# **Landowner and hunter surveys for white-tailed deer management in Minnesota:** factors impacting hunter access to private lands and cell-by-cell correction to reduce mixed-mode survey sampling effects

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## Dedication

This thesis is dedicated to my wife, Jennifer, and my daughter, Savannah. My wife has been by my side during this whole process and I would not be here today if not for her unwavering support, friendship, and love. She has been my sounding board and calming voice when needed. She has been the caring mother to my daughter and I thank her for all the sacrifices that she has given for me to accomplish this achievement. Savannah was born while I was working on this degree and watching her grow has given me great joy. She has provided me with needed distractions from my busy schedule and I love her more than she will ever know. I thank you both for being a part of my life.

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# CHAPTER 1

## Factors impacting hunter access to private lands in southeast Minnesota

**ABSTRACT** White-tailed deer (*Odocoileus virginianus*) have important socioeconomic and ecological impacts in the United States. Hunting is important for the effective management of deer and relies on access to privately owned lands. A majority of landowners allow hunting access for friends and family, however, fewer landowners allow access to the public. We surveyed southeast Minnesota landowners in 2013 to examine factors that influence landowners' decision to allow hunting access to the public. We found that landowners allowed hunting access at a high rate on both posted and non-posted properties (89% vs 88%), however, landowners with posted properties were more likely to restrict hunting access to family, friends, and neighbors (77% vs 69%) and less likely to allow public hunting access (11% vs 26%). Among all landowners, hunting access to small properties was more likely to be restricted to family, friends, and neighbors (83%) compared to medium (74%) or large properties (60%). General public hunters were more likely to have hunting access to large properties (27%) than medium (17%) or small properties (10%). Landowners who own large properties present the greatest potential for improving future public access due to the number of hunters that can be accommodated without crowding and because they are more likely to allow access.

**KEY WORDS:** deer hunting, human dimensions, hunting access, landowners, posting

## INTRODUCTION

Deer hunting in the United States (US) has significant economic, ecological, and social implications. White-tailed deer (*Odocoileus virginianus*) are the most hunted big game animal in Minnesota and the U.S. with approximately 500,000 hunters pursuing deer each year in Minnesota (McInenly 2013) and over 10.9 million nationwide (U.S. DOI 2014). Hunters spend $259 million each year in Minnesota on big game-related expenditures (U.S. DOI 2013) and an estimated $16.9 billion nationwide (U.S. DOI 2014). Landowners derive benefits from deer because they enjoy watching them, receive satisfaction from knowing the animals are there, satisfaction from providing habitat for wildlife, and hunting deer themselves (Lacey et al. 1993). Abundant deer populations provide plentiful recreational opportunities for hunters (Woolf and Roseberry 1998), yet also cause serious socioeconomic and ecological concerns about deer-vehicle collisions, forest regeneration, flora and fauna diversity, and depredation of crops (DeCalesta 1994; Mower et al. 1997; Waller and Alverson 1997; Brown et al. 2000; Bissonette et al. 2008). To relieve socioeconomic and ecological pressures presented by overabundant deer herds, state wildlife agencies use regulated harvest to maintain deer densities below the biological carrying capacity (Fieberg et al. 2010).

Hunting is the primary mechanism for controlling white-tailed deer populations on a broad scale (Woolf and Roseberry 1998; Brown et al. 2000). In the foreseeable future, hunting will remain the primary management mechanism because no socially or economically acceptable alternatives currently exist (Brown et al. 2000). In Minnesota, a majority of deer hunters pursue deer on privately owned lands (Pradhananga et al. 2013; Schroeder and Cornicelli 2013) with 86% of all Minnesota hunters using private lands for

part or all of their hunting activities (U.S. DOI 2013). Private-land hunters in Minnesota tend to change locations less frequently than public land hunters (Fulton et al. 2006). Most hunters (91% in southeast Minnesota) use the same areas every year, with hunters who own land tending to change locations less frequently than individuals who do not own property (Schroeder and Cornicelli 2013). A majority of Minnesota's forests (56%) are publicly owned, though a large percentage is located in northern Minnesota (Miles et al. 2011), while over 90% of land in southeast Minnesota is privately owned (LMIC 1983). The majority of Minnesota residents live in the seven county metropolitan area, meaning that access to private lands in areas such as southeast Minnesota is particularly important. Access to private lands in southeast Minnesota is essential for hunter participation and maintaining deer populations at desirable population densities based on management goals. Therefore, limited hunting access on private lands can impede the ability of the Minnesota Department of Natural Resources (DNR) to adequately manage the Minnesota deer population.

Access to hunting areas has an important influence on hunter participation, which affects the ability of agencies to achieve harvest goals (Brown et al. 2000). Hunter harvest may be sufficient to control deer populations in some areas, but hunters are seldom dispersed such that they provide a uniform harvest across broad landscapes (Curtis et al. 2000). Unhunted private lands can act as a refuge (Diefenbach et al. 2005; Poudyal et al. 2012). Areas with few hunters likely serve as refugia and a portion of the deer population is unlikely to be harvested (Diefenbach et al. 2005). Hunter access to private lands inhabited by deer is decreasing for numerous reasons, resulting in refugia

that affects harvest distribution and the overall ability to use hunting to control deer populations (Brown et al. 2000).

Conover (2001) found that landowners' perceptions of the benefits and liabilities from wildlife and hunters, influenced landowners' decisions to allow hunting access to their property. In east Texas, landowners with smaller properties were more likely to prohibit hunting because they were more likely to experience land-use conflicts and loss of privacy (Wright et al. 1988). Land uses such as row crop agriculture and livestock operations were often perceived by landowners to conflict with hunting (Wright et al. 1988). In Montana, Lacey et al. (1993) found that landowners with greater dependency on agricultural income typically desired fewer deer, were more likely to indicate big game had a harmful impact on forage and crop yields, and were more likely to allow hunting access. Among Wisconsin woodland owners, hunting was used by a majority of respondents to manage deer on their parcels (>90%) and hunting was the most common method to mitigate damage from deer (Christoffel and Craven 2000).

Conover (2001) reported that landowners tolerate some wildlife damage because of the benefits that wildlife provide, but suggested that without hunting, wildlife populations would increase, and animals would become more habituated to humans, thus decreasing landowners' tolerance of wildlife. He suggested landowners could benefit from allowing hunting access to reduce wildlife populations and change behavior of deer so they are less likely to cause crop damage. In southeast Minnesota, crop damage is a significant concern for landowners and wildlife managers because row crops are the main land use in the region (Pradhananga et al. 2013).

In the US, deer are estimated to cause $100 million in crop damage annually (Conover 1997). Deer were found to be the main source of crop damage in Pennsylvania (Tzilkowski et al. 2002). In Wisconsin deer caused an estimated 80% to 90% of the total annual crop damage (Yoder 2002). Nationally, 53% of U.S. agricultural producers indicated that the crop damage they experienced from wildlife exceeded tolerable levels (Conover 2001). Deer often select for and consume crops because they are typically more digestible and contain higher levels of crude protein than many native grasses and browse species (Mould and Robbins 1982). Reports of crop damage caused by deer are directly related to perceived deer densities and acreage allocation shifts from high-damage crops (e.g., feed corn, soybeans, alfalfa, and sweet corn) to other crops as deer densities increase, though this pattern can be reversed as compensation rates from wildlife damage programs increase (Yoder 2002). Wildlife agencies can increase hunting access to private lands by making wildlife damage abatement and compensation programs contingent on access rules that allow more hunting on their land (Yoder 2002). Wildlife damage programs can be used to reduce the cost of wildlife to landowners, reducing incentives to destroy habitat and harm wildlife populations through private abatement activities (Yoder 2002).

Posting is used by landowners to inform the public that access to their property is prohibited unless permission is granted and is done by placing signs around their property boundaries (Snyder et al. 2008). Landowners have increasingly posted their land resulting in decreased access to forested land (Snyder et al. 2009). Posting does not result in absolute denial of access to private lands for hunting, but is used to control access rather than prevent it entirely (Jagnow et al. 2006; Snyder et al. 2009). Siemer and Brown

(1993) found that approximately 75% of hunters reported experiencing one or more access-related problems including: finding that the land they wanted to hunt was posted, being unable to locate landowners to ask for permission to hunt, and being denied permission to hunt.

Negative experiences with hunters and other outdoor recreationists has been shown to be a strong predictor of posting land (Brown et al. 1984; Wright et al. 1988; Siemer and Brown 1993; Jagnow et al. 2006). In New York, landowners who perceived severe deer-related problems, especially related to overpopulation, were less likely to post their property (Lauber and Brown 2000). However, in Pennsylvania past negative experiences with recreationalists increased posting behavior (Jagnow et al. 2006). Landowners' concerns about deer damage were overridden by safety and hunter behavior concerns that resulted in landowners restricting access to their property by posting (Jagnow et al. 2008). In both Pennsylvania and Minnesota, posting of property was related to perceived liability from recreational users who are allowed open access onto private property (Jagnow et al. 2008; Snyder et al. 2008). Wright et al. (2002) argued that the perception of landowner liability appears to be greater than actual liability risks because state recreation-use statues provide significant liability protection for landowners. In east Texas, the major factors that influenced landowners' decisions to deny access were fear of being sued for injuries sustained by hunters, concerns about hunter-induced property damages, discharge of firearms too close to buildings, livestock protection, and inability to control actions of hunters (Wright et al. 1988).

Posting in the United States is likely to increase in the future due to increased urbanization, along with a decreasing supply of open land (Jagnow et al. 2006), either

through denied hunting access or through leased property. Landowners are unlikely to be persuaded by altruistic motives to open their land to public hunting (Deng and Munn 2015). As demonstrated in previous studies, the monetary benefits available to the landowner through leasing might be the stimulus needed to increase access (Wright and Fesenmaier 1988; Deng and Munn 2015).

Many landowners in Pennsylvania who posted their property still allowed hunting, though access was often limited to family and friends (Jagnow et al. 2006). The primary reason for forest land ownership for many individuals in Minnesota was for hunting purposes and many believe that allowing access to others would interfere with their own hunting enjoyment (Snyder et al. 2008). In areas with limited hunting access, land ownership or leasing may be the only way to secure exclusive hunting access rights (Snyder et al. 2009). Most Wisconsin landowners allowed deer hunting on their property (93%), although only 12% would allow people other than neighbors, relatives, or friends to hunt their property (Christoffel and Craven 2000). Social networks can play an important role in gaining and maintaining access to private land for hunting, and local residents usually have an easier time finding a place to hunt (Jagnow et al. 2008). In Pennsylvania, most landowners were comfortable allowing family, friends, and/or neighbors on their property, but were cautious and/or fearful when a stranger was on their property (Jagnow et al. 2008). Most southeast Minnesota landowners (72%) stated that they would allow or continue allowing other deer hunters on their property if hunters followed the rules on their property (Pradhananga et al. 2013).

Decreased access to private lands can increase hunting pressure on public lands and the quality of the hunter's experience may decline (Jagnow et al. 2006). Declining

hunting access to private lands also results in inadequate hunting pressure and harvest intensity on private lands, potentially resulting in refuges and limiting the effectiveness of hunting as a management tool. Additionally, public land hunters harvest fewer deer per hunter, especially antlerless deer (Stedman et al. 2008). Decreasing access to private lands may exacerbate hunters' capacity to manage deer because public land hunters seem more at risk of dropping out of the hunting population, as they are more likely to come from urban areas and hunt alone (Stedman et al. 2008).

The purpose of our research is to determine factors that limit public hunting access to private lands in southeast Minnesota. We focus on "public hunters" because the low rate of hunting access for this group presents the greatest potential for future growth in hunting access rates. We define "public hunters" as members of the general public that ask permission and are not the landowners' family or friends. Our objectives were to 1) identify factors that limit public hunting access to private lands; 2) identify the most informative models through an a priori model selection process based on variables known to impact hunting access; 3) assess to whom and why landowners allow public hunting on their land; and 4) assess spatial clustering of land parcels where public hunting access is allowed.

## METHODS

### *Research Area and Survey Methods*

The population of interest was private landowners within the southeast Minnesota counties of Goodhue, Wabasha, Winona, and Houston (Figure 1). We defined a sampling frame (N = 6,090) based on publicly available county property tax identification lists and a stratified random sample of landowners owning at least 40 acres of property within the

study area was selected. Property size for each landowner included the total acreage among all parcels they own within the study area. The sample was stratified into three categories based on number of acres owned: 40 to 79 acres (small), 80 to 250 acres (medium), and more than 250 acres (large). Hereafter property size will be referred to as small, medium, or large. The stratification resulted in three strata and a total sample size of 4,193 landowners.

All randomly selected landowners received self-administered mail-back questionnaires based on an adapted Dillman's (2009) tailored design method (Appendix A). Approval for human subjects research received via University of Minnesota IRB Study Number: 0609E92806. We contacted participants three times between October 2012 and January 2013 with a cover letter and full questionnaire to enhance response rates. A shortened version of the survey questionnaire was mailed to non-respondents in February 2013 and served as a non-response check. Data were collected from October, 2012 to March 2013.

***Data Analysis***

We used ArcGIS 10.2 (ESRI 2013) to create maps and perform Moran's I spatial autocorrelation analysis. Spatial Autocorrelation (Moran's I) was used to analyze the spatial distribution of parcel location based on: 1) public hunting access and 2) parcel size. Spatial relationships among parcels were conceptualized through the use of inverse distance, where nearby neighboring parcels have a greater influence on computations than features far away (ESRI 2013). Euclidean distance, straight-line distance between two points, was used to determine distance between parcels (ESRI 2013). Moran's I analysis produced a Moran's Index, z-score, and p-value to determine distribution and

significance of parcel distribution. Moran's Index grades the observed distribution of parcels from -1 (dispersed) to 1 (clustered). The Moran's Index is compared to the expected value if randomly distributed to produce a z-score and p-value.

Program R (R Version 3.2.2, www.r-project.org, accessed 24 November 2015) was used for subsequent statistical analyses. Data analysis methods were based on those used by Jagnow et al. (2006) to analyze posting behavior by landowners in Pennsylvania. Variables for analysis were selected based on literature supporting their impact on landowners' decisions to allow hunting access. Principal Components Analysis was conducted on the responses to 28 attitudinal questions (7-pt Likert scale) using a Varimax orthogonal rotation with Kaiser Normalization (Revelle 2015). Attitudinal questions were grouped based on loading values (>0.60) and the 15 remaining questions were averaged to create 5 variables representing hunter concerns, deer population control, hunting tradition, individual hunter behavior, and personal responsibility to manage deer populations (Table 1.1). Cronbach's alpha was used to estimate internal consistency and remove attitudinal questions that reduce the alpha value (Table 1.2).

We developed two conceptual logistic regression models that included key variables identified in previous research to potentially impact landowners' decision to: 1) provide public hunting access, and 2) post their property. Model variables were divided into four groups: 1) hunting beliefs, 2) deer population, 3) access-related concerns, and 4) land characteristics (Table 1.3). A possible fifth group, landowner demographics, was considered but was excluded because previous research has found these variables are not significantly associated with posting (Brown et al. 1984; Jagnow et al. 2006). We also found a lower percentage of demographic variables were completed and they were not

significantly correlated with public hunting access. The land characteristics group was ultimately excluded from the posting logit model to focus on attitudinal variables that impact posting. Listwise deletion was used to limit data analysis to respondents that provided responses to all variables within the four variable groups analyzed (n = 1,690).

A Pearson's r bivariate correlation analysis was conducted to determine the correlation of each variable to public hunting access or posting, along with determining the significance of the correlation. Variables without a significant correlation ($p<0.05$) to hunting access or posting were excluded from their respective logit model. Remaining significant variables were used to create nested logit models based on combinations of the four variable groups (Independent Variables) and public hunting access or posting (Dependent Variable). Model selection was performed using Akaike Information Criterion (AIC) to compare 15 public hunting access logit models and 7 posting logit models. As suggested by Burnham and Anderson (2002:131), the model with the lowest AIC value was selected unless another model had a ΔAIC less than 2 units, included fewer variables, and had essentially the same maximized log-likelihood value as the best model. Logit coefficients were used to identify the significance of each variable within the model and odds ratios (OR) were calculated to measure association between each variable and public hunting access or posting.

