MINNESOTA HUNTER OPINIONS ABOUT DEER POPULATIONS AND MANAGEMENT

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SUMMARY OF FINDINGS

The Minnesota Department of Natural Resources (MNDNR) Section of Wildlife conducted a survey of firearm white-tailed deer (*Odocoileus virginianus*) hunters to assess hunter preferences for deer population management, harvest regulations, and agency decision making. Results indicate hunter support for increased deer numbers, relative to 2014-2016, in many areas; however, factors identified by hunters as most important to consider in population management provide mixed direction for MNDNR. Although reported satisfaction with deer numbers and quality was generally low, satisfaction with the general hunting experience was relatively high; potentially influenced by non-consumptive motivations. Responses to questions regarding regulatory changes suggest that hunters, for the most part, prefer current regulations over commonly suggested alternatives and that hunting traditions have an important influence on regulatory preferences. Notably, however, establishment of a statewide youth season received relatively high levels of support statewide, suggesting further MNDNR consideration is warranted. Finally, results related to public participation in deer management suggest that opportunities to enhance relationships between staff and hunters should be explored. Given reported preferences for direct, rather than representative, means to provide input, MNDNR could revisit current public engagement methods to enhance support for management.

INTRODUCTION

MNDNR periodically conducts stakeholder surveys to collect information about public desires and opinions regarding specific natural resource management issues. Survey recipients are selected randomly and provide a statistically representative sample of stakeholder opinions. Over the past decade, MNDNR has conducted over a dozen deer hunter surveys to evaluate regulatory preferences and hunter satisfaction (Minnesota DNR 2016).

The 2015-2017 Minnesota deer hunting survey was conducted to assess hunters' season participation and activities, deer population perceptions and preferences, satisfaction, attitudes about deer management, regulatory preferences, relationship with MNDNR, and involvement in agency decision-making. During this time, MNDNR was coordinating a public process to revisit deer population goals for most of the deer permit areas (DPAs) in the state and public attention to deer management was high. Survey timing after the 2014 and 2015 seasons was coincident with the 2 lowest annual harvests in over a decade, a management response to population declines following 2 consecutive years (2013 and 2014) of moderate-to-severe winter conditions.

OBJECTIVES

The purpose of this study was to gather information at levels that adequately represent regional stakeholder attitudes (e.g., northeastern Minnesota). Specific survey objectives were to:

1) Continue to assess hunter perspectives on regional deer population trends and management,
2) Evaluate support for potential regulatory changes commonly raised by stakeholders, as well as the influence of deer population management decisions on regulatory preferences, and,
3) Better understand stakeholder relationships with MNDNR and preferences for communication/input in agency decisions to improve engagement processes and hunter satisfaction.

METHODS

Sampling

The 2015-2017 deer management study was divided into 5 strata covering all but the southeastern and southwestern portions of the state (Figure 1). Deer hunter attitude surveys were previously conducted in southeastern (Pradhananga et al. 2013) and southwestern (D'Angelo & Grund 2014) Minnesota. For this study, surveys were sent to 25,319 hunters in 5 different regions between winter 2015 and spring 2017, reflecting hunters' experiences and opinions after the 2014, 2015, or 2016 deer seasons. Because this survey was coincident with the deer population goal setting process in parts of the state, survey blocks H1, H3 and H4 were further stratified by sub-regions; the goal setting process in H2 and H5 was already complete. The target response size for each sub-region was 900; in former goal setting blocks, the target response size was 1,200. For all surveys, our error rate at the survey block level was approximately +/-3%.

For each survey block, random samples were drawn from the MNDNR electronic licensing system (ELS), selecting for adult hunters that declared intent to hunt a deer permit area (DPA) within that region during the most recent deer season[1]. Within each survey block, hunters were randomly assigned to 10 subsample groups. Each subsample group received 1 of 10 survey versions; all surveys were identical except for the order and set of regulatory choice options which were unique to each of the 10 survey versions. This design provided the ability to conduct a discrete choice experiment within each of the survey blocks (Louviere, Hensher & Swait 2000).

Data Collection

Surveys were presented online or as a 12-page paper booklet, including a cover page with photo. Online and paper surveys presented the same series of questions, tailored to the survey block of interest. Each survey contained 2 sections; a section focused on deer population observations and preferences and a section focused more broadly on hunting regulations, involvement with hunting, hunter satisfaction, hunter relationships with MNDNR, preferences related to MNDNR management and decision-making, and hunter demographics.

Data were collected using a web-first, mixed mode design that included a combination of online and mail surveys following the process outlined by Dillman and others (Dillman, Smyth, & Christian, 2014). The first 2 waves of letters requested survey completion online through the

[1] At the time of license purchase, hunters 'declare' an area they intend to hunt. However, they are not legally required to stay in that area and although there is high site fidelity, some movement across the state occurs.

internet survey platform (Qualtrics, Provo, UT); each online survey code was unique and could be used only once. The third and fourth waves included a cover letter, a self-administered mail back survey booklet, and a business reply envelope. Because the fourth wave only increased the overall response rate by a small percent for surveys H1 – H4 (range = 8% - 9%), we opted to employ a 3-wave survey (i.e., 2 letters requesting online survey response followed by 1 mail-back paper survey booklet) for the H5 study area.

Contact letters were sent approximately 2 weeks apart; potential survey respondents were contacted up to 4 times between February and May of 2015 (H1 and H2), November 2015 and April 2016 (H3 and H4), or January and February 2017 (H5). Personalized cover letters explained the purpose of the study and made an appeal for respondents to complete the survey online; however, for survey recipients that do not have internet access, letters indicated that a paper survey would be mailed at a later date. Data were collected through July 2015 for the H1 and H2 surveys; through June 2016 for the H3 and H4 surveys; and through April 2017 for the H5 survey.

