517) 355-2180.

Thank you for your contribution to the success of this study.

Sincerely,

Kristy Wallmo
Project Coordinator
Michigan State University

(printed on letterhead)

MICHIGAN STATE
UNIVERSITY

Name
Address

Date, 2001

During the last two months we have sent you several mailings about deer management in your area of Michigan. Our study is drawing to a close, but we would like to make one final attempt to obtain your input. Managing deer involves many trade-offs that affect you and the people in your community, and that means your input is ESSENTIAL!

By filling out the survey you are helping to provide guidance to the Michigan Department of Natural Resources in developing deer management policies that address the needs and concerns of residents in your area.

Please take a few minutes to share your viewpoint by filling out this survey. We remind you that all responses are completely confidential - your name and address will never be connected to your responses. Rest assured, your privacy will be protected to the maximum extent allowable by law.

If you have any questions or comments about this study feel free to call me at 517-432-5037. If you have any further questions concerning your rights as a survey respondent please contact Dr. David Wright, Chair of the MSU Committee on Research Involving Human Subjects, at (517) 355-2180.

Thank you for your contribution to the success of this study.

Sincerely,

Kristy Wallmo
Project Coordinator
Michigan State University

(printed on letterhead)

BIBLIOGRAPHY

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Adamowicz, W., Louviere, J., and Swait, J. 1998a. Introduction to Attribute-Based Stated Choice Methods. Final Report submitted to the Resource Valuation Branch Damage Assessment Center, NOAA, U.S. Department of Commerce.

Adamowicz, W., Boxall, P., Williams, M., and Louviere, J. 1998b. Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation. *American Journal of Agricultural Economics*, 80: 64-75.

Alverson, W., and Waller, D. 1997. Deer Populations and the Widespread Failure of Hemlock Regeneration in Northern Forests. Pages 280-297 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Alverson, W., Waller, D., and Solheim, S. 1988. Forests too deer: Edge effects in northern Wisconsin. *Conservation Biology*, 2: 348-58.

Black, HC., Dimock, E.J, Evans, J., Kao, C., and Rochelle, J.A. 1979. Animal Damage to Coniferous Plantations in Oregon and Washington: Part I. A Survey, 1963-75. Resource Bulletin 25, Forest Resources Laboratory, Oregon State University, Corvallis, OR.

Bradley, M., and Daly, A. 1994. Use of logit scaling approach to test for rank order and fatigue effects in stated preference data. *Transportation,* 21: 167-184.

Boxall, P., Adamowicz, W., Swait, J., Williams, M., and Louviere, J. 1996. A comparison of stated preference methods for environmental valuation. *Ecological Economics*, 18: 243-253.

Bull, P., and Peyton, R.B. 1999. Stakeholder Preferences for Deer Management in DMU 15. Report submitted to Champion International Corporation, The Sand County Foundation, and Michigan Wildlife Bureau.

Campa, H., Winterstein, S.R, and Raymer, D.F. 1996. Long-term Effects of Ungulate Browsing on Aspen Stand Regeneration and Structure. Michigan Dept. of Nat. Res., 1996. 230 pp. Final Report.

Campa, H., Winterstein, S., Peyton, R.B., Dudderar, G., and Leefers, L. 1997. An Evaluation of a Multidisciplinary Problem: Ecological and Sociological Factors Influencing White-tailed Deer Damage to Agricultural Crops in Michigan. *Transactions of the 62nd North American Wildlife and Natural Resource Conference.*

Carpenter, L., Decker, D.J., and Lipscomb, J. 2000. Stakeholder Acceptance Capacity in Wildlife Management. *Human Dimensions of Wildlife,* 5: 5-19.

Connelly, N.A., Decker, D.J., and Wear, S. 1987. Public Tolerance for Deer in a Suburban Environment: Implications for Management and Control. The 3rd Eastern Wildlife Damage Control Conference, Oct. 19-21, Gulf Shores, AL.

Conover, M. 2002. Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management. Lewis Publishers, CRC Press, Washington D.C.

Conover, M. 1997. Monetary and Intangible valuation of deer in the United States. *The Wildlife Society Bulletin,* 25(2): 298-305.

Cristoffel, R., and Craven, S. 2000. Attitudes of woodland owners toward white-tailed deer and herbivory in Wisconsin. *The Wildlife Society Bulletin,* 28(1): 227-234.