## RESULTS

### *Descriptive Results*

Of the 4,193 survey questionnaires mailed, 242 were undeliverable due to being sent to a deceased individual or invalid address. Of the remaining 3,951 surveys, a total of 2,312 were returned, resulting in an adjusted response rate of 59%. A non-response

check indicated that respondents were slightly older ($M$ = 60) on average than non-respondents ($M$ = 57) and slightly more likely to be male (89%) than non-respondents (79%). Overall, 40% of landowners indicated they posted their property. There was significant difference in posting rates ($\chi^2$=20.40, $p$<0.001) between the three property size categories with landowners being more likely to post small parcels (47%) than medium (38%) or large parcels (36%, Table 1.4). Among landowners that indicated they posted their property, 39% posted their property due to a single event with large landowners being more likely to do so (43%) than medium (40%) or small landowners (35%, Table 1.4). The main reasons indicated for posting were to eliminate trespassing (37%) and to control who uses their land (22%, Table 1.4). Eliminating trespassing was the only response category that resulted in a significant difference based on property size ($\chi^2$=6.73, $p$<0.05) with medium sized landowners posting (45%) for this reason more often than small (35%) or large landowners (30%, Table 1.4). Landowners who posted their property allowed hunting access (89%) at a similar rate as landowners who did not post their property (88%) but were more likely to restrict hunting access to family, friends, and neighbors (77% vs 69%) and less likely to allow public hunting access (11% vs 26%).

Hunting was allowed on most properties (88%) with 83% of landowners allowing hunting access by family members (64%) and friends/neighbors (66%, Table 1.5). Landowners were significantly more likely to allow hunting access ($\chi^2$=40.15, $p$<0.001) on large parcels (95%) than medium (87%) or small parcels (84%, Table 1.5). Landowners that allowed hunting access often restricted hunting access to family, friends, and neighbors (72%). Small landowners (83%) restricted hunting access to

family, friends, and neighbors more often than medium (74%) or large landowners (60%). Large landowners were more likely to allow hunting access for family, friends, and neighbors than on medium or small parcels (Table 1.5). Landowners allowed public hunting access on relatively few properties (18%) though landowners were significantly more likely to allow public hunting access ($\chi^2$=74.58, $p$<0.001) on large properties (27%) than medium (17%) or small properties (10%, Table 1.5).

Among landowners who allowed hunting access, the number of hunters allowed access increased as the property size increased (small: $M$ = 5.3, medium: $M$ = 6.9, large: $M$ = 9.2, Table 1.6). Family members (small: $M$ = 2.5, medium: $M$ = 2.6, large: $M$ = 3.2) and friends/neighbors (small: $M$ = 2.4, medium: $M$ = 3.6, large: $M$ = 4.6) represented a majority of hunters that were allowed hunting access (Table 1.6). Public hunters, people from organized hunting groups, people who lease property, and other hunters represented less than 1 hunter/parcel (Table 1.6). The number of public hunters allowed hunting access increased with parcel size (small: $M$ = 0.2, medium: $M$ = 0.5, large: $M$ = 0.9, Table 1.6). Landowners allowed hunting access to a small number of individuals from organized hunting groups (small: $M$ = 0.1, medium: $M$ = 0.1, large: $M$ = 0.1), property lessee's (small: $M$ = 0.1, medium: $M$ = 0.2, large: $M$ = 0.2), and other hunters (small: $M$ = 0.0, medium: $M$ = 0.1, large: $M$ = 0.2, Table 1.6).

***Posting Behavior Model***

Spatial distribution of public hunting access was analyzed with a Moran's I spatial autocorrelation analysis and resulted in a Moran's Index of 0.026 compared to an Expected index of -0.000456. The analysis also produced a significant z-score (4.73) and p-value ($p$<0.001). The Expected Index indicates that the distribution of parcels based on

hunting access should be slightly dispersed if randomly distributed, while the Moran's Index indicates that the measured distribution is slightly clustered. The significant p-value and the positive z-score indicated that the spatial distribution of parcels based on public hunting access was more spatially clustered than would be expected if underlying spatial processes were random. A second Moran's I analysis of the spatial distribution of public hunting access by parcel size resulted in a Moran's Index of 0.049 compared to an Expected Index of -0.000456. The analysis produced a significant z-score (9.00) and p-value ($p$<0.001), suggesting that parcels with similar public hunting access were significantly clustered by parcel size.

Of the 17 variables analyzed, 13 had a significant bivariate correlation to public hunting access. All of these variables had very weak correlations to public hunting access with parcel size ($r$ = 0.20) and family hunting tradition ($r$ = -0.20) having the strongest correlations ($p$<0.05, Table 1.7). The logit model that best represented public hunting access in southeast Minnesota was identified using AIC and included land characteristics, access-related concerns, and hunter-related factors (Table 1.7). The logit coefficients for the model indicated several variables were significant: posting properties ($p$<0.001), forest cover ($p$<0.01), parcel size ($p$<0.001), hunter concerns ($p$<0.05), hunter behavior ($p$<0.001), deer management knowledge ($p$<0.05), and hunting tradition ($p$<0.001, Table 1.7). The results of the model indicated that posting (OR = 0.51), hunter concerns (OR = 0.91), and hunting tradition (OR = 0.83) reduced the likelihood of allowing public hunting access, while increasing property size (OR = 1.78), ownership of agricultural land (OR = 2.25), hunter behavior (OR = 1.25), and deer management knowledge (OR = 1.19) increased the likelihood of public hunting access (Table 1.7).

Of the 12 variables analyzed, 9 had a significant bivariate correlation to landowners' decision to post their property (Table 1.8). All of these variables had very weak correlation to posting with hunter concerns ($r$ = 0.18) and whether the landowner hunts ($r$ = 0.17) having the strongest correlations (Table 1.8). The logit model that best represented posting in southeast Minnesota based on AIC included access-related concerns, hunter-related factors, and deer population (Table 1.8). The logit model indicated that several variables had significant logit coefficients: hunter concerns ($p$<0.001), DNR pays to allow access ($p$<0.01), whether the landowner hunts ($p$<0.01), deer management knowledge ($p$<0.001), personal responsibility ($p$<0.01), hunter density ($p$<0.05), and deer population control ($p$<0.01, Table 1.8). Hunter concerns (OR = 1.39), deer management knowledge (OR = 1.63), personal responsibility (OR = 1.12), and hunter density (OR = 9.65) increased the likelihood of posting, while DNR pays to allow access (OR = 0.91), whether the landowner hunts (OR = 0.20), and deer population control (OR = 0.85) decreased the likelihood of posting (Table 1.8).

## DISCUSSION

Due to the lack of public land in southeast Minnesota, public hunting access to privately owned land is important for deer population management. Liberal season structures increase the proportion of hunters that harvest antlerless deer (G.J. D'Angelo, Minnesota Department of Natural Resources, unpublished data) potentially allowing family and friends to effectively accomplish management goals on small properties, but likely not producing sufficient harvests on larger properties. Additionally, liberal hunting seasons can result in areas with higher hunter pressure being overharvested. Posting of properties is not an accurate measure of private land being closed to hunting, however, it

has been used as an indicator of landowner tolerance of hunting (Brown et al. 1984). The same landowners have also been shown to post their land more to control, rather than prohibit, access to their land (Brown et al. 1984). Our results support these conclusions in that while landowners allowed hunting access at a high rate on posted and non-posted properties (89% vs 88%), posted properties were more likely to restrict hunting access to family, friends, and neighbors (77% vs 69%) and less likely to allow public hunting access (11% vs 26%). In New York, 79% of landowners who posted their property allowed friends to hunt and only 7% gave permission to strangers (Lauber and Brown 2000). The high rate of hunting access on posted properties in this and other studies indicates that posting is not equivalent with prohibiting hunting access, although posting does restrict access for some hunters.

Among southeast Minnesota landowners, 40% stated that they posted their property, however, the rate of posting differed by parcel size. While landowners of large parcels were less likely to post their property, they were more likely to post due to a single event. The main reasons for posting were to control who uses their land and to deter trespassing. A study of northern U.S. landowners found a similar posting rate (42%, Cordell et al. 1998), but research in Pennsylvania (69%, Jagnow et al. 2006) and New York (83%, Lauber and Brown 2000) were found to have higher posting rates. Posting can limit public hunting access because hunters interpret posting signs to mean that hunting is not allowed and consequently do not seek permission to hunt those lands (Decker and Brown 1979). Landowners often live away from their properties and are not immediately available for people to seek permission to hunt (Brown et al. 1984),

although Wright et al. (1988) found that 90% of landowners in east Texas lived within 20 miles of their land and 38% resided on the property.

In the current study, most landowners allowed hunting access (88%) and a majority allowed hunting access to family (64%) and friends (66%), but only 18% allowed public hunting access. A study of northern U.S. states found similar results with 54% of landowners permitting hunting access to family, 55% to friends, and 16% to strangers (Cordell et al. 1998). Among landowners who permitted hunting access in the current study, a majority restricted hunting access to family, friends, and neighbors (72%). Landowners of small properties were more likely to restrict hunting access to family, friends, and neighbors (83%) compared to landowners of medium properties (74%) or large properties (60%). Public hunters were more likely to have hunting access to large properties (27%) than medium (17%) or small properties (10%). Owners of small properties are less likely to allow hunting and restrict access mostly to family, friends, and neighbors.

Landowners allowed an average of 7.14 hunters/property though a majority were family and friends (6.29 hunters/property) and few public hunters were allowed hunting access (0.85 hunters/property). Landowners of large properties allowed a greater number of hunters ($M$ = 9.16 hunters/property) than medium ($M$ = 6.93 hunters/property) or small properties ($M$ = 5.25 hunters/property). The limited number of public hunters allowed hunting access, along with the majority of properties restricting hunting access to family, friends, and neighbors indicates that exclusive hunting access is valuable, especially among small landowners. Landowners, especially hunters, often desire exclusive hunting rights on their property (Jagnow et al. 2008) and exclude others due to concerns over

hunting interference (Gramann et al. 1985). Obtaining exclusive rights to land-based resources, including deer, is often accomplished through owning or leasing land (Wright et al. 1988). These owners maintain exclusive access to wildlife resources for personal enjoyment (Wright et al. 1988) and this attitude of "protectionism" is perhaps the most difficult access problem to resolve (WMI 1983). Opportunity for increased access for acquaintances is unlikely because landowners' willingness to allow access for this group is already high, although access for public hunters is low and illustrates that access for this group is most in need for improvement (Lauber and Brown 2000). Small and medium sized properties are less likely to experience growth of public hunting access because of the large number of properties that restrict hunting access to family, friends, and neighbors. Family hunting tradition and problem behaviors from hunters are also factors that may make it less likely that owners of small properties would allow public hunting access.

The spatial location of properties where landowners allowed public hunting access were more clustered than would be expected with a random distribution ($z = 4.73$, $p<0.001$). The statistically significant results and visual examination suggests that parcel locations are slightly clustered but the location of the parcels likely had little impact on landowners' decision to allow public hunting access. Clustering of similar parcel characteristics such as land cover type (e.g., agricultural, forest) and parcel size likely lead to the significant result of the analysis. This is supported by our findings that parcels with similar public hunting access were clustered across the study area based on property size ($z = 9.00$, $p<0.001$). Smaller parcels may be clustered on the landscape due to larger parcels being divided through inheritance or sale. Smaller parcels are likely to be

purchased for personal hunting properties and are more likely to be posted for this reason. Fragmented forest lands cause concerns about access to properties because some landowners do not allow access across their land for adjacent property owners or hunters they provide access (MN OLA 2010). If management cooperation or shared attitudes among neighboring landowners impacted landowners' decision to allow public hunting access, then parcels would be expected to be clustered to a greater extent. Cooperative management programs would be more likely to impact deer population dynamics because they consolidate larger blocks through quality deer management or simple hunting agreements (Christoffel and Craven 2000).

Within the public hunting access logit model, several variables were found to be significant. Parcel posting rates, hunter concerns, and hunting tradition were found to be inversely related to public hunting access, while property size, amount of agricultural land, hunter behavior, and deer management knowledge was directly related to hunting access. Ultimately parcel characteristics had the strongest impact on landowners' decision to allow public hunting access, which suggests that the properties size and land cover is an important factor in a landowner's decision to allow public hunting access, along with concerns about hunter behavior and liability. Additionally, the model shows that knowledge about deer management in Minnesota and the landowners' hunting tradition were also major factors.

We created a second model to determine what factors impacted a landowners' decision to post their properties because posting was a significant variable within our public hunting access model and had the strongest negative impact (OR = 0.51). Our posting logit model found several significant variables: hunter concerns, DNR pays to

allow access, whether the landowner hunts, deer management knowledge, personal responsibility, hunter density, and deer population control. Hunter concerns, deer management knowledge, personal responsibility, and hunter density were directly related to landowners posting their properties, while DNR pays to allow access, whether the landowner hunts, and population control were inversely related to posting. Whether the landowner hunts and the hunter density on the property were significant factors within the model and suggest that maintaining exclusive hunting access is a concern for landowners, along with concerns about hunter behavior which includes liability concerns. Past studies have shown that the fear of being sued for injuries sustained by hunters is a major deterrent in access decisions for landowners (Wright et al. 1988), despite receiving liability protection. In Minnesota, landowners that allow access for recreation without charge receive liability protection, but this protection is lost if landowners charge a fee for access (MN Statute 604A.23). In their study, Wright et al. (1988) found that 75% of respondents did not know how much protection they had under state statutes.

Leasing is a possible way to increase availability of land open to public access, but in our study only 4% of landowners leased their property for deer hunting. The main reasons for leasing were to have better control over who uses their land (91%), earn extra income from their property (86%), and they see leasing as the future way landowners can manage their property (77%). Landowners' beliefs about payments from the Minnesota DNR impacting future decisions to allow deer hunting on their property was found to significantly impact posting rates, but was not significant in the public hunting access logit model. An important benefit for landowners leasing their land is to increase their ability to control hunter behavior (Wright and Fesenmaier 1990). Landowners who lease

their land believe that leasing gives them greater control over hunters' actions, serves as a deterrent to trespassing, and minimizes property damage (Wright et al. 1988). Government programs have not been found to increase availability of land through leasing (Wright and Fesenmaier 1990). Leasing either through government programs or private individuals is unlikely to increase because our results indicate that maintaining exclusive hunting rights is important for landowners and this is unlikely to change.

Hunting is the only feasible method at this time for managing white-tailed deer at landscape scales and hunting access to private lands is critical for future management purposes. In the US, 66% of the land is under private, nonindustrial ownership and constitutes 80% of wildlife habitats (Benson 2001). Lack of hunting access to private lands creates refuges for deer preventing uniform harvest pressure across the landscape which reduces the effectiveness of hunting as a management tool. Public access to private lands is necessary to achieve harvest quotas and meet recreational demand (Brown et al. 1984). In this study, posting of properties and property size represented the most significant factors that affected public hunting access to private land. Posting resulted in reduced public hunting access either intentionally or unintentionally, while landowners of large properties were more likely to allow public hunting access and more hunters overall.

Hunter concerns (e.g., liability) and knowledge about deer management was significant in both models, suggesting there are opportunities to educate landowners about the importance of allowing public hunting access and liability protections available to them. Landowners are often concerned about the liability associated with allowing public hunting access without understanding the liability protections that are provided to

them under state statutes. Educating landowners about the liability protections provided to them and ways to increase communications between landowners and hunters will be important strategies to increase public hunting access. Another important step is to educate hunters that landowners who post their lands are likely to allow hunting and encourage landowners to use signs that indicate hunting may be permitted upon request (Brown et al. 1984). Hunters also could be educated about proper hunter behavior to avoid property damage and other behaviors that can lead to limited public hunting access. This study suggests that focusing on posted and large properties through education efforts will provide the greatest potential for effectively managing white-tailed deer populations in the future.

## MANAGEMENT IMPLICATIONS

Our research findings suggest that parcel characteristics are the most important factors that impacted landowners' decision to allow hunting access, particularly the size of the property and whether it was posted. Posting did not have an impact on overall hunting access but rather restricted who was allowed hunting access, favoring family, friends, and neighbors while restricting public hunting access. We found a significant correlation between landowners' posting and allowing public hunting access, though this result indicates a relationship between these variables but not necessarily causation. Posting is likely acting as a proxy for factors that cause posting, such as the desire for exclusive hunting access and to prevent trespassing. Posting was not equivalent to the denial of hunting access but was a significant factor. The impacts of posting may be a combination between landowners' restricting access and hunters' misperceptions about posting. Large parcels provide the greatest potential for improving public hunting access

because large landowners were more likely to allow public hunting access and a greater number of hunters can be allowed access without experiencing crowding. Important areas of future focus will be to educate landowners about the liability protections that are provided to them for allowing recreation and educating hunters about proper hunting behaviors such as avoiding damaging property and other behaviors that can lead to limited hunting access. Currently, many states provide education to hunters and landowners through the hunting regulations handbook and their website, but these resources may be overlooked or individuals may not know they exist.