Discrete Choice Experiment

The survey also included a discrete choice experiment (DCE) designed to help MNDNR better understand individuals' preferences for different potential combinations of deer seasons and regulations in Minnesota. Discrete choice surveys present hypothetical scenarios and force respondents to choose an alternative among a suite of options (Adamowicz et al. 1994; Oh et al. 2005). By using an experimental design, scenarios selected by respondents can be used to identify the relative importance, or influence, of each attribute on regulatory and season combinations. In addition, by analyzing individuals' preferences for different levels of each attribute, we can estimate the utility, or relative desirability, of each level among respondents. The experiment in this survey focused on a combination of (1) management strategies that are often suggested by hunting stakeholders and (2) management designations that reflect both hunter opportunity and management toward a specific population goal. Survey respondents were presented with 8 deer season choice scenarios and asked to choose one option. Each scenario included 2 season structure choices plus a "none" (i.e., I would not hunt deer in Minnesota with these options).

Data Entry and Analysis

Online survey data were downloaded as .csv files using Qualtrics software (Qualtrics, 2015), converted to Excel 2013 spreadsheets, and provided the basic data entry template for hard-copy mail surveys. Data from mail surveys were manually entered in Excel 2013. A subsample of paper surveys (50 per survey) were double-entered to assess data entry error rates. Data entry error rates for each survey area ranged from 0.39% to 1.44%.

Basic descriptive summaries and statistical analyses were conducted using the Statistical Program for the Social Sciences (SPSS Statistics for Windows, version 24). Responses across survey blocks were compared using chi-squared tests and one-way analysis of variance (ANOVA). Independent samples t-tests or Mann-Whitney U tests were used to test differences in responses between groups. We measured effect size for chi-squared tests, ANOVA, and independent samples t-tests using Cramer's V, eta, and Cohen's *d*, respectively. Commonly accepted values (Cohen 1988, Vaske 2008) were used to interpret effect sizes as small, medium, and large (Cramer's $V \geq 0.1, 0.3, 0.5$; eta $\geq 0.1, 0.24, 0.37$; $d \geq 0.2, 0.5, 0.8$). The DCE portion of the survey was analyzed using Lighthouse Studio and hierarchical Bayes analysis.

State-level data were analyzed for all respondents, weighted by DPA to account for the proportion of hunters within the H1-H5 that purchased a 2014 license[2]. Region-level analyses were conducted by comparing responses across surveys and responses were similarly weighted by DPA to reflect the hunting population.

RESULTS

Overall, there were 973 undeliverable surveys; 10,894 completed hunter surveys were returned, yielding a 45% adjusted response rate (Table 1). Age and gender of non-responding survey recipients, from the MNDNR ELS, was compared with that of survey respondents to assess potential nonresponse bias. Median age of respondents was greater than that of non-respondents (52 versus 41) and Mann-Whitney U tests between these groups in each survey area indicate a substantial age difference (U = 1073047.5 – 4874450.0, Z = -14.388 – -20.450, $p < 0.001$, r = -0.238 – -0.265). No gender differences were detected.

Differences in attitudes and demographics between early respondents (mailing waves 1-3) and late respondents (mailing wave 4) were also explored to assess potential nonresponse bias. In general, no practical significance (effect size) was evident for most attitude responses. However, smaller proportions of late respondents in east central (H2) and northeastern (H3) Minnesota indicated preferences for population increases than did early respondents (V = 0.112 and 0.129, respectively). Median age of wave 4 respondents did not differ from earlier survey respondents.

Respondent Experience, Background, and Participation in Deer Hunting

On average, survey respondents were about 50 years old and nearly 90% of respondents were male. Most respondents (>60%) were not members of a hunting or conservation organization; reported membership was highest for local sporting clubs (14%) with smaller proportions of hunters indicating affiliation with organized deer hunting groups.

Respondents have hunted deer in Minnesota an average of 29 years overall and 20 years in the DPA they hunted most often. Almost all respondents (>98%) hunted during the previous deer season; less than 1% indicated they hadn't hunted during the three previous years. Overall, 98% of hunters in all survey areas hunted during the firearm season; far fewer hunters participated in the archery (17%) or muzzleloader (13%) seasons. Of the estimated days spent scouting and hunting, only days spent afield during the firearm season substantially differed across survey areas, likely a result of the 16-day firearm season in the 100-series zone (northeastern, north central, and east central Minnesota; Table 2). As expected, fidelity to deer permit area was high; most respondents (>90%) reported they hunt the same area every year. The percentage of time spent hunting private vs. public land varied considerably by public land availability (Table 3). Overall, more than half of hunters did at least some of their hunting on private land.

Respondents were asked to indicate agreement, on a scale of 1 ("strongly disagree") to 5 ("strongly agree"), with statements regarding their involvement (Kyle et al. 2007) with deer hunting in Minnesota (Table 4). Hunters indicated greatest agreement with items related to social relationships (e.g., opportunity to be with friends) and pleasure derived from the activity (e.g., one of the most enjoyable things I do). Notably, items associated with external perceptions (e.g., you can tell a lot about a person when you see them hunting) had some of the lowest levels of agreement. Similarly, respondents were also asked to rate, on a scale of 1 ("not at all") to 5 ("extremely"), the importance of experiences to their deer hunting satisfaction during the

[2] In Minnesota, hunters are required to designate the DPA they are most likely to hunt within during the hunting season; this information is used to estimate hunting pressure and can be assumed to reflect distribution of the hunting population.

previous deer season (Table 5). Factors respondents reported as most important to deer hunting satisfaction were also primarily experiential and social, including enjoying nature and the outdoors, hunting with family, enjoying a preferred pastime, being with hunting companions, and hunting with friends. Items associated with harvest success, and particularly buck harvest success, were rated among the least important.