Curtis, J., and Lynch, L. 2001. Explaining Deer Population Preferences: An Analysis of Farmers, Hunters, and the General Public. *Agricultural and Resource Economics Review,* 31(1): 44-55.

deCalesta, D. 1997. Deer and Ecosystem Management. Pages 267-279 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

deCalesta, D., and Stout, S. 1997. Relative deer density and sustainability: a conceptual framework for integrating deer management with ecosystem management. *The Wildlife Society Bulletin,* 25(2): 252-58.

deCalesta, D. 1994. Impacts of white-tailed deer on songbirds within managed forests in Pennsylvania. *Journal of Wildlife Management*, 58: 711-718.

Decker, D.J., and Brown, T. 1982. Fruit Growers vs. Other Farmers Attitudes Toward Deer in New York. *The Wildlife Society Bulletin*, 10: 150-155.

Decker, D.J., and Gavin, T.A. 1985. Public Tolerance of a Suburban Deer Herd: Implications for Control. *Eastern Wildlife Damage Control Conference* 2: 192-204.

Decker, D.J., and Gavin, T. 1987. Public Attitudes Toward a Suburban Deer Herd. *The Wildlife Society Bulletin*, 15: 173-180.

Decker, D.J., and Purdy, K. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. *The Wildlife Society Bulletin,* 16(1): 53-57.

Decker, D.J., and Chase, L. 1997. Human Dimensions of Living with Wildlife – A Management Challenge for the 21st Century. *The Wildlife Society Bulletin*, 25: 788-795.

Diefenbach, D., Palmer, W., and Shope, W. 1997. Attitudes of Pennsylvania sportsmen towards managing white-tailed deer to protect the ecological integrity of forests. *The Wildlife Society Bulletin*, 25(2): 244-251.

Frawley, B. 2003. Quality Deer Management Survey: Deer Management Units 035 and A135. Michigan Department of Natural Resources, Wildlife Division Report 3388, Lansing, MI.

Frawley, B. 2003. Quality Deer Management Survey: Deer Management Units 053. Michigan Department of Natural Resources, Wildlife Division Report 3389, Lansing, MI.

Frawley, B. 2003. Quality Deer Management Survey: Deer Management Units 117. Michigan Department of Natural Resources, Wildlife Division Report 3391, Lansing, MI.

Frawley, B. 2003. Quality Deer Management Survey: Deer Management Units 059. Michigan Department of Natural Resources, Wildlife Division Report 3390, Lansing, MI.

Frawley, B. 2003. Quality Deer Management Survey: Deer Management Units 118. Michigan Department of Natural Resources, Wildlife Division Report 3392, Lansing, MI.

Frelich, L., and Lorimer, C. 1985. Current and predicted long-term effects of deer browsing in Hemlock forests in Michigan. *Biological Conservation,* 34(2): 99-120.

Fritzell, P. 1998. A survey of Michigan agricultural producers attitudes, perceptions, and behaviors regarding deer crop depredation to fruit, vegetables, and field crops. Thesis. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI.

Gigliotti, L., Decker, D.J., and Carpenter, L. 2000. Developing the Wildlife Stakeholder Acceptance Capacity Concept: Research Needed. *Human Dimensions of Wildlife*, 5: 76-82.

Hanley, N., MacMillan, D., Wright, R., Bullock, C., Simpson, I., Parsisson, D., and Crabtree, B. 1998. Contingent Valuation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland. *Journal of Agricultural Economics*, 49(1): 1-15.

Hanley, N., Wright, R., and Adamowicz, V. 1998. Using Choice Experiments to Value the Environment: Design Issues, Current Experiments, and Future Prospects. *Environmental and Resource Economics,* 11(3-4): 413-428.

Healy, W. 1997. Influence of Deer on the Structure and Composition of Oak Forests in Central Massachusetts. Pages 249-266 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Hensher, D., Louviere, J., and Swait, J. 1999. Combining Sources of Preference Data. *Journal of Econometrics*, 89: 197-221.

Lancaster, K. 1966. A New Approach to Consumer Theory. *Journal of Political Economy*, 74: 132-157.

Langenau, E. 1994. 100 Years of Deer Management in Michigan. Michigan Department of Natural Resources, Wildlife Division Report 3213, Lansing, MI.

Langeneau, E. 1993. 1993 Evaluation of the deer damage block permit program. Michigan Department of Natural Resources, Wildlife Division Report 3194, Lansing, MI.

Lauber, T., Anthony, M., and Knuth, B. 2001. Gender and Ethical Judgements About Surburban Deer Management. *Society and Natural Resources*, 14: 571-583.