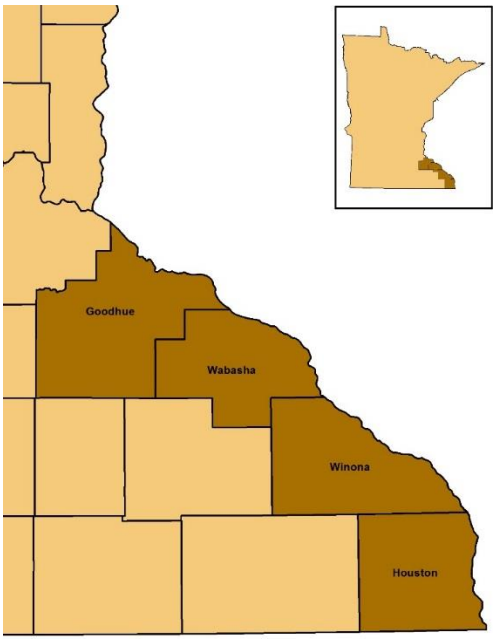


**Figure 1.1.** Southeast Minnesota landowner survey study area.

**Table 1.1.** Results of Principal Components Analysis. Grouped attitudinal questions based on factor loading values.

| Attitudinal Questions | Hunter Concerns | Deer Population Control | Hunting Tradition | Individual Hunter Behavior | Personal Responsibility to Manage Population |
|---|---|---|---|---|---|
| Hunter Concerns 1 | 0.76 | | | | |
| Hunter Concerns 2 | 0.64 | | | | |
| Hunter Concerns 3 | 0.73 | | | | |
| Hunter Concerns 4 | 0.63 | | | | |
| Population Control 1 | | 0.79 | | | |
| Population Control 2 | | 0.63 | | | |
| Population Control 3 | | 0.82 | | | |
| Hunting Tradition 1 | | | 0.76 | | |
| Hunting Tradition 2 | | | 0.74 | | |
| Hunter Behavior 1 | | | | 0.61 | |
| Hunter Behavior 2 | | | | 0.77 | |
| Hunter Behavior 3 | | | | 0.88 | |
| Hunter Behavior 4 | | | | 0.82 | |
| Personal Responsibility 1 | | | | | 0.83 |
| Personal Responsibility 2 | | | | | 0.82 |
| Personal Responsibility 3 | | | | | 0.80 |
| Personal Responsibility 4 | | | | | 0.79 |

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
(Loadings of <0.60 have been suppressed.)

**Table 1.2.** Cronbach's alpha results of attitudinal variable groups to remove variables that reduce internal consistency. Only groups with 3 or more variables are analyzed.

| Attitudinal Questions | Reliability if item dropped | Corrected item-total correlations |
|---|---|---|
| Hunter Concerns (α=0.74) | | |
| Hunter Concerns 1 | 0.62 | 0.74 |
| Hunter Concerns 2 | 0.69 | 0.60 |
| Hunter Concerns 3 | 0.68 | 0.63 |
| Hunter Concerns 4 | 0.72 | 0.52 |
| Deer Population Control (α=0.72) | | |
| Population Control 1 | 0.63 | 0.63 |
| Population Control 2 | 0.70 | 0.56 |
| Population Control 3 | 0.53 | 0.72 |
| Individual Hunter Behavior (α=0.80) | | |
| Hunter Behavior 1 | 0.80 | 0.61 |
| Hunter Behavior 2 | 0.72 | 0.75 |
| Hunter Behavior 3 | 0.73 | 0.78 |
| Hunter Behavior 4 | 0.76 | 0.71 |
| Personal Responsibility to Manage Population (α=0.83) | | |
| Personal Responsibility 1 | 0.76 | 0.79 |
| Personal Responsibility 2 | 0.77 | 0.77 |
| Personal Responsibility 3 | 0.80 | 0.70 |
| Personal Responsibility 4 | 0.80 | 0.68 |

**Table 1.3.** Description of all variables included in analysis.

| Variable | Description |
|---|---|
| Access (Dependent Variable) | Whether or not public hunters were allowed hunting access to property. |
| Hunting Beliefs | |
| Management Knowledge | Landowner's knowledge about deer management in southeast Minnesota. |
| Hunter Density | Total density of hunters on property, excluding public hunters. |
| Hunter | Whether or not landowner hunts. |
| Hunting Tradition | 1) Hunting is a tradition in my family. |
| | 2) Allowing other hunters on my property will reduce my or my family's opportunity to hunt deer. |
| Personal Responsibility | 1) It is my personal responsibility to manage deer populations. |
| | 2) Landowners in my community should be responsible for managing deer populations. |
| | 3) It is my personal responsibility to talk to others in my community about deer management. |
| | 4) Landowners in my community should talk to each other about managing deer populations. |
| Deer Population | |
| Perceived Population | Deer population on property and surrounding area. |
| Population Control | 1) Hunting reduces damage caused by deer on property. |
| | 2) Hunting improves the quality of habitat on property. |
| | 3) Hunting on property will help keep deer from being over-abundant in the area. |
| Access-related Concerns | |
| DNR Pay | Minnesota DNR would pay landowner to allow others to hunt. |
| Hunter Pay | Hunters or an outfitter would pay landowner in order to hunt. |
| Hunter Behavior | 1) Hunters would help landowner out by working on the property. |
| | 2) Landowner felt like hunter was interested in getting to know them and understanding what they're trying to do on their property. |
| | 3) Landowner knew hunter was safe and ethical. |
| | 4) Hunters follow the rules landowner has for hunting on property. |
| Hunter Concerns | 1) Hunters cause too many problems. |
| | 2) Concerned about liability of other hunters on landowner's property. |
| | 3) Hunting reduces landowner's privacy. |
| | 4) Hunting puts landowner's livestock at risk. |
| Land Characteristics | |
| Agricultural parcel | Percentage of agricultural land to property owned/leased |
| Forest parcel | Percentage of forest to property owned/leased |
| Private residence | Portion of property is used as private residence. |
| Distance to city | Distance from property to nearest city (meters). |
| Parcel size | Size of property owned based on strata. |
| Property posted | Property is posted. |

**Table 1.4.** Posting by private landowners in southeast Minnesota by parcel size. Posting rate of properties and main reason for posting. Strata: small = 40-79 acres owned, medium = 80-250 acres owned, large >250 acres owned. Chi-squared ($\chi^2$) significance test for comparison between parcel sizes and Cramer's V for effect size.

| | Small | | Medium | | Large | | Overall | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | n | %[1] | n | %[1] | n | %[1] | n | %[1] | $\chi^2$ | Cramer's V |
| N | 709 | | 818 | | 706 | | 2,233 | | | |
| Posted | 333 | 47 | 309 | 38 | 255 | 36 | 897 | 40 | 20.40*** | 0.10 |
| Posted due to single event? | 112 | 35 | 116 | 40 | 101 | 43 | 329 | 39 | 0.82 | 0.02 |
| If yes, why? | 100 | | 106 | | 88 | | 294 | | | |
| Control who uses my land | 25 | 25 | 20 | 19 | 20 | 23 | 65 | 22 | 0.77 | 0.08 |
| Human safety | 8 | 8 | 4 | 4 | 3 | 3 | 15 | 5 | 2.80 | 0.31 |
| Liability concerns | 5 | 5 | 3 | 3 | 4 | 5 | 12 | 4 | 0.50 | 0.14 |
| Eliminate trespass | 35 | 35 | 48 | 45 | 26 | 30 | 109 | 37 | 6.73* | 0.18 |
| Keep wildlife for myself/family/friends | 4 | 4 | 4 | 4 | 3 | 3 | 11 | 4 | 0.18 | 0.09 |
| Reduce property damage | 1 | 1 | 8 | 8 | 4 | 5 | 13 | 4 | 5.69 | 0.47 |
| Livestock safety | 1 | 1 | 2 | 2 | 5 | 6 | 8 | 3 | 3.25 | 0.45 |
| Relationship with neighbor | 7 | 7 | 7 | 7 | 5 | 6 | 19 | 6 | 0.42 | 0.11 |
| Better control of deer population | 1 | 1 | 2 | 2 | 2 | 2 | 5 | 2 | 0.40 | 0.20 |
| Family tradition | 1 | 1 | 0 | 0 | 2 | 2 | 3 | 1 | 2.00 | 0.58 |
| Conflict with other recreational users | 7 | 7 | 3 | 3 | 5 | 6 | 15 | 5 | 1.60 | 0.23 |
| Other | 5 | 5 | 5 | 5 | 9 | 10 | 19 | 6 | 1.68 | 0.21 |

[1]Percentages may not total 100% due to rounding.
*$p$<0.05, ** $p$<0.01, *** $p$<0.001

**Table 1.5.** Percentage of private landowners in southeast Minnesota that allowed hunting access. Separated by parcel size and type of hunters allowed. Strata: small = 40-79 acres owned, medium = 80-250 acres owned, large >250 acres owned. Chi-squared ($\chi^2$) significance test for comparison between parcel sizes and Cramer's V for effect size.

| Hunter type | Small | Medium | Large | Overall | $\chi^2$ (df=2) | Cramer's V |
|---|---|---|---|---|---|---|
| Overall hunting access | 83.9% | 87.1% | 94.5% | 88.4% | 40.15*** | 0.14 |
| Myself or family | 61.8% | 62.1% | 69.2% | 64.2% | 10.79** | 0.07 |
| Friends or neighbors | 59.3% | 64.4% | 73.7% | 65.7% | 32.52*** | 0.12 |
| Public hunters | 9.6% | 16.6% | 27.2% | 17.7% | 74.58*** | 0.18 |
| People affiliated with organized hunting group | 0.6% | 1.7% | 2.5% | 1.6% | 8.01* | 0.06 |
| People who lease property | 3.3% | 4.2% | 7.2% | 4.9% | 12.76** | 0.08 |
| Other | 1.0% | 2.5% | 2.8% | 2.1% | 6.04* | 0.05 |

*$p$<0.05, ** $p$<0.01, *** $p$<0.001 (n=2,194)

**Table 1.6.** Mean number of hunters provided hunting access by landowners that allowed hunting in southeast Minnesota. Density of hunters is separated by parcel size and type of hunters allowed. Strata: small = 40-79 acres owned, medium = 80-250 acres owned, large >250 acres owned. One-way ANOVA to produce F-value and eta-squared ($\eta^2$) for effect size. Pairwise T-test for pairwise comparison between parcel sizes with Bonferroni correction for multiple tests.

| Hunter type | Small | Medium | Large | Overall | F (df=1) | $\eta^2$ |
|---|---|---|---|---|---|---|
| Total hunters | $5.25_{ab}$ | $6.93_{ac}$ | $9.16_{bc}$ | 7.14 | 153.70*** | 0.08 |
| Myself or family | $2.45_{a}$ | $2.57_{b}$ | $3.22_{ab}$ | 2.75 | 20.04*** | 0.01 |
| Friends or neighbors | $2.43_{ab}$ | $3.55_{bc}$ | $4.58_{ac}$ | 3.54 | 88.42*** | 0.04 |
| Public hunters | $0.18_{ab}$ | $0.48_{ac}$ | $0.86_{bc}$ | 0.51 | 60.13*** | 0.03 |
| People affiliated with organized hunting group | 0.05 | 0.11 | 0.13 | 0.10 | 1.87 | 0.00 |
| People who lease property | 0.13 | 0.15 | 0.21 | 0.16 | 2.03 | 0.00 |
| Other | 0.02 | 0.05 | 0.16 | 0.08 | 9.10** | 0.00 |

*Note*. Means in a row sharing subscripts are significantly different from each other.
*$p$<0.05, ** $p$<0.01, *** $p$<0.001 (n=1,879)

**Table 1.7.** Results of Pearson's r bivariate correlation and logit model representing public hunting access to private lands in southeast Minnesota. Logit coefficients provided by logit model with lowest AIC value. Odds ratio represents the effect size of each variable.

| Characteristics | Bivariate Correlation | Logit Coefficient | Odds Ratio |
|---|---|---|---|
| Land characteristics | | | |
| Property posted | -0.19*** | -0.67*** | 0.51 |
| Forested parcel | -0.16*** | -0.17 | 1.19 |
| Agricultural parcel | 0.18*** | 0.81** | 2.25 |
| Parcel size | 0.20*** | 0.58*** | 1.78 |
| Access-related concerns | | | |
| Hunter Concerns | -0.07** | -0.10* | 0.91 |
| Hunter Behavior | 0.10*** | 0.22*** | 1.25 |
| DNR Pays | 0.08*** | 0.02 | 1.02 |
| Hunter-related factors | | | |
| Hunter | -0.14*** | -0.16 | 0.85 |
| Management Knowledge | 0.11*** | 0.17* | 1.19 |
| Hunting Tradition | -0.20*** | -0.19*** | 0.83 |
| Personal Responsibility | -0.12*** | -0.09 | 0.91 |
| | | | |
| Intercept | | -2.40*** | |
| -2 log likelihood | | -696.57 | |
| ΔAIC | | -1.19 | |

*$p$<.05, ** $p$<.01, *** $p$<.001 (n=1,690)

**Table 1.8.** Results of Pearson's r bivariate correlation and logit model representing posting of private lands in southeast Minnesota. Logit coefficients provided by logit model with lowest AIC value. Odds ratio represents the effect size of each variable.

| Characteristics | Bivariate Correlation | Logit Coefficient | Odds Ratio |
|---|---|---|---|
| Access-related concerns | | | |
| Hunter concerns | 0.18*** | 0.33*** | 1.39 |
| DNR Pays | -0.10*** | -0.09** | 0.91 |
| Hunter-related factors | | | |
| Hunter | 0.17*** | 0.49*** | 0.20 |
| Management Knowledge | -0.16*** | -0.32*** | 1.63 |
| Hunting Tradition | 0.17*** | 0.05 | 1.05 |
| Personal Responsibility | 0.15*** | 0.11** | 1.12 |
| Hunter Density | 0.08** | 2.27* | 9.65 |
| Deer Population | | | |
| Perceived Population | 0.14*** | 0.09 | 1.10 |
| Population Control | -0.11*** | -0.16*** | 0.85 |
| | | | |
| Intercept | | -1.63*** | |
| -2 log likelihood | | -1,053.63 | |
| ΔAIC | | -15.93 | |

*$p$<.05, ** $p$<.01, *** $p$<.001 (n=1,690)

# CHAPTER 2

## Capability of cell-by-cell correction to reduce mixed-mode sampling effects for hunter surveys

**ABSTRACT** Stakeholder surveys are an important source of information for natural resource managers. Single survey mode designs present the potential for nonresponse errors and may result in an inaccurate representation of the survey results. Mixed-mode survey designs are often used to produce more representative results, although they introduce the potential for measurement error due to mode effects. A cell-by-cell correction can be applied to survey results to adjust for nonresponse error. We surveyed a random sample of 2015 Minnesota deer hunters using a sequential mixed-mode design with Internet and mail surveys. Applying a cell-by-cell correction caused Internet survey mode results to be significantly different from the combined mixed-mode results and also inflated variance values. There were significant demographic differences between modes for age and residence, and between mailing waves for age. Our results also showed that the fourth mailing wave using a mail survey produced a low response rate and contributed little to the results. Future surveys need to consider the demographic composition of their population of interest when choosing survey methodology and mixed-mode surveys may be a beneficial way to produce representative results.

**KEY WORDS:** Cell-by-cell correction, deer hunters, demographic differences, mixed-mode survey, mode effects

## INTRODUCTION

Many state management agencies use data collected from stakeholder surveys to assist natural resource management decisions. Survey research, in fact, is a fundamental method of the applied social sciences, including the human dimensions of wildlife management (Vaske 2008; Dillman et al. 2014). When confronted with management issues that involve socioeconomic and ecological challenges, state and federal natural resources agencies frequently assess public attitudes through surveys to determine user preferences for various options under consideration (Vaske 2008; Connelly et al. 2012). Data need to be representative of the population of interest to managers and decision makers; otherwise, use of the results can lead to incorrect conclusions regarding the programs and services that managers provide (Vaske 2008; Dillman et al. 2014).

While statistically representative surveys have informed management for almost a century, the 1990s through the present have been described as "turbulent times" for survey methodology due to fast-paced cultural and technological changes (Dillman et al. 2009). During the past 20 years, concerns related to unlisted telephone numbers, caller identification, the transition from landlines to cell phones, the ascent of internet communications, increasing mail survey expenses, and declining response rates for all survey modes have led to a shift from single-mode surveys to using multiple modes for data collection within the same study (Dillman et al. 2014). The expectation is that survey methods can be consolidated through a mixed-mode strategy to receive the benefits and reduce the weaknesses from each method; however, this approach presents its own challenges.