Hunting techniques, personal harvest restrictions, and hunting approaches differed slightly across the areas. Most respondents reported using an elevated stand for hunting with smaller percentages of respondents indicating use of a ground stand, stalking, or participation in deer drives (Figure 2). Although a majority of hunters reported that they focus at least a portion of the firearm season on harvesting a large buck (44%) or any antlered buck (17%), most (83%) indicated they would shoot an antlerless deer if given the opportunity.

Population Trends and Perceptions about Deer Populations

A majority of hunters (67%) indicated there were fewer deer in the DPA they hunt most often than 5 years ago. Substantial differences in perceptions were observed among survey areas; in northeastern Minnesota, 82% of respondents indicated deer populations had declined whereas only 52% reported a decline in south central Minnesota. Statewide, 62% of respondents believed the population was too low. Again, differences were observed across all 5 regions. Respondents in northeastern Minnesota were most likely to indicate that populations were too low (80%) whereas nearly half of the respondents in south central and north central Minnesota reported that they felt the deer population had not changed (44% and 44% respectively) or was too high (5% and 4% respectively).

More than two-thirds of respondents wanted to see an increase in deer densities at some level (Figure 3). Across areas, preferences for future deer population management also varied depending on the type of land hunted, with greater proportions of hunters who primarily hunt public land supporting deer population increases (>80%) than those who primarily hunt private land (65% - 81%, depending on the type of land hunted).

Population Management Considerations

To better understand the factors hunters believe are most important to consider when setting deer population goals, MNDNR asked respondents to rate the importance of 12 items that would lead to management for either higher or lower deer populations (Figure 4). Respondents rated severe winter mortality, deer hunting heritage, and hunter satisfaction as the 3 most important items. Respondents were asked about their level of agreement with steps in setting deer population goals. On a scale of 1 (“strongly disagree”) to 5 (“strongly agree”), strongest agreement was with the importance of having decision makers explain the different options considered when deer population goals are set and why the final option was selected ($\bar{x}$ = 4.4), followed by opportunities for hunters and landowners to provide input ($\bar{x}$ = 4.3). With respect to input opportunities, more respondents felt it was important that hunters (93%) and landowners (91%) have opportunities to provide input regarding deer population goals than did those that felt it was important for Minnesotans, in general (67%), to have input opportunities. A majority of respondents also agreed that it is important to use the best available science (77%) and follow consistent decision-making procedures (73%). Less than half (48%) of hunters agreed that it is important to consider diverse interests in setting deer population goals.

Hunter Success and Satisfaction

Deer season regulations from 2014 to 2016 were conservative (i.e., designed to limit harvest and increase populations) in most deer permit areas statewide. As a result, harvest was biased toward legal bucks and antlerless permits were unavailable or limited in many areas. Roughly twice as

many hunters reported they killed and tagged a legal buck (22%) as compared to those who reported killing an antlerless deer (12%). Overall, 27% to 44% of hunters reported harvesting a deer for themselves or another hunter, depending on the survey area.

Reported hunter satisfaction with deer numbers and quality was low. When asked about current (2014, 2015, or 2016) deer numbers in the DPA they hunt, most respondents in northeastern (76%), east central (63%), and northwestern (53%) Minnesota reported they were dissatisfied; just under half of hunters in south central (46%) and north central (49%) Minnesota reported dissatisfaction. Similar to reports of satisfaction with deer numbers in DPAs, a majority of hunters in northeastern (69%) and east central (60%) Minnesota indicated dissatisfaction with the number of deer seen while hunting; smaller proportions of hunters in northwestern (47%), north central (42%), and south central (42%) Minnesota indicated dissatisfaction with the number of deer seen. While the importance of seeing a lot of bucks for personal hunting satisfaction received only moderate ratings ($\bar{x}$ = 3.0; on a scale of 1 to 5 where 3 = "somewhat important"), most hunters reported dissatisfaction with the number of legal bucks (55%) and reported satisfaction was negatively correlated with the relative importance individual hunters placed on seeing bucks (r = -0.157, p < .05). Statewide, more hunters reported dissatisfaction (53%) than satisfaction (29%) with the quality of legal bucks. Reported satisfaction with the number of antlerless deer varied across the state (X^2=572.652, p < 0.001, V = 0.116), with hunters indicating greater satisfaction in south central (56%), north central (54%), and northwestern (49%) Minnesota than those in northeastern (30%) or east central (40%) Minnesota. Contrary to responses regarding deer numbers and quality, a majority of hunters (71%) indicated satisfaction with their general deer hunting experience during the recent season and this didn't substantially differ by area (X^2=287.957, p < 0.001, V = 0.083).

Overall satisfaction with the most recent deer hunt, a rating that likely included aspects of the deer population (numbers and quality) and the individual experience, varied across survey areas (Table 6). Higher overall satisfaction levels were reported in northwestern, south central, and north central Minnesota than in northeastern or east central Minnesota. Of the hunters reporting overall satisfaction with their deer season, satisfaction ratings were significantly higher for those who reported killing a deer than for those who did not, and this trend was evident within all survey areas (Figure 5).