Louviere, J., Hensher, D., and Swait, J. 2000. Stated Choice Methods: Analysis and Application. Cambridge University Press, UK.

Louviere, J., and Timmermans, H. 1990. Stated Preference and Choice Models Applied to Recreation Research: A Review. *Leisure Sciences*, 12: 9-32.

Marquis, D.A. 1981. Effect of deer browsing on timber production in Allegheny hardwood forests of northwestern Pennsylvania. Northeast Forest Experiment Station, Broomall, PA.

McCabe, T., and McCabe, R. 1997. Recounting Whitetails Past. Pages 11-26 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press,

Washington, D.C.

McCreedy, C., McCreedy, C., and McCreedy, P. 2001. Economic Impacts of White-tailed Deer in Indiana. FNR-160, Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN.

McShea, W., and Rappole, J. 2000. Managing the Abundance and Diversity of Breeding Bird Populations through Manipulation of Deer Populations. *Conservation Biology*, 14(4): 1161-1170.

McShea, W., and Rappole, J. 1997. Herbivores and the ecology of understory birds. Pages 298-309 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

McShea, W., Underwood, B., and Rappole, J. 1997. Deer Management and the Concept of Overabundance. Pages 1-10 in W.J. McShea, H.B. Underwood, and H.J. Rappole, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

McNew, K., and Curtis, J. 1997. Maryland Farmers Lose Bucks on Deer-Damaged Crops. Economic Viewpoints (December). Cooperative Extension Service, University of Maryland, College Park, MD.

Michigan Department of Natural Resources. 1987. Deer-vehicle collisions in Michigan: A task force report. Wildlife Division Report 3072, Lansing, MI.

Miller, S., Bratton, S., and Hadidian, J. 1992. Impacts of White-tailed Deer on Endangered and Threatened Vascular Plants. *Natural Areas Journal*, 12(2): 67-74.

Minnis, D., and Peyton, R.B. 1993. Cultural Carrying Capacity: Modeling a Notion. Pages 19-34 in Jay B. McAninch, ed. Urban Deer: A Manageable Resource? Proceedings of a Symposium held at the 55th Midwest Fish and Wildlife Conference, December 12-14, St. Louis, MO.

Morrison, G.C. 2000. WTP and WTA in repeated trial experiments: learning or leading? *Journal of Economic Psychology*, 21: 57-72.

Organ, J., and Ellingwood, M. 2000. Wildlife Stakeholder Acceptance Capacity for Black Bears, Beavers, and Other Beasts in the East. *Human Dimensions of Wildlife*, 5:63-75.

Peyton, R.B. 1984. A typology of natural resource issues with implications for resource management and education. *Michigan Academician*, 17(1): 49-58.

Sayre, R.W., Decker, D.J., and Good, G. 1992. Deer Damage to Landscape Plants in New York State: Perceptions of Nursery Producers, Landscape Firms, and Homeowners. *Journal of Environmental Horticulture,* 10(1): 46-51.

Stout, R., Knuth, B., and Curtis, P. 1997. Preferences of suburban landowners for deer management techniques: a step towards better communication. *The Wildlife Society Bulletin*, 25(2): 348-359.

Stout, R., Stedman, R., Decker, D.J., and Knuth, B. 1993. Perceptions of Risk from Deer-related Vehicle Accidents: Implications for Public Preferences for Deer Herd Size. *The Wildlife Society Bulletin*, 21:237-249.

Tilghman, N. 1989. Impacts of White-Tailed Deer on Forest Regeneration in Northwestern Pennsylvania. *Journal of Wildlife Management*, 53(3): 524-532.

Train, K. 2003. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge, UK.

Van Deelen, T., Pregitzer, K., and Haufler, J. 1996. A comparison of presettlement and present-day forests in two northern Michigan deer yards. *American Midland Naturalist*, 135(2): 181-194.

Verme, L., and Johnston, W. 1986. Regeneration of Northern White Cedar Deeryards in Upper Michigan. *Journal of Wildlife Management*, 50(2): 307-313.

Wisconsin Department of Natural Resources. 1999. Damage Abatement and Claims Program.Report prepared by Sarah Carter, Wisconsin Department of Natural Resources.

Woolf, A., and Roseberry, J. 1998. Deer management: our profession's symbol of success or failure? *The Wildlife Society Bulletin*, 26(3): 515-521.

U.S. Fish and Wildlife Service. 1996. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. U.S. Fish and Wildlife Service, Washington D.C.