In an effort to learn if mixed-mode approaches might better serve its information needs, the Minnesota Department of Natural Resources (DNR) used a web-first mixed-mode probabilistic sample survey method that included a combination of Internet and mail surveys (Smyth et al. 2010; Messer and Dillman 2011; Miller and Dillman 2011). We believe such a design held potential to reduce costs, improve timeliness, and reduce nonresponse error (Dillman et al. 2014). This web-first, mixed-mode survey (web+mail) targeted a sample of white-tailed deer (*Odocoileus virginianus*) hunters and private landowners in Minnesota to gather information about their preferences for deer population levels and management.

Recent studies have suggested that offering a mail questionnaire follow-up to an initial Internet questionnaire can increase response rates substantially (Smyth et al. 2010; Messer and Dillman, 2011; Millar and Dillman 2011). Internet surveys are often not representative of the population if responses are not weighted (Graefe et al. 2011); thus, they can lead to incorrect management decisions (Gigliotti and Dietsch 2014). When there is a substantive difference between respondents and nonrespondents, weighting responses by population proportions can provide a more accurate reflection of the population (Kalton and Flores-Cervantes 2003). Our goal was to examine whether using a 2 wave each web + mail sequential mixed-mode survey optimized survey design. We evaluated whether data collected through different response modes were comparable, and if not, whether weighting could reduce mode effects. We examined the demographic differences between response mode and whether the removal of a mail survey mode or 4$^{th}$ mailing wave would have provided similar results.

The specific research questions addressed were: 1) how did the response rates of different modes and waves of survey administration compare; 2) what differences existed on key data across modes and waves of data collection; 3) did cell-by-cell correction reduce sampling effects associated with the use of multiple survey modes; and 4) what survey mode and administration protocols best balanced efficiency of time and expense and minimize error.

## Conceptual Background

### *Sources of Error in Surveys*

Study designs incorporating a probability sample allow results to be generalized to the larger target population, allow for the estimation of sampling error, and are more representative than other types of samples because biases can be avoided (Vaskeet al. 2011). Survey errors are the difference between an estimate from survey data and the true value in the study population (Dillman et al. 2014). There are four main error sources that need to be minimized to improve survey estimates, including: coverage error, measurement error, nonresponse error, and sampling error (Dillman et al. 2014). Coverage errors occur when there is a difference between the target population and the study sample (Vaske 2008). For a study to be unbiased, every member of the population needs to have a known nonzero probability of being sampled (Duda and Nobile 2010; Dillman et al. 2014).

Measurement error refers to the difference between survey estimates and the true value caused by respondents providing inaccurate answers to the survey questions (Dillman et al. 2014). Measurement error can occur because survey questions may not be understood in the same way by all respondents (Vaske 2008). Nonresponse error occurs

when respondents to the survey and nonrespondents would provide responses that differ in such a way that influences the estimate (Dillman et al. 2014). Nonresponse error can be countered through encouraging high response rates, conducting nonresponse bias checks, and weighting data (Vaske 2008). Sampling error refers to the difference between an estimate based on a sample of the population compared to conducting a census of the whole population (Dillman et al. 2014). Large sample sizes are usually adventageous to minimize sampling error (Vaske 2008). Sample data may be representative of and generalizable to the target sample population if a large sample size is used, while minimizing potential sources of error related to coverage, nonresponse, and measurement errors (Vaske 2008).

### *Survey Modes*

Probabilistic Internet surveys typically have considerably lower response rates than mail surveys, although this difference varies within populations (Shih and Fan 2009; Borkan 2010; Smyth et al. 2010; Graefe et al. 2011; Shin et al. 2012; Schouten et al. 2013). Internet surveys are attractive due to the cost savings associated with eliminating printing, mailing, and data entry costs, while providing prompt responses (Vaske 2008; Lesser et al. 2011; Connelly et al. 2012; Dillman et al. 2014). Internet surveys have also produced more accurate results with lower item non-response than other survey modes (Shin et al. 2012). Internet surveys typically suffer from undercoverage of the population due to incomplete contact information, while mail surveys are assumed to have full coverage (Schouten et al. 2013). Given the allure of Internet surveys coupled with their short-comings, mixed-mode surveys have become much more common in survey research.

Mixed-mode surveys are distributed using multiple methods of contact (e.g., mail, Internet, phone, face-to-face) and allow researchers to offer participants several response mechanisms from which they can choose to complete the survey (Carrozzino-Lyon et al. 2013). Mixed-mode designs provide the benefits of each survey mode while minimizing weaknesses at an affordable cost, increasing the perceived importance of the survey for participants, and decreasing perceived personal cost of participation (de Leeuw 2005; Sexton et al. 2011; Carrozzino-Lyon et al. 2013). Mixed-mode surveys can reduce coverage error by contacting different groups of hard-to-reach respondents and increasing response rates (Dillman et al. 2009; Vannieuwenhuyze et al. 2010; Messer and Dillman 2011). Demographic groups have different levels of nonresponse to survey modes, making mixed-mode surveys advantageous because nonrespondents can be approached subsequently with a different mode to increase response rates (Voogt and Saris 2005; Vannieuwenhuyze et al. 2010). A mail survey is a potentially appropriate supplementary survey mode in addition to Internet surveys because both modes use many of the same communication channels (i.e., visual; Dillman et al. 2009), although both modes need to be carefully designed to closely resemble each other to assure the validity and reliability of the survey (Smyth et al. 2010; Carrozzino-Lyon et al. 2013).

### *Weighting Strategies*

One of the key concerns in a mixed-mode approach is the comparability of data collected across different survey modes for the same study population (Vooget and Saris 2005; Vannieuwenhuyze et al. 2010; Dillman et al. 2014). The ability to compare data between survey modes is limited because the nature and magnitude of coverage, nonresponse, and measurement errors differ across modes (Jackle et al. 2010; Schouten et

al. 2013). Mode effects are the combined differences between survey modes caused by sampling errors, coverage errors, selective nonresponse, and measurement bias (Schouten et al. 2013). There are three approaches available to minimize mode effects: good questionnaire design, adapting the choice of survey modes to the population of interest, and using weighting or matching techniques after data collection (Schouten et al. 2013). We focus on weighting techniques since they can be applied after data collection to ensure that respondents represent the target population.

Respondents may not be representative of the target population if the individuals who completed the questionnaire are different from nonrespondents (Vaske et al. 2011). Weighting can be used when population proportions are known in advance and survey results reveal that specific groups are overrepresented or underrepresented in the data (Vaske et al. 2011). Weighting adjustments are mainly used to reduce bias in the survey estimates caused by nonresponse and noncoverage error with the aim of making the weighted sample more reflective of the larger population (Kalton and Flores-Cervantes 2003; Vaske et al. 2011). Auxiliary information can be used to compensate for nonresponse by identifying respondents who are similar to nonrespondents, and then applying weights to respondents so that they represent similar nonrespondents (Kalton and Flores-Cervantes 2003). Large variability of weighted adjustments can cause inflated variances of survey estimates and lower precision of the survey estimates, particularly when small sample sizes occur in a number of the adjustment cells (Kalton and Flores-Cervantes 2003; Vaske et al. 2011).

Although there are several weighting methods that can be used, we focused on weighting based on population proportions through cell-by-cell correction. In many cases

little is known about nonrespondents other than strata or demographic information, so a simple cell weighting adjustment might be a practical weighting strategy (Kalton and Flores-Cervantes 2003). Population proportions from a single variable can be used to perform a cell-by-cell correction to adjust for overrepresented or underrepresented groups (Vaske et al. 2011). The correction weight that a cell receives is calculated by taking the corresponding cell proportion in the sample population divided by the cell proportion among survey responses. This simple weighting scheme allows responses within each cell to become more representative of the sample population.

$$\text{Weight} = \frac{\textit{Sample \%}}{\textit{Response \%}}$$

For example, if males represent 80% of the population but only represent 40% of respondents, then males are underrepresented and would receive a 2.0 correction weight. Multiple variable cell-by-cell weighting can be used if population proportions are known in advance and specific groups are found to be overrepresented or underrepresented within survey results (Vaske et al. 2011). Variables such as age, gender, and residence can be used to create more cells for comparison. The combination of three variables and their respective levels can result in 12 cells (3 age classes * 2 genders * 2 residence classes). Cell weighting adjustments for nonresponse assumes that the respondents within a cell represent the nonrespondents within that cell, but unlike other methods, makes no assumptions about the structure of the response probabilities across cells (Kalton and Flores-Cervantes 2003).

## METHODS

### *Study Context and Survey Methods*

We examined the results of a survey of white-tailed deer hunters in northwest Minnesota. The goal of the survey was to collect information about public desires and opinions regarding deer management in northwest Minnesota. Hunters were surveyed using a sequential web + mail, or web-push, mixed-mode design (Dillman et al. 2014) that included two waves of letters through the mail requesting recipients complete a Qualtrics Internet survey, followed by two waves that include a self-administered mail back questionnaire. Deer hunters in northwest Minnesota were the population of interest. We randomly sampled 7,801 adults who had purchased a license for the 2014 Minnesota deer hunting season and indicated they intended to hunt within a deer permit area (DPA) in the study area. Approval for human subjects research received via University of Minnesota IRB Study Number: 1405E50825. Survey recipients were contacted four times between February and May, 2015 with data collected until July, 2015.

### *Data Analysis*

Data analysis was conducted using Program R (R Version 3.2.2, www.r-project.org, accessed 24 November 2015). Survey mode and wave were examined to determine if there were significant demographic differences. T-tests were used to examine demographic differences among respondents based on survey mode. ANOVA tests were used to examine if demographic differences existed among respondents based on mailing wave and t-tests were used to examine demographic differences between waves within each survey mode (i.e., wave 1 vs 2, wave 3 vs 4).

Data analysis methods were based on those used by Vaske et al. (2011) to compensate for sampling issues in Internet surveys through weighting. We weighted survey responses to adjust for overrepresented or underrepresented groups based on multiple variable proportions within our sample. Three weighting variables were used: 1) age (<35, 35-55, >55 years), 2) gender (male, female), and 3) residence (urban, rural). Age will hereafter be referred to as: young (<35 years old), middle-aged (35-55 years old), and older (>55 years old). The combination of the three variables and their respective levels resulted in 12 cells (3 * 2 * 2). Residence classification was based on the population size of the city where sampled individuals had their permanent residence. Cities with at least 2,500 people based on the 2010 United States census were considered urban (U.S. Census Bureau 2015). Age, gender, and residence were chosen because these demographic data were available through the Minnesota DNR license database and these variables have been found to be related to response propensity and to be influential for survey weighting (Tivesten et al. 2012).

Survey mode (Internet or mail) and mailing wave were used to group responses into three response mode-groups: 1) responses to the two Internet survey waves (Internet), 2) responses to the two Internet survey waves and the first mail survey wave (3-wave), and 3) responses to the two Internet survey waves and the two mail survey waves (Combined). Each mode-group received a unique cell-by-cell correction based on the number of responses within each weighting cell compared to the expected number of responses based on sample proportions. Chi-squared tests were used to determine if the observed number of responses within a cell differed significantly from the expected number of responses. Responses within a cell received a correction if the p-value from

the chi-squared test was significant after applying a Bonferroni correction (p-value/number of tests) and the cell had more than 10 responses. The Bonferroni correction was applied to adjust for multiple tests being conducted to reduce the potential for Type 1 error. Cells with fewer than 10 responses did not receive a correction to avoid variance inflation.

Responses to five survey questions, measuring respondent's attitudes on key issues related to deer management, were selected for evaluation. Mean values for each question were calculated and then compared between the uncorrected control mode-group (Combined Uncorrected) and the other two uncorrected mode-groups. Corrected mode-groups were compared in the same manner as the uncorrected mode-groups. T-test comparison between mode-groups was used to determine if removing a survey mode or wave would produce results that did not differ significantly from the control mode-group. Additionally, t-tests were used to determine if applying a cell-by-cell correction to responses for each survey question resulted in significant differences between the corrected control mode-group to each of the correction mode-groups.

## RESULTS

Of the 7,801 surveys mailed, 332 were undeliverable and 3,095 were returned, yielding an adjusted response rate of 41.4% (Table 2.1). A total of 1,934 individuals responded to the Internet survey (25.9%) and 1,161 responded to the mail survey (15.5%). Of these, 840 responded to the first wave (11.2% response rate), 1,094 responded to the second wave (14.6%), 883 responded to the third wave (11.8%), and 278 responded to the fourth wave (3.7%). Removal of the 4$^{th}$ mailing wave (37.7%; 3-wave mode-group) resulted in a slightly lower response rate than the Combined mode-

group (41.4%) and produced similar response rates for each age, gender, and residence category. Middle-aged and older recipients had a higher response rate than younger recipients across all mailing waves and mode-groups. Males had a higher response rate across all mailing waves and mode-groups compared to female recipients. Also, urban residents had a higher response rate to the Internet survey compared to rural residents who responded to the mail survey at a slightly higher rate.

We examined the demographic differences between survey mode and mailing waves. We found that respondents to the mail survey were significantly older ($M$=54.1) than Internet respondents ($M$=47.4, $t$=-11.23, $p$<0.001, $\eta^2$=0.042). Males were slightly more likely to use the mail survey (87.6%) than the Internet survey (86.8%) but the difference was not significant. Urban respondents were significantly more likely to respond to the Internet survey (57.5%) than the mail survey (47.4%, $t$=5.48, $p$<0.001, $\eta^2$=0.010). We also found significant differences in Internet access between urban and rural respondents (94% vs 89%; $p$<0.001) and females and males (94% vs 91%; $p$<0.05). Internet access was significantly different by age class with younger individuals (99%) having greater access than middle-aged (97%) or older individuals (83%, $p$<0.001).

We found significant differences between mailing waves for age (F=49.8, $p$<0.001) and residence (F=18.9, $p$<0.001), but was not significant for gender (Table 2.2). Respondents were significantly older in wave 1 ($M$=48.7) than wave 2 ($M$=46.4, $t$=3.47, $p$<0.001), and wave 3 ($M$=55.5) than wave 4 ($M$=49.6, $t$=5.12, $p$<0.001). There was not a significant difference in gender between respondents to wave 1 (88.3%) compared to wave 2 (85.6%), and wave 3 (87.8%) compared to wave 4 (87.1%). There was not a

significant difference in urban residence between respondents to wave 1 (56.4%) than wave 2 (58.3%), and wave 3 (47.2%) than wave 4 (47.8%).

We partitioned respondents into 12 cells by age, gender, and residence and found a significant difference between the number of observed and expected responses within each cell ($\chi^2$=113.2, $p$<0.001) indicating a cell-by-cell correction was needed for the Internet mode-group (Table 2.3). After applying the Bonferroni correction ($p$<0.004) four cells did not represent the sample population. Young rural respondents were underrepresented and urban males were overrepresented within the Internet mode-group. When examining responses from the first three mailing waves, we found a significant difference ($\chi^2$=249.8, $p$<0.001) between the expected and observed number of responses per cell and a cell-by-cell correction was necessary; six cells were misrepresentative of the sample population – young adults of both sexes were underrepresented, while older males were overrepresented (Table 2.4). When examining the combined responses from the Internet and mail survey responses, we found a significant difference ($\chi^2$=262.3, $p$<0.001) between the expected and observed number of responses per cell and a cell-by-cell correction was necessary; six cells misrepresented the sample population – young adults of both sexes were underrepresented compared to the sample population, while older males were overrepresented within the Combined mode-group (Table 2.5). The same cells were underrepresented and overrepresented in the 3-wave mode-group as the Combined mode-group.

We examined the mean values of responses to five questions based on corrected and uncorrected responses in three mode-groups (Tables 2.6 and 2.7). Mean values for the uncorrected Internet and 3-wave mode-groups were not significantly different from

the Combined Uncorrected values (Table 2.7). The variance for each of the uncorrected mode-groups did not vary by a large amount from the Combined Uncorrected variance values. Comparing the corrected control mode-group (Combined Corrected) and the other two corrected mode-groups allowed us to examine the impacts of applying a cell-by-cell correction on variance and mean values. The Internet Corrected responses produced significantly lower mean values for each question and the lowest variance values among corrected mode-groups. Variance values for all corrected mode-groups were larger than the uncorrected mode-groups. The 3-wave Corrected responses were not significantly different from the Combined Corrected mode-group. The Combined Uncorrected mean values were lower than the Combined Corrected, but the difference was not significant.