Regulatory Preferences for Deer Management

Hunters were asked about their preferences regarding the scale of regulation implementation, season options, and various potential regulatory changes. Across all survey areas, a preference for more local (DPA; 44%) or regional (zone; 40%), rather than statewide, application was evident. Regardless of survey area, a majority of hunters supported the establishment of a statewide youth season in mid-October (Figure 6). In contrast, hunter preference regarding firearm season length varied across survey areas (X^2=878.222, p < 0.001, V = 0.291), with the majority of hunters in northwestern (60%) and south central (58%) Minnesota indicating a preference for a 9-day season and hunters in northeastern (75%), east central (66%), and north central (58%) Minnesota indicating a preference for a 16-day season, consistent with the prevalent season length offered in the respective survey areas. Across all areas, hunters indicated general support for a regulation that would increase the proportion of antlered bucks in the deer permit area they hunted most often. Consistent with previous surveys of Minnesota deer hunters, support for specific regulatory alternatives was lower than that expressed for an unspecified regulation (Figure 7).

Discrete Choice Experiment: Regulatory Combinations

Alternative hunting season packages presented in the DCE consisted of 5 attributes concerning different potential combinations of deer seasons and regulations in Minnesota: (1) cross-tagging

of harvested deer, (2) whether or not antler point restrictions are in place, (3) timing of the firearm opener during or out of the rut, (4) deer population level, and (5) deer harvest limit. Across all survey areas, timing of the opener - either in early or in late November (in or out of the rut) - had the most influence on scenario choice followed closely by deer numbers in all but north central Minnesota (Table 7). The third most important attribute was cross-tagging in the majority of survey areas. Implementation of antler point restrictions had the least influence on scenario choice in northwestern and east central Minnesota whereas harvest limit was least important in northeastern, south central, and north central Minnesota.

Across all survey areas, a hunting opener in early November had the highest utility and was preferred over a late-November opener, legal cross-tagging for either sex was preferred over antlerless-only cross-tagging or no cross-tagging, no antler point restriction was preferred over an antler point restriction regulation, deer numbers higher than 2014-2016 levels were preferred over levels experienced during that time period or lower population levels, and, the preferred seasonal harvest (bag) limit was a 1-deer, either sex regulation (Hunter Choice) rather than a 1-deer limit with an antlerless lottery (Lottery) or a 2-deer limit (Managed) (Table 8).

Results of the DCE allow comparison of various regulatory packages via market simulation to estimate the proportion of respondents that would be expected to choose a particular scenario. For example, a simulation comparing a regulatory package representing existing regulatory structures with 2014-2016 population levels compared to similar packages with a higher deer population suggest that hunters would prefer scenarios with higher deer populations (68%) and, of those, most would prefer regulations requiring a 1-deer limit (40%). A second simulation was conducted to examine preferences related to 5 regulatory packages that could increase the proportion of antlered bucks in the population. In this simulation, the option describing existing regulations was preferred (31%). Notably, not hunting (13%) was predicted to be preferred over a package including a late-November hunt at 2014-2016 population levels (10%). If the same package were offered but with higher deer population levels, the existing regulations were predicted to receive an even greater share (33%) of hunter preference and a smaller percentage (9%) of hunters were predicted to indicate they would not hunt given the options provided.

Public Participation in Deer Management

With respect to statements about the approach MNDNR uses to set deer population goals (e.g., provides enough opportunities for input, provides adequate information), responses indicated neutral to slight disagreement across all areas. Statewide, the greatest proportion of respondents disagreed that MNDNR provides enough opportunities for hunters to provide input (40%) and do not trust MNDNR to establish appropriate deer goals (38%). Respondents were undecided – or not sure – about their level of agreement with most other statements related to agency decision making about deer population goals, including consideration of science (53%), consistency of decision-making processes (51%), input opportunities for Minnesotans (47%) and landowners (45%), explanation of decision alternatives (42%), and the adequacy of information provided by MNDNR (41%). Hunters were similarly undecided regarding their agreement with statements about the MNDNR approach to setting deer hunting rules, including opportunities for hunters to provide input (46%).

Overall, fewer respondents were neutral about their relationship and communication with MNDNR than they were with statements about agency decision-making procedures. Hunter agreement was neutral to negative regarding having adequate opportunities to communicate with MNDNR staff ($\bar{x}$ = 2.9; on a scale of 1 to 5 where 1 = “strongly disagree” and 5 = “strongly agree”). In contrast, hunter agreement was neutral to positive regarding knowing who to contact if they have questions or comments about deer management ($\bar{x}$ = 3.1).

Responses indicated greater ties to local conservation officers than with local wildlife managers or deer management staff (Figure 8). Across all areas, a majority of those familiar with their local area manager felt that they had adequate opportunities to communicate with MNDNR whereas only about a quarter of those who did not know their local area manager felt they had adequate opportunities to communicate with MNDNR (Table 9).

Hunters indicated a preference for direct rather than representative input to MNDNR, with preferences for online questionnaires (42%), written questionnaires (17%), and general public meetings (14%). The least preferred option to provide input was via advisory teams (3%), followed by informal communication (4%) and input through a representative organization (4%). Notably, providing no input (8%) rated higher than all but the top three options (Figure 9). Statewide, greater proportions of hunters over the age of 50 indicated a preference to provide input via general and issue-based public meetings (22%) and written questionnaires (19%) than younger hunters (16% and 12%, respectively), whereas a greater proportion of younger hunters reported a preference to provide input via online questionnaires (49% versus 33% for older hunters) (X^2=321.886, $p < 0.001$, $V = 0.178$).