**DISCUSSION**

A majority of respondents used the Internet survey mode (25.9%) though the addition of a mail survey (15.5%) improved the overall response rate. The removal of the 4$^{th}$ mailing wave (37.7%; 3-wave mode-group) reduced the overall response rate slightly and produced similar response rates for each age, gender, and residence category. Responses to each mailing wave and survey mode showed a response bias in age, urban/rural residence, and gender when compared to the study population. Respondents to the Internet survey were significantly younger and more urban than mail survey respondents. There were significant differences between mailing waves for age and residence, but not for gender. Gender was not expected to be significant due a large majority of the sample population being male, limiting the potential for a gender response bias. Past studies have shown similar age differences between survey modes (Smyth et al. 2010; Graefe et al. 2011; Carrozzino-Lyon et al. 2013).

With the current study design we were unable to determine if any differences between mode-groups is due to survey mode or demographic causes. Mode effects are difficult to correct for because they are often confounded with self-selection effects (de Leeuw 2005). Answers may differ between survey modes because of the survey mode or because different subgroups responded in different modes (de Leeuw 2005). These results illustrate the importance of carefully considering demographic characteristics of the study population and choosing survey modes accordingly.

Within our study, there was a significant difference in Internet access between urban and rural respondents (94% vs 89%; $p<0.001$) and females and males (94% vs 91%; $p<0.05$) though these differences in Internet access were likely too small to impact response rates. Internet access varied to a greater degree by age class with younger individuals (99%) having significantly greater access than middle-aged (97%) or older individuals (83%, $p<0.001$). Internet access has been found to be more limited in rural than urban areas and among older Americans, those with lower incomes, and those with less education (Smyth et al. 2010). Older individuals are less likely to complete Internet surveys due in part to lower Internet-access rates (Smyth et al. 2010).

In addition to careful consideration of survey mode, our results demonstrate the importance of using a weighting strategy (e.g., cell-by-cell weighting) to compensate for mode effects. Because all three response mode-groups misrepresented the sample population, a cell-by-cell correction was applied to make the responses more representative. Across all correction mode-groups young individuals were underrepresented and older individuals were overrepresented. These findings match past

studies that found younger adults to have lower response rates to the Internet and mail portions of a mixed-mode survey (Dillman et al. 2009; Gigliotti and Dietsch 2014).

Before applying the cell-by-cell correction, the three mode-groups produced similar mean values for the five survey questions, while the corrected responses showed greater differences between mode-groups and larger variance values. The Internet Corrected mean values were significantly lower than the Combined Corrected mean values for each question, while the 3-wave Corrected mean values did not vary significantly. The Combined Corrected and 3-wave mode-groups produced similar variance values, while the Internet Corrected mode-group produced lower variance values. Due to our sample size we did not have an issue with low number of responses within correction cells that would cause inflated variance values. This may be a problem in other studies where some groups may experience lower response rates caused by survey mode or smaller sample size within the survey population (e.g., female hunters). The 3-wave results were likely similar to the Combined responses due to the low response rate in the 4$^{th}$ mailing wave (3.7% response rate).

Our results suggest that using an Internet survey without a mail survey would not provide representative results of the study population due to significant demographic differences. We were unable to determine the impacts of using the mail survey in a single-mode approach since we did not have a true experimental design. Using a single survey mode would likely result in certain demographic groups being misrepresentative of the survey population depending on the survey mode selected. Demographic characteristics have been shown to be strongly aligned with survey mode preferences with rural, older respondents choosing the mail survey mode more often and younger,

urban respondents choosing the Internet survey mode more often (Smyth et al. 2010; Messer and Dillman 2011; Carrozzino-Lyon et al. 2013). Older recipients who use the Internet will respond to an Internet survey, but a large contingent of older individuals would prefer not to use the Internet survey (Gigliotti and Dietsch 2014). Respondents to a single survey mode may not be representative of others in a similar demographic, such as older Americans participating in an Internet survey may have more education than nonrespondents.

Since a significant number of respondents still lack Internet access and others prefer to respond by mail, there is a need for a supplementary mode such as mail along with an Internet mode (Smyth et al. 2010). A mixed-mode design using an Internet survey with a mail follow-up increases response rates and provides better representation of the general public than using an Internet survey alone, especially among individuals who are less likely to have internet access or who live in rural areas (Lesser et al. 2011; Smyth et al. 2010). Optimal survey design requires careful consideration of the different sources of error present and whether expected mode effects are serious enough to avoid mixed-mode designs compared to the advantages (de Leeuw 2005).

Our results suggest that using a three-wave mixed-mode design instead of a four-wave design would be advantageous due to the similarity of survey responses, while providing multiple response modes to account for demographic differences due to survey mode. Eliminating the fourth mailing wave would be finiancially benefical due to the printing, mailing, and data entry costs that are associated with a mail survey, while only experiencing a small loss in response rate. Combining the most cost effective method with a second, more expensive method provides the benefits of cost savings and less error

than a single-mode approach, while providing higher response rates (de Leeuw 2005). Using a mixed-mode survey design with Internet and mail survey options provides survey recipients the choice of survey mode and reduces the impact of demographic differences between survey modes.

A cell-by-cell correction reduced nonresponse errors and sampling effects associated with the use of multiple survey modes, though this approach can inflate variance. We did observe significant demographic differences between survey modes for age and residence, and between mailing waves for age. Our results indicated that we could have removed results from the 4$^{th}$ mailing wave and still produced valid and accurate results. A sequential mixed-mode survey design using two Internet survey mailings and a single paper survey mailing wave along with a cell-by-cell correction can produce statistically representative results. Using a combination of Internet and paper surveys is beneficial because it allows for higher response rates than an Internet survey alone, while accounting for demographic differences present between survey modes and using the same information transmission mode to avoid some mode effects. Some individuals had difficulty accessing the Internet survey and/or expressed a preference for an alternative survey mode. The 4$^{th}$ mailing wave can be removed due to a low response rate that did not alter the demographic makeup or response means. Internet surveys were beneficial due to their cost savings and quicker access to data, but required more educational effort and technical problem solving than a paper survey.

In summary, we found that a sequential web + mail mixed-mode survey design was a beneficial approach for survey research due to the response rates and demographic differences within our study. A majority of respondents used the Internet survey (25.9%)

though the addition of a paper survey improved response rates (37.7%). There were significant demographic differences between survey modes and mailing waves reinforcing the importance of a mixed-mode design to balance demographic response bias. Cell-by-cell correction was necessary within our survey results because the demographic proportions of respondents were not representative of the sample population. A sequential web + mail survey design using three mailing waves was found to best balance the time and expenses while minimizing sources of error.

Future reseach should examine the impact of completing an Internet survey with a mobile telephone compared to completion with a computer. Survey practitioners must consider how mobile phone use will affect the survey response process as smartphone use increases and more individuals rely on them for internet access (Millar and Dillman 2012; Dillman et al. 2014). Optimizing surveys for mobile completion can be difficult, especially on lengthy or difficult questionnaires (Toepoel and Lugtig 2014). Mobile phones provide opportunities because they can use both aural and visual channels of communication to enrich the survey and collect data such as GPS or motion (Toepoel and Lugtig 2014).

**Table 2.1.** Adjusted response rate for demographic groups (age, gender, residence) by mailing wave and response mode-group.

| | 1st Wave (Internet) | | 2nd Wave (Internet) | | Combined Internet Only | | 3rd Wave (Mail) | | Internet + 3rd Wave | | 4th Wave (Mail) | | Total Combined | | Sample Size | Invalid |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | % | *n* | *n* | *n* |
| <35 years old | 7.6 | 182 | 12.2 | 291 | 19.8 | 473 | 5.7 | 135 | 25.5 | 608 | 2.9 | 70 | 28.4 | 678 | 2,545 | 161 |
| 35-55 years old | 12.1 | 352 | 16.8 | 488 | 28.9 | 840 | 8.9 | 260 | 37.8 | 1,100 | 3.3 | 95 | 41.1 | 1,195 | 3,029 | 119 |
| >55 years old | 14.1 | 306 | 14.5 | 315 | 28.6 | 621 | 22.4 | 488 | 51.0 | 1,109 | 5.2 | 113 | 56.2 | 1,222 | 2,227 | 52 |
| Male | 11.7 | 742 | 14.7 | 936 | 26.4 | 1,678 | 12.2 | 775 | 38.6 | 2,453 | 3.8 | 242 | 42.4 | 2,695 | 6,610 | 253 |
| Female | 8.8 | 98 | 14.2 | 158 | 23.0 | 256 | 9.7 | 108 | 32.7 | 364 | 3.2 | 36 | 36.0 | 400 | 1,191 | 79 |
| Urban | 12.5 | 474 | 16.8 | 638 | 29.3 | 1,112 | 11.0 | 417 | 40.3 | 1,529 | 3.5 | 133 | 43.8 | 1,662 | 3,954 | 163 |
| Rural | 10.0 | 366 | 12.4 | 456 | 22.3 | 822 | 12.7 | 466 | 35.0 | 1,288 | 3.9 | 145 | 39.0 | 1,433 | 3,847 | 169 |
| Overall | 11.2 | 840 | 14.6 | 1,094 | 25.9 | 1,934 | 11.8 | 883 | 37.7 | 2,817 | 3.7 | 278 | 41.4 | 3,095 | 7,801 | 332 |

Combined Internet Only = Responses to first two mailing waves, two Internet survey mailings.
Internet + 3rd Wave = Responses to first three mailing waves, two Internet survey mailings and a mail survey mailing.
Total Combined = Responses to four mailing waves, two Internet survey mailings and two mail survey mailings.

**Table 2.2.** Comparison of demographic variables by mailing wave. Used T-tests to compare waves within survey modes (Wave 1 vs 2 & Wave 3 vs 4) and a one-way ANOVA to test for significant differences between all four mailing waves. Calculated eta squared ($\eta^2$) to determine effect size of the demographic variable.

| | Wave | | | | T-test (Wave 1 vs 2) | | T-test (Wave 3 vs 4) | | One-way ANOVA | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | t | p-value | t | p-value | F | $\eta^2$ |
| Mean Age | 48.7 | 46.4 | 55.5 | 49.6 | 3.47 | <0.001 | 5.12 | <0.001 | 49.81*** | 0.016 |
| Gender (% Male) | 88.3% | 85.6% | 87.8% | 87.1% | 1.81 | 0.071 | 0.31 | 0.755 | 0.07 | 0.000 |
| Residence (% Urban) | 56.4% | 58.3% | 47.2% | 47.8% | -0.83 | 0.405 | -0.18 | 0.858 | 18.88*** | 0.006 |

*$p$<.05, ** $p$<.01, *** $p$<.001 ($n$=3,095)

**Table 2.3.** Cell-by-cell correction for responses to first two survey mailings, two Internet survey mailings (Internet mode-group). Survey recipients are partitioned into 12 cells by demographic variables (age, gender, residence). Observed and expected number of responses are compared through Chi-squared ($\chi^2$) analysis to determine significant response differences.

| Gender | Residence | Age | Sample size *n* | Sample size % | Observed responses *n* | Observed responses % | Expected responses[1] | Chi-squared test statistic | Difference test p-value | Statistical significance Bonferroni correction[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | Rural | <35 | 913 | 11.7 | 157 | 8.1 | 226.3 | 23.72 | <0.001 | Yes |
| | | 35-55 | 1,191 | 15.3 | 283 | 14.6 | 295.3 | 0.55 | 0.457 | No |
| | | >55 | 1,051 | 13.5 | 236 | 12.2 | 260.6 | 2.57 | 0.109 | No |
| | Urban | <35 | 1,112 | 14.3 | 240 | 12.4 | 275.7 | 5.24 | 0.022 | No |
| | | 35-55 | 1,396 | 17.9 | 451 | 23.3 | 346.1 | 38.36 | <0.001 | Yes |
| | | >55 | 947 | 12.1 | 311 | 16.1 | 234.8 | 27.80 | <0.001 | Yes |
| Female | Rural | <35 | 289 | 3.7 | 37 | 1.9 | 71.6 | 16.90 | <0.001 | Yes |
| | | 35-55 | 249 | 3.2 | 59 | 3.1 | 61.7 | 0.08 | 0.773 | No |
| | | >55 | 154 | 2.0 | 50 | 2.6 | 38.2 | 3.42 | 0.064 | No |
| | Urban | <35 | 231 | 3.0 | 39 | 2.0 | 57.3 | 5.68 | 0.017 | No |
| | | 35-55 | 193 | 2.5 | 47 | 2.4 | 47.8 | 0.00 | 0.959 | No |
| | | >55 | 75 | 1.0 | 24 | 1.2 | 18.6 | 1.31 | 0.253 | No |
| Total | | | 7,801 | 100% | 1,934 | | | $\chi^2 = 113.19$, $p<0.001$ | | |

[1]Expected response = total sample size * population percent
[2]Bonferroni correction = p-value/number of tests = 0.05/12 = 0.004

**Table 2.4.** Cell-by-cell correction for responses to first three survey mailings, two Internet and one mail survey mailings (3-wave mode-group). Survey recipients are partitioned into 12 cells by demographic variables (age, gender, residence). Observed and expected number of responses are compared through Chi-squared ($\chi^2$) analysis to determine significant response differences.

| Gender | Residence | Age | Sample size *n* | Sample size % | Observed responses *n* | Observed responses % | Expected responses[1] | Chi-squared test statistic | Difference test p-value | Statistical significance Bonferroni correction[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | Rural | <35 | 913 | 11.7 | 208 | 7.4 | 329.7 | 50.45 | <0.001 | Yes |
| | | 35-55 | 1,191 | 15.3 | 403 | 14.3 | 430.1 | 1.94 | 0.164 | No |
| | | >55 | 1,051 | 13.5 | 471 | 16.7 | 379.5 | 25.20 | <0.001 | Yes |
| | Urban | <35 | 1,112 | 14.3 | 291 | 10.3 | 401.6 | 35.18 | <0.001 | Yes |
| | | 35-55 | 1,396 | 17.9 | 557 | 19.8 | 504.1 | 6.63 | 0.010 | No |
| | | >55 | 947 | 12.1 | 523 | 18.6 | 342.0 | 108.47 | <0.001 | Yes |
| Female | Rural | <35 | 289 | 3.7 | 57 | 2.0 | 104.4 | 21.85 | <0.001 | Yes |
| | | 35-55 | 249 | 3.2 | 74 | 2.6 | 89.9 | 2.73 | 0.098 | No |
| | | >55 | 154 | 2.0 | 75 | 2.7 | 55.6 | 6.55 | 0.011 | No |
| | Urban | <35 | 231 | 3.0 | 52 | 1.8 | 83.4 | 11.81 | <0.001 | Yes |
| | | 35-55 | 193 | 2.5 | 66 | 2.3 | 69.7 | 0.15 | 0.699 | No |
| | | >55 | 75 | 1.0 | 40 | 1.4 | 27.1 | 5.75 | 0.017 | No |
| Total | | | 7,801 | 100% | 2,817 | | | $\chi^2 = 249.75$, $p<0.001$ | | |

[1]Expected response = total sample size * population percent
[2]Bonferroni correction = p-value/number of tests = 0.05/12 = 0.004

**Table 2.5.** Cell-by-cell correction for responses to all four survey mailings, two Internet and two mail survey mailings (Combined mode-group). Survey recipients are partitioned into 12 cells by demographic variables (age, gender, residence). Observed and expected number of responses are compared through Chi-squared ($\chi^2$) analysis to determine significant response differences.

| Gender | Residence | Age | Sample size *n* | Sample size % | Observed responses *n* | Observed responses % | Expected responses[1] | Chi-squared test statistic | Difference test p-value | Statistical significance Bonferroni correction[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | Rural | <35 | 913 | 11.7 | 234 | 7.6 | 362.2 | 51.01 | <0.001 | Yes |
| | | 35-55 | 1,191 | 15.3 | 441 | 14.2 | 472.5 | 2.40 | 0.121 | No |
| | | >55 | 1,051 | 13.5 | 531 | 17.2 | 417.0 | 35.72 | <0.001 | Yes |
| | Urban | <35 | 1,112 | 14.3 | 320 | 10.3 | 441.2 | 38.50 | <0.001 | Yes |
| | | 35-55 | 1,396 | 17.9 | 599 | 19.4 | 553.9 | 4.38 | 0.036 | No |
| | | >55 | 947 | 12.1 | 570 | 18.4 | 375.7 | 113.76 | <0.001 | Yes |
| Female | Rural | <35 | 289 | 3.7 | 64 | 2.1 | 114.7 | 22.79 | <0.001 | Yes |
| | | 35-55 | 249 | 3.2 | 83 | 2.7 | 98.8 | 2.44 | 0.118 | No |
| | | >55 | 154 | 2.0 | 80 | 2.6 | 61.1 | 5.65 | 0.017 | No |
| | Urban | <35 | 231 | 3.0 | 60 | 1.9 | 91.6 | 10.91 | <0.001 | Yes |
| | | 35-55 | 193 | 2.5 | 72 | 2.3 | 76.6 | 0.22 | 0.638 | No |
| | | >55 | 75 | 1.0 | 41 | 1.3 | 29.8 | 3.92 | 0.048 | No |
| Total | | | 7,801 | 100% | 3,095 | | | $\chi^2 = 262.31$, $p<0.001$ | | |

[1]Expected response = total sample size * population percent
[2]Bonferroni correction = p-value/number of tests = 0.05/12 = 0.004

**Table 2.6.** Survey questions used to analyze the impacts of cell-by-cell correction.

| Question | Description |
|---|---|
| A[1] | Over the past 5 years, what trend have you seen in the deer population in the permit area you hunt most often? |
| B[2] | In thinking about the deer permit area you hunt, please indicate your overall satisfaction with current deer numbers. |
| C[3] | In thinking about the property you hunt and the surrounding area, at what level do you think the deer population should be managed? |
| D[4] | To what extent would you support or oppose a regulation that would increase the proportion of antlered bucks in the deer area you hunt most often? |
| E[5] | How satisfied were you with your 2014 deer hunt? |

[1]Scale: 1 = Much fewer deer to 5 = Many more deer.
[2]Scale: 1 = Very dissatisfied to 5 = Very Satisfied.
[3]Scale: 1 = Decrease population 50% to 7 = Increase population 50%.
[4]Scale: 1 = Strongly oppose to 5 = Strongly support.
[5]Scale: 1 = Very dissatisfied to 5 = Very satisfied.

**Table 2.7.** Mean values (*M*) for uncorrected and corrected responses to five key management relevant questions. Responses were grouped into three mode-groups: 1) Internet surveys only (Internet), 2) first three mailing waves (3-wave), and 3) combined Internet and mail surveys (Combined). Calculated variance ($\sigma^2$) and T-tests were calculated between the uncorrected or corrected control mode-group (Combined) and the three other mode-groups that are either uncorrected or corrected, respectively.

| | **Question** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **A** | | | **B** | | | **C** | | | **D** | | | **E** | |
| **Correction** | *M* | *t* | $\sigma^2$ | *M* | *t* | $\sigma^2$ | *M* | *t* | $\sigma^2$ | *M* | *t* | $\sigma^2$ | *M* | *t* | $\sigma^2$ |
| Internet Uncorrected | 2.02 | -0.61 | 1.23 | 2.63 | -0.50 | 2.02 | 2.29 | 0.91 | 0.67 | 3.60 | -1.71 | 1.45 | 3.18 | -0.55 | 1.82 |
| 3-wave Uncorrected | 2.00 | 0.04 | 1.21 | 2.61 | 0.00 | 1.96 | 2.29 | 0.68 | 0.67 | 3.55 | -0.11 | 1.47 | 3.16 | -0.07 | 1.82 |
| Combined Uncorrected | 2.00 | - | 1.21 | 2.61 | - | 1.93 | 2.31 | - | 0.84 | 3.54 | - | 1.45 | 3.16 | - | 1.81 |
| Internet Corrected | 1.94 | 2.37* | 1.43 | 2.53 | 2.33* | 2.33 | 2.19 | 4.25*** | 0.92 | 3.47 | 3.00** | 2.20 | 3.03 | 2.88** | 2.15 |
| 3-wave Corrected | 2.04 | -0.28 | 1.75 | 2.65 | -0.37 | 2.77 | 2.32 | 0.18 | 1.21 | 3.63 | -0.54 | 3.08 | 3.18 | -0.41 | 2.71 |
| Combined Corrected | 2.03 | - | 1.73 | 2.64 | - | 2.66 | 2.33 | - | 1.61 | 3.61 | - | 2.97 | 3.17 | - | 2.65 |

*$p$<0.05, **$p$<0.01, ***$p$<0.001

A. Over the past 5 years, what trend have you seen in the deer population in the permit area you hunt most often?

B. In thinking about the deer permit area you hunt, please indicate your overall satisfaction with the current deer numbers.

C. In thinking about the property you hunt and the surrounding area, at what level do you think the deer population should be managed?

D. To what extent would you support or oppose a regulation that would increase the proportion of antlered bucks in the deer area you hunt most often?

E. How satisfied were you with your 2014 deer hunt?

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# 2012 STUDY OF DEER MANAGEMENT ON PRIVATE LANDS IN SOUTHEAST MINNESOTA

**A cooperative study conducted by the University of Minnesota for the Minnesota Department of Natural Resources**

**Your help on this study is greatly appreciated!**

*Please return your completed questionnaire in the enclosed envelope. The envelope is self-addressed and no postage is required. Thanks!*

Minnesota Cooperative Fish and Wildlife Research Unit,
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, Minnesota 55108

**First, we would like to know about your property**

1. How many total number of acres did you own or lease at the end of 2011.

   _____ Acres Owned

   _____ Acres Leased

2. Please make a "rough" estimate as to how many acres of your property (owned and leased) are in each of the following categories:

| Acres Owned | Acres Leased | Land Type |
|---|---|---|
| _____ | _____ | Private Residence (house, lawns, associated buildings) |
| _____ | _____ | Row Crops |
| _____ | _____ | Hay fields or Pasture |
| _____ | _____ | Orchards or vineyards |
| _____ | _____ | Vegetables or other truck crops |
| _____ | _____ | Woodlands (natural forest or tree plantings) |
| _____ | _____ | Brushland (including abandoned, overgrown fields) |
| _____ | _____ | Wetlands |
| _____ | _____ | Lands enrolled in State or Federal Conservation Programs |
| _____ | _____ | Other (please list:_____) |

**Next we would like to understand how you manage hunting on your land.**

3. Is your property posted? Posting means signs displayed on the property line that indicate the land is private.

   - ❑ Yes
   - ❑ No → PLEASE SKIP TO QUESTION 6

4. Please indicate whether you agree or disagree with the following reasons for posting your property:

| | Strongly Disagree | Moderately Disagree | Slightly Disagree | Neither | Slightly Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| (A) Control who uses my land | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (B) Human safety | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (C) Liability concerns | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (D) Eliminate trespass | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (E) Keep wildlife for myself/family/friends | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (F) Reduce property damage | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (G) Livestock safety | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (H) Relationship with neighbor | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (I) Better control of deer population | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (J) Family tradition | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (K) Conflict with other recreational users | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| (L) Other (please describe): | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

5. Did a single event cause you to post your property? (*Check only one*)
   - ❑ Yes. If yes, please choose the one letter (select one from A through L) from **question 4** that best describes why you posted your property: _____
   - ❑ No

6. Did you allow hunting on your property during the 2011 deer season? (*Check only one*)
   - ❑ Yes
   - ❑ No→PLEASE SKIP TO QUESTION 9

7. Who did you allow to hunt deer on your property? (*Check all that apply*). Please also estimate the number of people who hunted your property in 2011.
   - ❑ Myself or family members _____ people
   - ❑ Friends or neighbors _____ people
   - ❑ Strangers who ask permission _____ people
   - ❑ Specific groups of people who are affiliated with an organized hunting group _____ people
   - ❑ People who lease my property _____ people
   - ❑ Other (please list: _____) _____ people

8. Please indicate if you impose any deer harvest restrictions on your property. (*Please check one only*)
   - ❑ Antlerless harvest is restricted, but hunters can take any legal buck
   - ❑ Buck harvest is restricted to only large antlered bucks, but hunters can take any antlerless deer
   - ❑ Buck harvest restricted to only large antlered bucks, and antlerless harvest is also restricted
   - ❑ No restrictions on the type of deer that can be harvested
   - ❑ Don't know
   - ❑ Other (please list: _____)

9. To what extent do you agree or disagree with the following statements regarding your decision about allowing or not allowing deer hunting on your property. (*Please circle one number for each statement*)

| | **Strongly Disagree** | **Moderately Disagree** | **Slightly Disagree** | **Neither** | **Slightly Agree** | **Moderately Agree** | **Strongly Agree** |
|---|---|---|---|---|---|---|---|
| Hunting will reduce the number of deer on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting is a tradition in my family. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I feel pressure from my neighbors to allow hunting. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting will reduce the number of mature bucks on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Allowing other hunters on my property will reduce my or my family's opportunity to hunt deer. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunters cause too many problems. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I am concerned about the liability of other hunters on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I am opposed to deer hunting in general. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I am not opposed to hunting, but I want to provide a refuge for deer. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting reduces my privacy. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting reduces damage caused by deer on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting improves the quality of habitat on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting on my property will help keep deer from being over-abundant in the area. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Letting others hunt on my property encourages a hunting tradition. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting puts my livestock at risk. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

10. To what extent do you agree or disagree with the following statements about your <u>future decisions</u> about allowing other people to hunt deer on your property. (*Please circle one number for each statement below*).

| **I would be more likely to allow or continue to allow other people to deer hunt on my property if…** | **Strongly Disagree** | **Moderately Disagree** | **Slightly Disagree** | **Neither** | **Slightly Agree** | **Moderately Agree** | **Strongly Agree** |
|---|---|---|---|---|---|---|---|
| The hunters would help me out by working on the property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I felt like they were interested in getting to know me and understanding what I'm trying to do on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I knew that they were safe and ethical hunters. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| The hunters or an outfitter would pay me in order to hunt. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| The Minnesota DNR would pay me to allow others to hunt. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| They follow the rules I have for hunting on my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

11. Do you lease any of your property for deer hunting?
    - ❑ Yes
    - ❑ No→PLEASE SKIP TO QUESTION 13

12. Please indicate to the extent you agree or disagree regarding your decision to lease your property to deer hunters. (*Please circle one number for each statement below*).

| | Strongly Disagree | Moderately Disagree | Slightly Disagree | Neither | Slightly Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| I have better control over who is using my land. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I have better control over the type of deer that are harvested. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I am managing my property for mature bucks. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Leasing allows me to earn extra money from my property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I feel pressure from my neighbors who also lease their property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I see leasing as the future way landowners can manage their property | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Other (please indicate): | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**In the next section we have questions about your deer hunting participation in Minnesota.**

13. To what extent would you support or oppose a regulation that would increase the proportion of antlered bucks in the deer area you hunt most often? (*Please check one only*).

- ❑ Strongly Oppose
- ❑ Moderately Oppose
- ❑ Neither Oppose nor Support
- ❑ Moderately Support
- ❑ Strongly Support
- ❑ Don't Know

14. Please check the boxes below to report when you hunted deer in Minnesota during the 2009, 2010 or 2011 Minnesota deer season? (*Please check all that apply*).

- ❑ 2009→ ❒ Archery | ❒ Firearm | ❒ Muzzleloader
- ❑ 2010→ ❒ Archery | ❒ Firearm | ❒ Muzzleloader
- ❑ 2011→ ❒ Archery | ❒ Firearm | ❒ Muzzleloader
- ❑ I DID NOT HUNT ANY OF THESE YEARS→PLEASE SKIP TO QUESTION 20 BELOW

15. Which **ONE** deer permit area did you hunt most often during the <u>most recent</u> deer season you hunted ***(check one)***:

❑ 338 |❑ 339 |❑ 341 | ❑ 342 |❑ 343 | ❑ 344 | ❑ 345 | ❑ 346 | ❑ 347 | ❑ 348 |❑ 349 | ❑ 602

If you <u>did not hunt one of the permit areas</u> listed above, please tell us which one you did hunt: _____

16. How much of your deer hunting did you do on each of the following types of land during your most recent deer hunting season? (*Circle one number for each item*).

| | None | Some | Most | All | Don't Know |
|---|---|---|---|---|---|
| Private land that I own | 1 | 2 | 3 | 4 | 9 |
| Private land that I lease for hunting | 1 | 2 | 3 | 4 | 9 |
| Private land that I do **not** own or lease | 1 | 2 | 3 | 4 | 9 |
| Public land | 1 | 2 | 3 | 4 | 9 |

**The next section will address deer populations and harvest management strategies in southeastern Minnesota. Please answer the questions to the best of your ability, even if you are not entirely familiar with the deer regulations. The regulations we refer to in this survey include:**

- A 4-point to one side antler point restriction regulation for all deer seasons
- A prohibition on buck cross-tagging
- The 3A season was lengthened to 9 days (from 7).
- Youth hunters (17 or younger) are exempt from the regulation and can take any buck

17. The regulations that were put in place in southeastern Minnesota in 2010 were designed to put more harvest pressure on antlerless deer and at the same time protect a large percentage of yearling bucks. In thinking back to when the regulations were announced before the 2010 deer season, please indicate your level of support at that time (again, *prior* to the 2010 deer season).
    - ❑ Strongly Opposed
    - ❑ Moderately Opposed
    - ❑ Neither Opposed nor Supported
    - ❑ Moderately Supported
    - ❑ Strongly Supported
    - ❑ Don't Know

18. After hunting under the antler point restriction regulations, please indicate whether or not your overall satisfaction with your hunting experience in southeastern Minnesota may have changed over time. (*Circle one response*)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| Much Less Satisfied | Somewhat Less Satisfied | Slightly Less Satisfied | No Change | Slightly More Satisfied | Somewhat More Satisfied | Much More Satisfied |

19. After hunting under the antler point restriction regulations, please indicate whether or not your support for antler point restrictions in southeastern Minnesota may have changed over time. (*Circle one response*)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| Much Less Support | Somewhat Less Support | Slightly Less Support | No Change | Slightly More Support | Somewhat More Support | Much More Support |

20. While no decision has been made to continue the following deer hunting regulations, please indicate your level of support for continuation of the regulations that were enacted in 2010. (*Please circle one number for each item*).

| | Entirely Oppose | Moderately Oppose | Slightly Oppose | Neither Oppose or Support | Slightly Support | Moderately Support | Entirely Support | Don't Care |
|---|---|---|---|---|---|---|---|---|
| Keeping the 3A season at 9 days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 |
| Continue the 4-point to one side antler point restriction | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 |
| Continue the prohibition of buck cross-tagging | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 |
| Exemption of youth from the antler point restriction | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 |

21. Including 2011, how many years have you been hunting deer in Minnesota? _____ Years.
Please check this box ❒ if you have not hunted deer in Minnesota.

**Next we would like to know about crop and other damage caused by wildlife on your property.**

22. Did you experience deer damage to crops on lands that you own or leased in 2011?
- ❑ Yes
- ❑ No→PLEASE SKIP TO QUESTION 24
- ❑ Don't have crops→PLEASE SKIP TO QUESTION 28

23. How would you describe the total amount of deer damage you experienced in 2011?
- ❑ Negligible
- ❑ Minor
- ❑ Moderate
- ❑ Severe
- ❑ Don't Know

24. How would you compare the amount of deer damage you experienced in 2011 to what you experienced 5 years ago?
- ❑ Much less damage in 2011 than 5 years ago
- ❑ Slightly less damage in 2011 than 5 years ago
- ❑ About the same damage in 2011 than 5 years ago
- ❑ Slightly more damage in 2011 than 5 years ago
- ❑ Much more damage in 2011 than 5 years ago
- ❑ I was not farming 5 years ago

25. In addition to deer, please indicate which other species caused damage to your crops in 2011. (*check <u>all</u> that apply*)
    - ❑ Raccoon
    - ❑ Turkey
    - ❑ Geese
    - ❑ Small rodents (mice, voles)
    - ❑ Gophers/Woodchucks
    - ❑ Other (please list: _____)

26. Of all the damage you attributed to wildlife in 2011, what percentage do you feel was due to deer? (*Please circle one percentage*).