Hunter agreement was neutral to negative with statements that MNDNR can be trusted to make decisions that are good for the resource ($\bar{x} = 3.0$), will be open and honest in the things they do and say ($\bar{x} = 2.9$), or will listen to the concerns of hunters ($\bar{x} = 2.9$). In contrast, hunter agreement was neutral to positive with statements that MNDNR will make decisions about deer management in a way that is fair ($\bar{x} = 3.1$) and that MNDNR has deer managers and biologists who are well trained for their jobs ($\bar{x} = 3.3$). Age was weakly but negatively correlated ($r = -0.052$, $p < .001$) with trust that MNDNR will establish appropriate deer population goals. Members of organized deer groups (MDHA, QDMA, MBI, and MWA[3]) also reported significantly lower levels of trust than those who were not members of an organized deer group ($\bar{x} = 2.6$ and 2.9, respectively; $t = 9.004$, $p <0.001$, $d = 0.429$).

DISCUSSION

Although differences were observed by region, the majority of hunters reported recent declines in deer populations, felt deer populations were too low, and desired management to increase deer densities in their area. Factors identified by hunters as most important to consider in setting population goals provide mixed direction for management because concerns about deer mortality would suggest management for lower populations whereas concerns about deer hunting heritage and hunter satisfaction might suggest management for higher populations. Most respondents also felt that hunter and landowner input, as well as the best available science, should be considered in setting deer population goals; however, less than half agreed it was important to consider diverse interests in setting goals. This finding is counter to the recommendation made by the Minnesota Office of the Legislative Auditor for MNDNR to enhance human dimension surveys in order to consider more diverse perspectives (Minnesota OLA 2016). Although the state manages wildlife for public benefit, broadly, continued tension relative to the weight given to various stakeholder perspectives should be anticipated.

Measures of hunter satisfaction can be difficult to interpret because a number of variables may influence a satisfaction rating (see also Cornicelli & McInenly 2016). Contributing factors include personal motivations and expectations (many of which are non-consumptive), the context of the experience, and harvest success. Notably, hunters in areas with the lowest estimated deer densities (D'Angelo & Giudice 2015) reported both the lowest (northeastern Minnesota) and

[3] MDHA = Minnesota Deer Hunters Association, QDMA = Quality Deer Management Association, MBI = Minnesota Bowhunters Inc., MWA = Minnesota Whitetail Alliance (Facebook group)

highest (south central Minnesota) levels of satisfaction with deer numbers. Of note, larger proportions of hunters in each survey area reported satisfaction with the number of deer *seen while hunting* than reported satisfaction with deer numbers *in the DPA they hunt most often*, suggesting greater satisfaction with deer numbers observed at more local levels. Contrary to responses regarding deer numbers and quality, a majority of hunters indicated satisfaction with their general deer hunting experience during the recent season, reinforcing earlier results that suggest non-consumptive motivations can have a greater influence on satisfaction with the deer hunting experience than do consumptive motivations.

Results from this survey suggest that hunters, for the most part, prefer current regulations over commonly suggested alternatives (e.g., prohibition of cross-tagging) and that hunting traditions (e.g., early November firearm opener and current season length) have an important influence on regulatory preferences. Notably, however, this is the first time MNDNR included a question about support for a statewide youth season. Results of this survey suggest further MNDNR consideration regarding establishment of a statewide youth season is warranted.

Market simulation results, based on the DCE, suggest that bag limit preferences are somewhat insensitive to population levels, i.e., the preference for a higher population is not driven by a desire to harvest more than deer based on current statewide hunter preferences. Additionally, simulation results suggest that, statewide, commonly proposed DNR regulatory packages that could increase the proportion of antlered bucks in the population are currently less attractive than existing DNR regulations even at higher population levels. Future work exploring the influence of hunter heterogeneity on preferences could refine these findings.

Finally, results related to public participation in deer management suggest that opportunities to enhance relationships between staff and hunters should be explored. Although >90% of respondents indicated it was important to provide opportunities for hunter input in decision making, nearly half were unsure about MNDNR decision-making processes and opportunities for input. Most hunters also reported that they have not communicated with or did not know area wildlife managers or deer management staff. Given reported preferences for direct, rather than representative, means to provide input, MNDNR could revisit current public engagement methods to enhance support for management.

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Table 1. Overall sample size, returns, adjusted response rates, and survey timing for Minnesota deer hunter surveys, 2015 - 2017. Youth respondents (reported ages <18 years) removed from analysis.

Survey block	Region	*N*	Undeliverable	Returned	Response	Survey timing
H1	Northwestern MN	7,801	333	3,095	41.4%	Spring 2015
H2	East Central MN	3,616	138	1,553	44.7%	Spring 2015
H3	Northeastern MN	5,202	222	2,544	51.1%	Fall/Winter 2015-16
H4	South Central MN	5,201	152	2,313	45.8%	Fall/Winter 2015-16
H5	North Central MN	3,499	128	1,389	41.2%	Fall/Winter 2016-17
Total		25,319	973	10,894	44.8%	

Table 2. Average number of days spent scouting or hunting reported by Minnesota deer hunters, 2015-2017, by season.

		Area								
Days scouting	*n*	1 (NW)	2 (EC)	3 (NE)	4 (SC)	5 (NC)	TOTAL	*F*	*p*	η^2
Archery	666	14.1	12.1	10.8	15.1	10.0	11.3	2.526	0.040	0.015
Firearm	3,870	5.5	7.0	7.7	7.3	6.1	6.4	3.617	0.006	0.004
Muzzleloader	14	8.0	7.2	5.9	7.8	4.7	6.1	1.028	0.392	0.008
Days hunting										
Archery	1,763	16.8	18.4	14.6	16.8	13.2	16.1	5.726	.000	0.013
Firearm	9,629	4.9	6.1	7.5	4.6	5.7	5.7	336.512	.000	0.123
Muzzleloader	1,368	5.8	6.2	5.8	6.3	6.1	6.0	1.301	.268	0.004

Table 3. Type of land hunted during most recent deer hunting season, reported by Minnesota deer hunters, 2015-2017.