    0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

27. In the table below, for each type of crop you grew in 2011, please provide your best estimate of the total acres you grew, the dollar value of deer damage to that crop, and the estimated percentage of the total crop value lost to deer damage.

| Crop | Acres grown, 2011 | Estimated dollar loss from deer damage to crop | Estimated percent of total crop value lost to deer damage |
|---|---|---|---|
| Corn | _____ acres | $ _____ | _____% lost |
| Soybeans | _____ acres | $ _____ | _____% lost |
| Alfalfa | _____ acres | $ _____ | _____% lost |
| Other hay | _____ acres | $ _____ | _____% lost |
| Tree fruits | _____ acres | $ _____ | _____% lost |
| Grapes | _____ acres | $ _____ | _____% lost |
| Stored Forage | _____ acres | $ _____ | _____% lost |
| Nursery Products | _____ acres | $ _____ | _____% lost |
| Vegetables | _____ acres | $ _____ | _____% lost |
| Other: _____ | _____ acres | $ _____ | _____% lost |
| TOTALS | _____ acres | $ _____ | _____% lost |

**In the next section we would like to understand your preferences for deer management.**

28. Would you say you know A GREAT DEAL, A MODERATE AMOUNT, A LITTLE, OR NOTHING about deer management in southeastern Minnesota? (*Please check one only*).
    - ❑ A GREAT DEAL - I read most of the hunting handbook, DNR news releases, follow the outdoor media, and am very familiar with the Zone 3 deer season changes
    - ❑ A MODERATE AMOUNT - I read parts of the handbook and occasionally follow the outdoor media
    - ❑ A LITTLE - I only read the parts that pertain to me and otherwise don't follow the outdoor media
    - ❑ NOTHING - I buy my license but I am not following the southeast deer management issue
    - ❑ DON'T KNOW

29. Over the past 5 years, what trend have you seen in the deer population in the area of your property?
    - ❑ More deer now than 5 years ago
    - ❑ About the same number of deer now as 5 years ago
    - ❑ Fewer deer now than 5 years ago
    - ❑ Don't know

30. In thinking about your property and the surrounding area, would you say the deer population is,
    - ❑Too high
    - ❑About right
    - ❑Too low
    - ❑Don't know

31. In thinking about your property and the surrounding area, at what level do you think the deer population should be managed? (*Please circle one*)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| Decrease 50% (Significant) | Decrease 25% (Moderate) | Decrease 10% (Slight) | No Change | Increase 10% (Slight) | Increase 25% (Moderate) | Increase 50% (Significant) |

32. During the last 5 years, about how many deer were killed on your property each year?
_____number of bucks/antlered deer each year

_____number of does/antlerless deer each year

33. How many deer would you prefer to have killed on your property each year?
_____number of bucks/antlered deer each year

_____number of does/antlerless deer each year

34. When you think about deer management in your area, to what extent do you agree or disagree with the following statements?

| | **Strongly Disagree** | **Moderately Disagree** | **Slightly Disagree** | **Neither** | **Slightly Agree** | **Moderately Agree** | **Strongly Agree** |
|---|---|---|---|---|---|---|---|
| It is my personal responsibility to manage deer populations. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Landowners in my community should be responsible for managing deer populations. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| The Minnesota DNR should be responsible for managing deer populations. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| The Minnesota DNR should be responsible for talking to community members about managing deer populations. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| It is my personal responsibility to talk to others in my community about deer management. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Landowners in my community should talk to each other about managing deer populations. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| The deer populations in my community are well managed. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |

35. With 1 being your most preferred and 6 being your least preferred, please rank (from 1 to 6) the following strategies that could be implemented to lower deer populations.

_____ **Earn-A-Buck**. This would require all deer hunters to kill an antlerless deer before killing an antlered buck. Under this regulation, hunters cannot shoot a buck until they first killed an antlerless deer. As a result, harvest rates on antlerless deer will increase.

_____ **Buck License Lottery**. The annual firearm license would be valid for antlerless deer only. Hunters interested in killing antlered bucks would need to apply for a permit through a lottery system. Only lottery winners would be eligible to hunt antlered deer. Unsuccessful applicants would be restricted to hunting antlerless deer during the current year, but would gain preference points in the lottery which would improve their chance of getting drawn for a buck license in future years. A hunter would likely win a buck permit every 2-3 years depending on hunting pressure.

_____ **Antler Point Restriction**. This regulation has been used since 2010. Only bucks with at least one 4-point antler would be legal to harvest. Hunters could take any antlerless deer.

_____ **Early Antlerless Season**. This regulation has been used since 2005. A 2-day antlerless only season would be implemented over the MEA weekend and deer taken during this season would not count against the annual bag limit.

_____ **Limited Depredation Permits**. These are permits issued to landowners that could be used during the deer season. The permits would be valid for antlerless deer only and only on specified private lands.

_____ **Localized special seasons**. These would be firearms hunts on private lands before or after the regular firearms season.

36. One idea for lowering deer populations in local areas is to develop localized special seasons. In general please let us know what you think about such seasons. Please circle one response to indicate how much you agree or disagree with each statement.

| **Do you agree or disagree with the following**… | **Strongly Disagree** | **Moderately Disagree** | **Slightly Disagree** | **Neither** | **Slightly Agree** | **Moderately Agree** | **Strongly Agree** |
|---|---|---|---|---|---|---|---|
| In general I support the idea of firearms hunts on private lands either before or after the regular season. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| I would prefer that such a season be **before** the regular firearm deer season in **late summer (August- Sept.)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| I would prefer that such a season be **before** the regular firearm deer season in **early fall (mid-Sept – early Oct.)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| I would prefer that such a season be **after** the muzzleloader deer season (**mid-Dec**.) | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| I would prefer that such a season be **after** all the seasons are over (**January)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |

37. To what extent do you agree or disagree with the following statements about managing your land, use of wildlife and how you see your community.

| | Strongly Disagree | Moderately Disagree | Slightly Disagree | Neither | Slightly Agree | Moderately Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| Managing deer on my land is something I rarely think about. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Being a good private land wildlife steward is an important part of who I am. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I often think of myself as a good private land wildlife steward. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Managing deer and other wildlife on my land is central to who I am. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I feel strongly attached to the community I live in. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| There are many people in my community who I think of as good friends. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I often talk about my community as being a great place to live. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Humans should manage fish and wildlife populations so that humans benefit. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| We should strive for a world where there's an abundance of fish and wildlife for hunting and fishing. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting does not respect the lives of animals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| The needs of humans should take priority over fish and wildlife protection. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Fish and wildlife are on earth primarily for people to use. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Hunting is cruel and inhumane to the animals. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| People who want to hunt should be provided the opportunity to do so. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| It is acceptable for people to kill wildlife, if they think it poses a threat to their life. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| It is acceptable for people to kill wildlife, if it poses a threat to their property. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

38. What is your gender?
    - ❑ Male
    - ❑ Female

39. What was your total household income before taxes last year? $ _____

40. What year were you born? _____YEAR

41. What is the highest level of formal education you have completed? *(Please check one).*

- ❑ Grade school
- ❑ Some high school
- ❑ High school diploma or GED
- ❑ Some vocational or technical school
- ❑ Vocational or technical school (associate's)
- ❑ Some college
- ❑ Four-year college (bachelor's)
- ❑ Some graduate school
- ❑ Graduate/Professional degree

**Please write any additional comments you might have in the space below:**

**Thank you for your help!**

**Please complete the survey and mail it back in the enclosed self-addressed envelope. No postage is necessary.**

If you have any questions about the survey please contact Dr. David Fulton, Department of Fisheries and Wildlife, 1980 Folwell Ave, 200 Hodson Hall, St. Paul, MN 55108 Phone: (612) 625-5256 or Amanda Sames by e-mail at same0057@umn.edu

**Appendix B. 2015 Survey of Minnesota Deer Hunters.**

# 2015 Survey of Minnesota Deer Hunters (H1): Hunters Opinions and Activities

## A cooperative study conducted by the University of Minnesota for the Minnesota Department of Natural Resources

## Your help on this study is greatly appreciated!

*Please return your completed questionnaire in the enclosed envelope. The envelope is self-addressed and no postage is required. Thanks!*

Minnesota Cooperative Fish & Wildlife Research Unit,
1980 Folwell Ave., 200 Hodson Hall
Department of Fisheries, Wildlife and Conservation Biology
University of Minnesota
St. Paul, MN 55108

**Part I. Goal-Setting Survey**

1. Please check the boxes below to report if you hunted deer in Minnesota during the 2012, 2013 or 2014 Minnesota deer season. (*Please check all that apply*).

   ❑ 2012 | ❒ 2013| ❒ 2014

   ❑ I did not hunt deer any of these years → **PLEASE SKIP TO QUESTION 13**

2. Minnesota allows people to hunt deer during all 3 seasons. For the most recent year you hunted, which seasons did you participate? Please mark 'Yes' if you hunted a season and also estimate the number of days you scouted and hunted.

| Season | Yes | No | If Yes, Number of Days Scouting | If Yes, Number of Days Hunting |
|---|---|---|---|---|
| Archery | ❒ | ❒ | _____ | _____ |
| Firearm | ❒ | ❒ | _____ | _____ |
| Muzzleloader | ❒ | ❒ | _____ | _____ |

3. Which **ONE** deer permit area did you hunt most often during the <u>most recent</u> deer season you hunted?

   ❑ 201 | ❑ 203 | ❑ 208 | ❑ 209 | ❑ 213 | ❑ 214 | ❑ 215 | ❑ 218 | ❑ 239 | ❑ 240 | ❑ 256 |

   ❑ 257 | ❑ 260 | ❑ 261 | ❑ 262 | ❑ 263 | ❑ 264 | ❑ 265 | ❑ 266 | ❑ 267 | ❑ 268 | ❑ 269 |

   ❑ 270 | ❑ 271 | ❑ 272 | ❑ 273 | ❑ 276 | ❑ 277 | ❑ 297 ❑ I hunted a permit area not listed

4. If you <u>did not hunt one of the permit areas</u> listed above, please tell us which one you hunted most often:

   _____Area Number

5. Including 2014, how many years have you hunted deer in the permit area you hunt most often?

   _____ Years

6. Including 2014, how many years have you been hunting deer in Minnesota? _____ Years

7. How much of your deer hunting did you do on each of the following types of land during your most recent deer hunting season? *(Please circle one item from each row.)*

| | **None** | **Some** | **Most** | **All** |
|---|---|---|---|---|
| Private land that I own | 1 | 2 | 3 | 4 |
| Private land that I lease for hunting | 1 | 2 | 3 | 4 |
| Private land that I do **<u>not</u>** own or lease | 1 | 2 | 3 | 4 |
| Public land | 1 | 2 | 3 | 4 |

8. Please indicate if there are any deer harvest restrictions on the property you hunt most often.

   - ❑ Antlerless harvest is restricted, but hunters can take any legal buck
   - ❑ Buck harvest restricted to large antlered bucks, but hunters can take any antlerless deer
   - ❑ Buck harvest restricted to large antlered bucks, and antlerless harvest is also restricted
   - ❑ No restrictions on the type of deer that can be harvested
   - ❑ Other (please explain): _____

9. Please indicate whether you agree or disagree with the following statements regarding your most recent deer hunt. (*Please circle one number for each statement below*).

| | **Strongly Disagree** | **Slightly Disagree** | **Neither Agree nor Disagree** | **Slightly Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| I was satisfied with the number of legal bucks | 1 | 2 | 3 | 4 | 5 |
| I was satisfied with the quality of bucks | 1 | 2 | 3 | 4 | 5 |
| I heard about or saw legal bucks while hunting | 1 | 2 | 3 | 4 | 5 |
| I was satisfied with the number of antlerless deer | 1 | 2 | 3 | 4 | 5 |
| I was satisfied with the number of deer I saw while hunting | 1 | 2 | 3 | 4 | 5 |

10. Will you shoot an antlerless deer if given the opportunity?
    ❑ Yes ❑ No

11. Over the past 5 years, what trend have you seen in the deer population in the permit area you hunt most often?
    - ❑ Much fewer deer now than 5 years ago
    - ❑ Slightly fewer deer now than 5 years ago
    - ❑ About the same number of deer as 5 years ago
    - ❑ Slightly more deer now than 5 years ago
    - ❑ Many more deer now than 5 years ago

12. In thinking about the deer permit area you hunt, please indicate your overall satisfaction with current deer numbers.
    - ❑ Very Dissatisfied
    - ❑ Slightly Dissatisfied
    - ❑ Neither Dissatisfied nor Satisfied
    - ❑ Slightly Satisfied
    - ❑ Very Satisfied

13. How much importance should we assign to each of the following considerations when setting deer population goals? (*Please circle one number for each statement below*).

| | **Not at all Important** | **A little Important** | **Moderately Important** | **Important** | **Very Important** |
|---|---|---|---|---|---|
| Amount of deer mortality during an **average** winter | 1 | 2 | 3 | 4 | 5 |
| Amount of deer mortality during a **severe** winter | 1 | 2 | 3 | 4 | 5 |
| Potential health risks to the deer herd | 1 | 2 | 3 | 4 | 5 |
| Public health (human-deer diseases) | 1 | 2 | 3 | 4 | 5 |
| Amount of crop damage from deer | 1 | 2 | 3 | 4 | 5 |
| Number of deer-vehicle collisions | 1 | 2 | 3 | 4 | 5 |
| Deer over-browsing of forests | 1 | 2 | 3 | 4 | 5 |
| Impacts of deer on other wildlife species | 1 | 2 | 3 | 4 | 5 |
| Deer hunting heritage and tradition | 1 | 2 | 3 | 4 | 5 |
| Hunter satisfaction with deer numbers | 1 | 2 | 3 | 4 | 5 |
| Public satisfaction with deer numbers | 1 | 2 | 3 | 4 | 5 |
| Impact of deer hunting on the local economy | 1 | 2 | 3 | 4 | 5 |

14. Please identify up to 3 other factors that you believe are important and should be considered when setting deer population goals.

    1) _____

    2) _____

    3) _____

15. In thinking about the deer permit area you hunt, would you say the deer population is,

    ❑ Much too Low ❑ Too Low ❑ About Right ❑ Too High ❑ Much too High

16. In thinking about the property you hunt and the surrounding area, at what level do you think the deer population should be managed? (*Please circle one*).

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| Decrease Population 50% (Significant) | Decrease Population 25% (Moderate) | Decrease Population 10% (Slight) | No Change | Increase Population 10% (Slight) | Increase Population 25% (Moderate) | Increase Population 50% (Significant) |

17. To what extent would you support or oppose a regulation that would increase the proportion of antlered bucks in the deer area you hunt most often?
    - ❑ Strongly Oppose
    - ❑ Slightly Oppose
    - ❑ Neither Oppose nor Support
    - ❑ Slightly Support
    - ❑ Strongly Support

**Part II. Extended Survey**

18. Would you say you know a great deal, a moderate amount, a little, or nothing about DNR's deer management program? (*Check one*).
    - ❑**A great deal** – For example, I read most of the hunting handbook, DNR news releases, and/or follow the outdoor media
    - ❑**A moderate amount** – For example, I read parts of the handbook and/or occasionally follow the outdoor media
    - ❑**A little** – For example, I only read the parts of the handbook that pertain to me and don't follow the outdoor media
    - ❑**Nothing** – For example, I buy my license just before the season and follow the advice of my friends

19. Indicate how strongly you agree or disagree with the following statements about steps in setting deer population goals. *(Please choose only one response for each statement.)*

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| It is important for hunters to have opportunities to provide input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| It is important for landowners to have opportunities to provide input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| It is important for Minnesotans to have opportunities to provide input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| It is important to use the best available science when setting population goals | 1 | 2 | 3 | 4 | 5 |
| It is important to consider diverse interests when setting population goals | 1 | 2 | 3 | 4 | 5 |
| It is important to follow consistent decision-making procedures when setting population goals | 1 | 2 | 3 | 4 | 5 |
| It is important that decision-makers explain different options considered when deer population goals are set, and why the final option was selected | 1 | 2 | 3 | 4 | 5 |

20. Indicate how strongly you agree or disagree with the following statements about the approach used by the Minnesota Department of Natural Resources to set deer population goals. *(Please choose only one response for each statement.)*

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| DNR provides enough opportunities for hunters to have input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| DNR provides enough opportunities for landowners to have input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| DNR provides enough opportunities for Minnesotans to have input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| DNR provides adequate information for the public to provide input regarding population goals | 1 | 2 | 3 | 4 | 5 |
| DNR considers the best available science when setting population goals | 1 | 2 | 3 | 4 | 5 |
| DNR follows consistent decision-making procedures when setting population goals | 1 | 2 | 3 | 4 | 5 |
| DNR explains different options considered when deer population goals are set, and why the final option was selected | 1 | 2 | 3 | 4 | 5 |
| I trust the DNR to establish appropriate deer population goals | 1 | 2 | 3 | 4 | 5 |

21. Which one of the following best describes how you deer hunted deer during the 2014 regular firearms deer hunting season in Minnesota? Would you say you (*Check only one*):
    - ❑ Hunted for large antlered bucks during the entire season
    - ❑ Hunted for large antlered bucks early season and any legal deer later
    - ❑ Would shoot any antlered buck
    - ❑ Would shoot the first legal deer (either antlered or antlerless) that offered a good shot
    - ❑ Would shoot only antlerless deer
    - ❑ Chose not to harvest a deer due to population concern