Type of land hunted	Area						Significance	
	1 (NW)	2 (EC)	3 (NE)	4 (SC)	5 (NC)	TOTAL		
Private land that I own	None	36.0%	38.6%	40.8%	43.2%	40.7%	39.5%	χ^2=157.957*** V = 0.077
	Some	10.0%	10.5%	18.0%	10.7%	15.2%	13.0%	
	Most	18.8%	15.7%	17.2%	16.2%	15.7%	16.8%	
	All	35.1%	35.2%	24.0%	29.8%	28.4%	30.7%	
Private land that I lease for hunting	None	92.0%	94.6%	89.5%	91.1%	92.2%	92.0%	χ^2=26.472** V = 0.035
	Some	3.4%	2.7%	4.1%	3.8%	2.8%	3.4%	
	Most	2.2%	1.6%	2.8%	2.5%	2.6%	2.3%	
	All	2.4%	1.1%	3.6%	2.7%	2.3%	2.3%	
Private land that I do not own or lease	None	32.1%	35.9%	49.4%	20.2%	41.8%	37.0%	χ^2=541.189*** V = 0.143
	Some	18.4%	15.5%	21.5%	17.0%	19.1%	18.4%	
	Most	18.8%	14.7%	12.8%	22.1%	13.6%	16.0%	
	All	30.8%	33.9%	16.4%	40.7%	25.4%	28.6%	
Public land	None	59.0%	57.3%	22.8%	54.0%	28.5%	42.9%	χ^2=1398.245*** V = 0.235
	Some	29.2%	22.7%	27.5%	31.7%	25.3%	26.7%	
	Most	6.8%	9.0%	22.2%	7.9%	18.3%	13.7%	
	All	5.0%	11.0%	27.4%	6.4%	27.9%	16.6%	

*** p < 0.01, **** p < 0.001*

Table 4. Involvement in deer hunting in Minnesota Level of agreement, reported by Minnesota deer hunters, 2015-2017.

Statement	*n*	Mean[1]
Deer hunting provides me with the opportunity to be with friends	10415	4.3
Deer hunting is one of the most enjoyable things I do	10441	4.3
I enjoy discussing deer hunting with my friends	10395	4.3
I contribute to deer management through hunting	10405	4.2
Deer hunting is very important to me	10413	4.1
To change my preference from deer hunting to another activity would require major thinking	10419	4.0
Deer hunting is one of the most satisfying thing I do	10421	3.9
I can really be by myself	10413	3.8
I identify with people and images associated with deer hunting	10409	3.8
When I am deer hunting, others see me the way I want them to see me	10411	3.8
Most of my friends are in some way connected with deer hunting	10425	3.7
Participating in deer hunting says a lot about who I am	10405	3.6
You can tell a lot about a person when you see them deer hunting	10392	3.5
When I am deer hunting, I don't have to be concerned about what other people think of me	10409	3.4
Deer hunting has a central role in my life	10392	3.4
A lot of my life is organized around deer hunting	10436	3.4

[1] *Mean is based on the scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4= agree, 5 = strongly agree.*
Note: Means reflect weighted averages for a statewide response.

Table 5. Average importance rating of experiences to deer hunting satisfaction during the recent hunting season, reported by Minnesota deer hunters, 2015-2017.

Experience	*n*	Mean[1]
Enjoying nature and the outdoors	10308	4.5
Hunting with family	10307	4.2
Enjoying a preferred pastime	10300	4.1
Being with hunting companions	10353	3.9
Hunting with friends	10326	3.9
Seeing a lot of deer	10309	3.6
Becoming a better deer hunter	10340	3.5
Improving my knowledge	10309	3.4
Helping manage deer populations	10291	3.4
Developing skills and abilities	10341	3.3
Harvesting at least one deer	10287	3.2
Getting food for my family	10331	3.1
Proving my hunting skills and knowledge	10272	3.0
Challenges of harvesting a trophy	10296	3.0
Seeing a lot bucks	10298	3.0
Harvesting any deer for meat	10305	2.9
Influencing deer sex ratios or age structure	10265	2.9
Harvesting a large buck	10277	2.7
Harvesting any buck	10295	2.5
Selectively harvesting a large buck	10300	2.5
Getting a buck every year	10305	1.9

[1] *Mean is based on the scale: 1 = not at all important, 2 = slightly important, 3 = somewhat important, 4= very important, 5 = extremely important. Note: Means reflect weighted averages for a statewide response.*

Table 6. Overall satisfaction with most recent deer hunt, reported by Minnesota deer hunters, 2015-2017.

Area	*n*	Year	Very dissatisfied	Slightly dissatisfied	Neither	Slightly satisfied	Very satisfied	Mean[1]
1 (NW)	2919	2014	13.2%	23.3%	14.9%	28.4%	20.3%	3.2
2 (EC)	1455	2014	18.9%	28.0%	13.5%	26.6%	12.9%	2.9
3 (NE)	2416	2015	20.8%	28.1%	13.7%	25.3%	12.1%	2.8
4 (SC)	2222	2015	10.1%	21.8%	13.3%	33.4%	21.3%	3.3
5 (NC)	1322	2016	10.0%	19.6%	13.8%	32.7%	23.9%	3.4
TOTAL	10302		15.2%	24.5%	13.9%	28.8%	17.7%	3.1
					χ2=330.621***			F=81.621***
					V = 0.089			η^2 = 0.031

*Mean is based on the scale: 1 = very dissatisfied, 2 = slightly dissatisfied, 3 = neither dissatisfied nor satisfied, 4 = slightly satisfied, 5 = very satisfied. *** p < 0.001*

Table 7. Relative importance of season choice attributes derived from hierarchical Bayes estimation of utilities of Minnesota deer hunters surveyed 2015-2017.

	Importances (SD)					
	NW	EC	NE	SC	NC	Statewide
Season choice attribute	*n = 1,234*	*n = 958*	*n = 1,098*	*n = 1,597*	*n = 869*	*n = 2,757*
Cross-tagging	18.7 (9.4)	19.0 (9.7)	15.1 (8.4)	19.1 (11.1)	21.9 (10.6)	18.5 (9.8)
Antler Point Restrictions	15.7 (10.9)	15.1 (10.3)	15.8 (11.0)	18.6 (13.0)	15.6 (11.2)	15.9 (11.1)
Timing of opener	26.5 (14.9)	26.5 (14.5)	30.2 (15.4)	25.0 (15.5)	27.8 (15.1)	28.0 (15.6)
Deer numbers	22.0 (12.3)	23.2 (11.9)	25.0 (14.1)	22.1 (12.5)	21.0 (13.2)	22.0 (13.1)
Harvest limit	17.1 (10.9)	16.3 (9.9)	13.9 (9.0)	15.2 (9.4)	13.6 (9.4)	15.5 (10.3)

Table 8. Statewide results of the hierarchical Bayes model for regulatory choice for Minnesota deer hunters showing utilities of different levels of season attributes of Minnesota deer hunters surveyed 2015-2017.

Choice attribute - level	Average utilities	*SD*
Cross-tagging		
- Cross-tagging legal for antlerless only	8.4	21.1
- Cross-tagging illegal for both sexes	-40.8	39.8
- *Cross-tagging legal for either sex*	32.3	33.9
Antler Point Restrictions		
- *No antler point restrictions*	17.4	45.3
- Antler point restrictions	-17.4	45.3
Timing of opener		
- *Early November*	59.2	54.1
- Late November	-59.2	54.1
Deer numbers		
- Deer numbers lower than current levels	-55.7	40.2
- Deer numbers at current levels	11.3	14.1
- *Deer numbers higher than current levels*	44.5	39.1
Harvest limits		
- One deer limit, antlerless by permit only (lottery)	-14.0	35.9
- *One deer limit, either sex (hunter choice)*	23.8	26.3
- Two deer limit (managed)	-9.8	43.5
None	-99.9	219.3

Notes: n=2,757, attribute level with highest utility italicized

Table 9. Agreement with statement… I have adequate opportunities to communicate with MNDNR, based on reported familiarity with area wildlife manager, from Minnesota deer hunters surveyed 2015-2017.

Know area manager	n	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Significance	Effect size
				Area 1 (NW)				
No	2585	8.5%	30.3%	36.6%	22.9%	1.7%	$\chi 2$=170.144***	V = 0.242
Yes	317	2.5%	17.4%	22.1%	50.5%	7.6%		
				Area 2 (EC)				
No	1319	8.3%	26.2%	38.4%	25.6%	1.4%	$\chi 2$=73.278***	V = 0.225
Yes	124	8.9%	11.3%	19.4%	53.2%	7.3%		
				Area 3 (NE)				
No	2196	8.5%	27.6%	38.9%	24.2%	0.8%	$\chi 2$=203.866***	V = 0.291
Yes	208	3.4%	19.7%	16.3%	49.5%	11.1%		
				Area 4 (SC)				
No	1994	8.2%	25.7%	40.1%	24.4%	1.5%	$\chi 2$=176.833***	V = 0.284
Yes	198	3.0%	11.1%	19.2%	55.6%	11.1%		
				Area 5 (NC)				
No	1168	6.4%	24.7%	40.8%	25.9%	2.1%	$\chi 2$=90.438***	V = 0.264
Yes	132	3.8%	10.6%	20.5%	53.8%	11.4%		
				STATE				
No	9237	8.0%	27.1%	38.7%	24.7%	1.5%	$\chi 2$=638.559***	V = 0.250
Yes	973	4.3%	14.5%	19.8%	52.0%	9.4%		