22. Which statement best characterizes where you hunt?
    - ❑ I almost never hunt the same area every year
    - ❑ I change my hunting location every 1 to 2 years
    - ❑ I change my hunting location every 3 to 5 years
    - ❑ I typically hunt the same area every year

23. If you hunt private land, what size is the parcel you typically hunt? _____ acres

24. Do you cooperate with other deer hunters on nearby properties with respect to deer harvest restrictions, so that there are similar strategies in place in the area you hunt?
    - ❑ Yes ❑ No

25. Which techniques did you use to hunt during the most recent year you hunted? Check each item that applies.
    - ❑ Stand hunting from ground stand/blind
    - ❑ Stalking or moving slowly
    - ❑ Hunting from elevated tree stand
    - ❑ Participated in deer drives as member of a party

26. During the 2014 Minnesota deer season, did you,

| | Yes | No |
|---|---|---|
| Kill and tag an antlerless deer | ❑ | ❑ |
| Kill and tag a legal buck | ❑ | ❑ |
| Kill a deer for another hunter (a member of your party tagged the deer you killed) | ❑ | ❑ |
| Use your tag on a deer that another hunter killed? | ❑ | ❑ |

27. Please indicate how much you support or oppose the following potential changes to deer hunting regulations in Minnesota.

| | Strongly Oppose | Slightly Oppose | Neither | Slightly Support | Strongly Support |
|---|---|---|---|---|---|
| **Delay the firearm deer season one week.** The deer season would open the Saturday closest to November 13th. Currently, the season opens the Saturday closest to November 6th, which is about one week prior to peak rut. | 1 | 2 | 3 | 4 | 5 |
| **Delay the firearm deer season until late November.** The deer season would open the Saturday closest to November 20th. | 1 | 2 | 3 | 4 | 5 |
| **Institute an antler point restriction.** This would be for adult hunters only. Youth hunters could still take any deer. | 1 | 2 | 3 | 4 | 5 |
| **Eliminate buck cross-tagging.** People would still be allowed to hunt as a party but hunters would be required to shoot and tag their own buck. Hunters would still be allowed to shoot and tag antlerless deer for each other. | 1 | 2 | 3 | 4 | 5 |
| **Eliminate cross-tagging for bucks and antlerless deer.** | 1 | 2 | 3 | 4 | 5 |

28. Below is a series of 8 hypothetical scenarios for potential combinations for deer seasons and regulations. We are interested in your preferences for potential deer hunting regulations in Minnesota. Some of these scenarios may seem unlikely, and there are no specific changes planned at this time. (*For each scenario, select the one choice with the characteristics you would prefer.)*

| | | | |
|---|---|---|---|
| Scenario 1. | **Option 1**<br>➢ Cross-tagging illegal for both sexes<br>➢ Antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers higher than current levels<br>➢ Two deer limit (Managed) | **Option 2**<br>➢ Cross-tagging legal for either sex<br>➢ No antler point restrictions<br>➢ Early November opener (during the rut)<br>➢ Deer numbers lower than current levels<br>➢ One deer limit, either sex (Hunter Choice) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 2. | **Option 1**<br>➢ Cross-tagging legal for either sex<br>➢ No antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers higher than current levels<br>➢ Two deer limit (Managed) | **Option 2**<br>➢ Cross-tagging legal for antlerless only<br>➢ Antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers at current levels<br>➢ One deer limit, antlerless by permit only (Lottery) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 3. | **Option 1**<br>➢ Cross-tagging legal for antlerless only<br>➢ Antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers at current levels<br>➢ One deer limit, antlerless by permit only (Lottery) | **Option 2**<br>➢ Cross-tagging illegal for both sexes<br>➢ No antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers lower than current levels<br>➢ One deer limit, either sex (Hunter Choice) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 4. | **Option 1**<br>➢ Cross-tagging legal for either sex<br>➢ No antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers higher than current levels<br>➢ One deer limit, antlerless by permit only (Lottery) | **Option 2**<br>➢ Cross-tagging illegal for both sexes<br>➢ Antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers higher than current levels<br>➢ One deer limit, either sex (Hunter Choice) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 5. | **Option 1**<br>➢ Cross-tagging legal for antlerless only<br>➢ No antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers lower than current levels<br>➢ Two deer limit (Managed) | **Option 2**<br>➢ Cross-tagging legal for antlerless only<br>➢ Antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers at current levels<br>➢ One deer limit, either sex (Hunter Choice) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 6. | **Option 1**<br>➢ Cross-tagging illegal for both sexes<br>➢ No antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers at current levels<br>➢ Two deer limit (Managed) | **Option 2**<br>➢ Cross-tagging legal for either sex<br>➢ Antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers lower than current levels<br>➢ Two deer limit (Managed) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 7. | **Option 1**<br>➢ Cross-tagging legal for antlerless only<br>➢ Antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers higher than current levels<br>➢ One deer limit, antlerless by permit only (Lottery) | **Option 2**<br>➢ Cross-tagging illegal for both sexes<br>➢ No antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers lower than current levels<br>➢ One deer limit, antlerless by permit only (Lottery) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

| | | | |
|---|---|---|---|
| Scenario 8. | **Option 1**<br>➢ Cross-tagging legal for antlerless only<br>➢ Antler point restrictions<br>➢ Early November opener (during rut)<br>➢ Deer numbers at current levels<br>➢ One deer limit, either sex (Hunter Choice) | **Option 2**<br>➢ Cross-tagging illegal for both sexes<br>➢ No antler point restrictions<br>➢ Late November opener (out of the rut)<br>➢ Deer numbers at current levels<br>➢ Two deer limit (Managed) | **NONE**: I would not hunt deer in MN with these options. |
| **Check <u>one</u> box ►** | ❑ | ❑ | ❑ |

29. Please indicate how much you agree or disagree with the following statements about your involvement in deer hunting in Minnesota. (*Please circle <u>one</u> response <u>for each</u>):*

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| Deer hunting is one of the most enjoyable things I do. | 1 | 2 | 3 | 4 | 5 |
| Deer hunting provides me with the opportunity to be with friends. | 1 | 2 | 3 | 4 | 5 |
| To change my preference from deer hunting to another recreation activity would require major rethinking. | 1 | 2 | 3 | 4 | 5 |
| A lot of my life is organized around deer hunting. | 1 | 2 | 3 | 4 | 5 |
| Deer hunting has a central role in my life. | 1 | 2 | 3 | 4 | 5 |
| Most of my friends are in some way connected with deer hunting. | 1 | 2 | 3 | 4 | 5 |
| When I am deer hunting, others see me the way I want them to see me. | 1 | 2 | 3 | 4 | 5 |
| I identify with the people and images associated with deer hunting. | 1 | 2 | 3 | 4 | 5 |
| Deer hunting is one of the most satisfying things I do. | 1 | 2 | 3 | 4 | 5 |
| Participating in deer hunting says a lot about who I am. | 1 | 2 | 3 | 4 | 5 |
| Deer hunting is very important to me. | 1 | 2 | 3 | 4 | 5 |
| You can tell a lot about a person when you see them deer hunting. | 1 | 2 | 3 | 4 | 5 |
| When I am deer hunting I can really be myself. | 1 | 2 | 3 | 4 | 5 |
| I enjoy discussing deer hunting with my friends. | 1 | 2 | 3 | 4 | 5 |
| When I am deer hunting, I don't have to be concerned about what other people think of me. | 1 | 2 | 3 | 4 | 5 |
| I contribute to deer management through hunting. | 1 | 2 | 3 | 4 | 5 |

30. During the 2014 Minnesota deer hunting season, how satisfied or dissatisfied were you with the following?

| | Very dissatisfied | Slightly dissatisfied | Neither | Slightly satisfied | Very satisfied |
|---|---|---|---|---|---|
| General deer hunting experience | 1 | 2 | 3 | 4 | 5 |
| Deer hunting harvest | 1 | 2 | 3 | 4 | 5 |
| Deer hunting regulations | 1 | 2 | 3 | 4 | 5 |
| Number of other deer hunters seen | 1 | 2 | 3 | 4 | 5 |

31. Overall, how satisfied were you with your 2014 deer hunt?

- ❑ Very dissatisfied
- ❑ Slightly dissatisfied
- ❑ Neither satisfied or dissatisfied
- ❑ Slightly satisfied
- ❑ Very satisfied

32. Please tell us how important each of the following experiences was to your deer hunting satisfaction during the 2014 season.

| | Not at all important | Slightly important | Somewhat important | Very important | Extremely important |
|---|---|---|---|---|---|
| Being with hunting companions | 1 | 2 | 3 | 4 | 5 |
| The challenge of harvesting a trophy buck | 1 | 2 | 3 | 4 | 5 |
| Developing my skills and abilities with hunting equipment | 1 | 2 | 3 | 4 | 5 |
| Becoming a better deer hunter | 1 | 2 | 3 | 4 | 5 |
| Influencing deer sex ratios or age structures | 1 | 2 | 3 | 4 | 5 |
| Hunting with friends | 1 | 2 | 3 | 4 | 5 |
| Improving my knowledge about deer and deer management | 1 | 2 | 3 | 4 | 5 |
| Getting food for my family | 1 | 2 | 3 | 4 | 5 |
| Harvesting any deer for meat | 1 | 2 | 3 | 4 | 5 |
| Enjoying a preferred pastime | 1 | 2 | 3 | 4 | 5 |
| Harvesting any buck | 1 | 2 | 3 | 4 | 5 |
| Enjoying nature and the outdoors | 1 | 2 | 3 | 4 | 5 |
| Helping manage deer populations | 1 | 2 | 3 | 4 | 5 |
| Getting a buck every year | 1 | 2 | 3 | 4 | 5 |
| Hunting with family | 1 | 2 | 3 | 4 | 5 |
| Seeing a lot of bucks | 1 | 2 | 3 | 4 | 5 |
| Harvesting a large buck | 1 | 2 | 3 | 4 | 5 |
| Proving my hunting skills and knowledge | 1 | 2 | 3 | 4 | 5 |
| Harvesting at least one deer | 1 | 2 | 3 | 4 | 5 |
| Selectively harvesting a large buck even if it means not killing a deer | 1 | 2 | 3 | 4 | 5 |
| Seeing a lot of deer | 1 | 2 | 3 | 4 | 5 |

33. How would you best describe your identification with the activity of deer hunting (*While more than one option may apply to you, please select one choice*)
    - ❑ **I am a recreational deer hunter** – I hunt to get away from my regular routine, enjoy nature and an outdoor recreation experience.
    - ❑ **I am a meat hunter** – I hunt to provide food for my family and friends. Venison is an important part of our annual diet.
    - ❑ **I am a trophy hunter** – I hunt for the challenge of harvesting a large buck. The opportunity to see or harvest a trophy animal is more important to me than tagging a deer every year.
    - ❑ **I am a social deer hunter** – The companionship of the hunt is most important to me. Hunting gives me an opportunity to spend time with family and friends.
    - ❑ **I am a science-oriented hunter** – I spend a significant amount of time reading about deer behavior and deer management. I look for the most up-to-date research and expertise to inform my hunt. I make hunting decisions based on deer management objectives.
    - ❑ **I am a skills-oriented hunter** – Hunting is a way to test and improve my skills. I enjoy the challenge of using new equipment and spend considerable time practicing to become more proficient.
    - ❑ **I am a casual/occasional deer hunter** – I enjoy deer hunting but don't go every year. I don't spend a lot of time preparing for my season.

34. Currently, Minnesota holds a youth deer season mid-October in portions of northwestern and southeastern Minnesota with additional special youth hunts held during the same period throughout the state. Would you support or oppose a statewide youth season in mid-October? (*Please circle one.*)

| **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|
| Strongly oppose | Oppose | Neutral | Support | Strongly support |

35. Currently, Minnesota employs different firearm season lengths statewide (e.g. 100-series season is 16 days while the 200-series is 9 days). If a consistent, statewide season were implemented, which length would you prefer?

❑ 9 days ❑ 16 days

36. If the MnDNR were to adopt new deer management regulations, would you prefer to see them applied (*Check one*).

❑ Statewide
❑ By Zone (e.g., 100-series, 200-series, 300-series)
❑ By Deer Permit Area

37. Indicate how strongly you agree or disagree with the following statements about the approach used by the Minnesota Department of Natural Resources to set deer hunting rules. *(Please choose only one response for each statement.)*

| | **Strongly Disagree** | **Disagree** | **Not Sure** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| DNR provides enough opportunities for hunters to have input regarding hunting rules | 1 | 2 | 3 | 4 | 5 |
| DNR considers the best available science when setting hunting rules | 1 | 2 | 3 | 4 | 5 |
| DNR follows consistent decision-making procedures when setting hunting rules | 1 | 2 | 3 | 4 | 5 |
| DNR explains different options considered when deer hunting rules are set, and why the final option was selected | 1 | 2 | 3 | 4 | 5 |
| I trust the DNR to establish appropriate deer hunting rules | 1 | 2 | 3 | 4 | 5 |

38. Indicate how strongly you agree or disagree with the following statements about your relationship with Minnesota DNR as it relates to deer management. *(Please choose only one response for each statement.)*

| | **Strongly Disagree** | **Disagree** | **Not Sure** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| I have adequate opportunities to communicate with DNR staff | 1 | 2 | 3 | 4 | 5 |
| I know who to contact if I have questions or comments | 1 | 2 | 3 | 4 | 5 |
| I have communicated with my local conservation officer | 1 | 2 | 3 | 4 | 5 |
| I know my local conservation officer | 1 | 2 | 3 | 4 | 5 |
| I have communicated with my local wildlife manager | 1 | 2 | 3 | 4 | 5 |
| I know my local wildlife manager | 1 | 2 | 3 | 4 | 5 |
| I have communicated with deer management staff | 1 | 2 | 3 | 4 | 5 |
| I know deer management staff | 1 | 2 | 3 | 4 | 5 |

39. What is your preferred means to provide input on deer management decisions?

- ❑ General public meetings
- ❑ Issue-based public meetings
- ❑ Through a representative organization
- ❑ Online questionnaires
- ❑ Other _____
- ❑ Written questionnaires
- ❑ Advisory teams
- ❑ Informal communication (e.g., telephone)
- ❑ None

40. Are you currently a member of: (*Check <u>all</u> that apply*.)

- ❑ Minnesota Deer Hunters Association
- ❑ Quality Deer Management Association
- ❑ Local sporting club
- ❑ Other national/statewide conservation/hunting organization(s):
  Please specify:_____.
- ❑ Minnesota Whitetail Alliance
- ❑ Minnesota Bowhunters, Inc

41. Please let us know how you feel about the Minnesota Department of Natural Resources. (*Please circle one response for each of the following statements.)*

| | **Strongly Disagree** | **Slightly Disagree** | **Neither Agree nor Disagree** | **Slightly Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| The MnDNR does a good job of managing deer in Minnesota. | 1 | 2 | 3 | 4 | 5 |
| When deciding about deer management in Minnesota, the MnDNR will be open and honest in the things they do and say. | 1 | 2 | 3 | 4 | 5 |
| The MnDNR can be trusted to make decisions about deer management that are good for the resource. | 1 | 2 | 3 | 4 | 5 |
| The MnDNR will make decisions about deer management in a way that is fair. | 1 | 2 | 3 | 4 | 5 |
| The MnDNR has deer managers and biologists who are well-trained for their jobs. | 1 | 2 | 3 | 4 | 5 |
| The MnDNR listens to the concerns of deer hunters. | 1 | 2 | 3 | 4 | 5 |

42. How many years have you lived in Minnesota? _____ Years

43. What is your gender?

❑Male ❑ Female

44. What is your age? _____

45. What is the highest level of education you have completed? *(Check one.)*

- ❑Grade school
- ❑Some high school
- ❑High school diploma or GED
- ❑Some vocational or technical school
- ❑Vocational or technical school (associate's) degree
- ❑ Some college
- ❑ Four-year college (bachelor's) degree
- ❑ Some graduate school
- ❑ Graduate (master's or doctoral) degree

46. Do you have access to the internet at home or another location?

❑Yes ❑ No

If you would be willing to respond to additional questions about deer management and hunting in Minnesota and are willing to provide your email address, please write it below. We will only use your email address for research related to deer management and will not share it with anyone.

E-mail address:

_____

❑ I do not have an e-mail address