*** $p< 0.001$

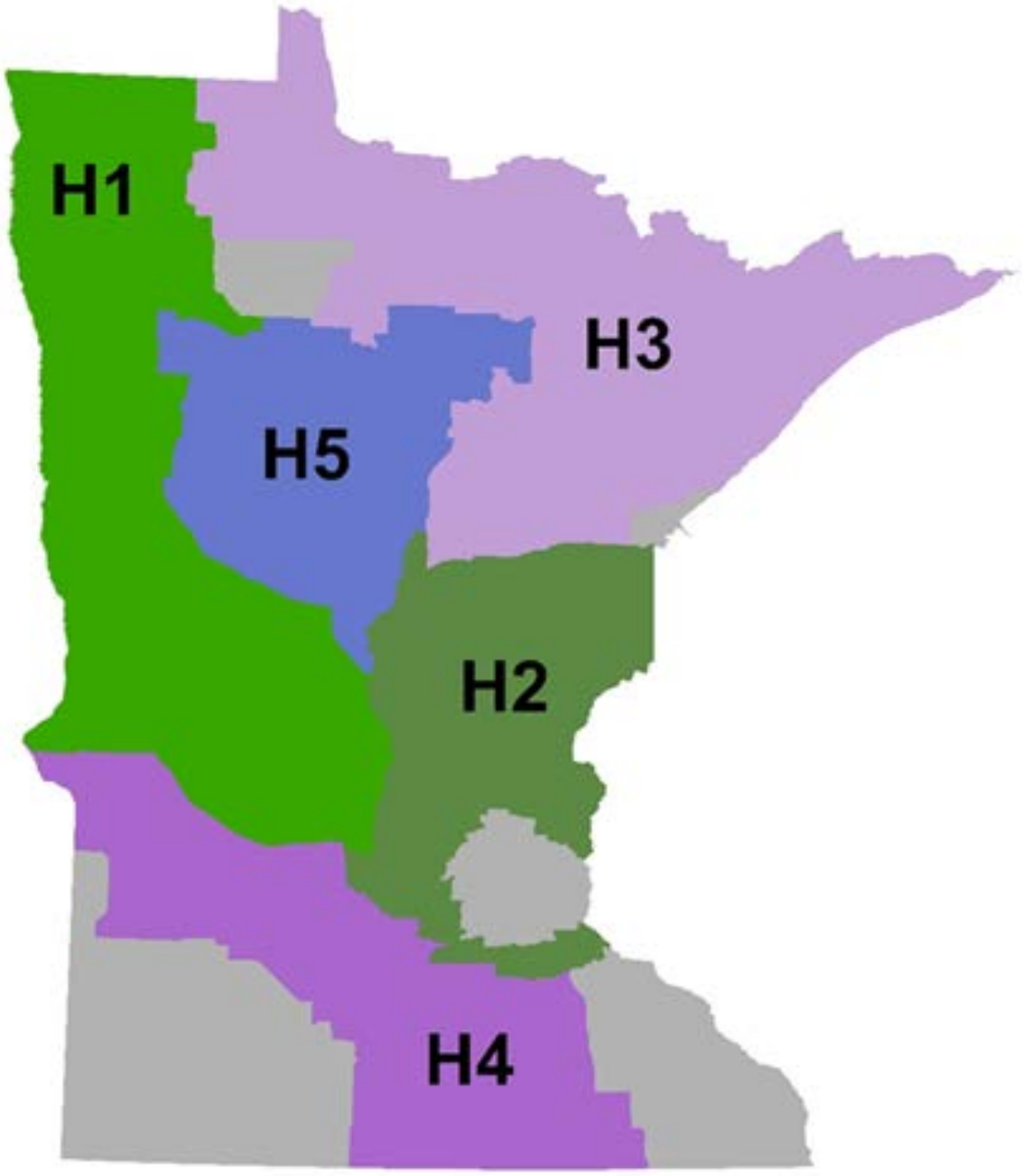


Figure 1. Hunting regions (survey blocks) surveyed by Minnesota Department of Natural Resources between 2015 and 2017 to evaluate hunter preferences for managing white-tailed deer in the region.

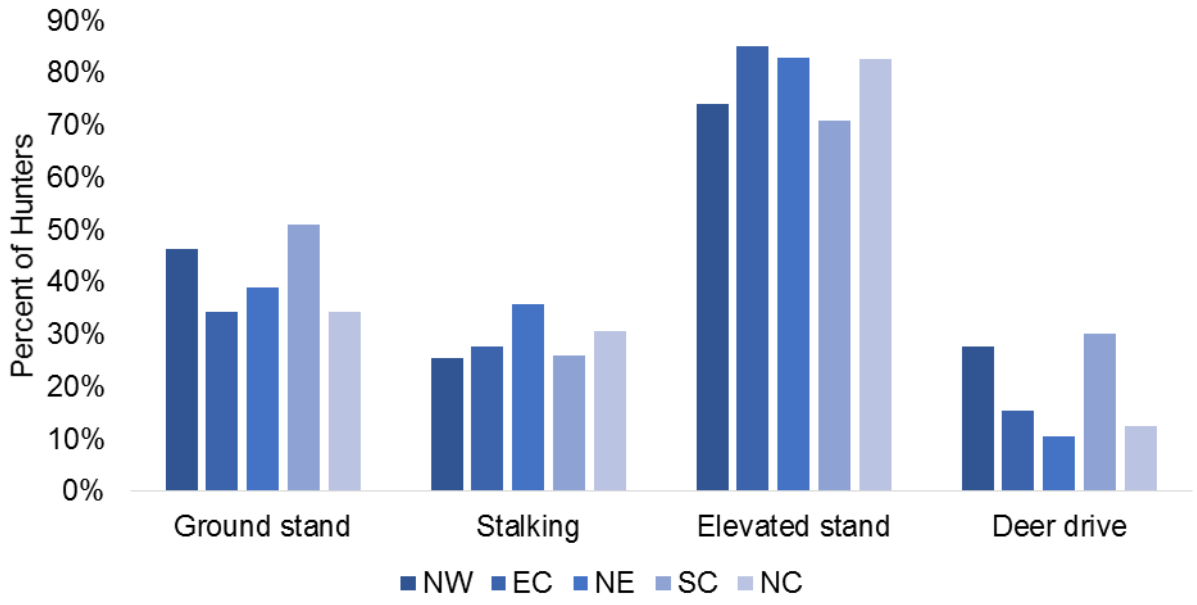


Figure 2. Hunting techniques used during most recent year hunted, by Minnesota deer hunter survey area, 2015-2017.

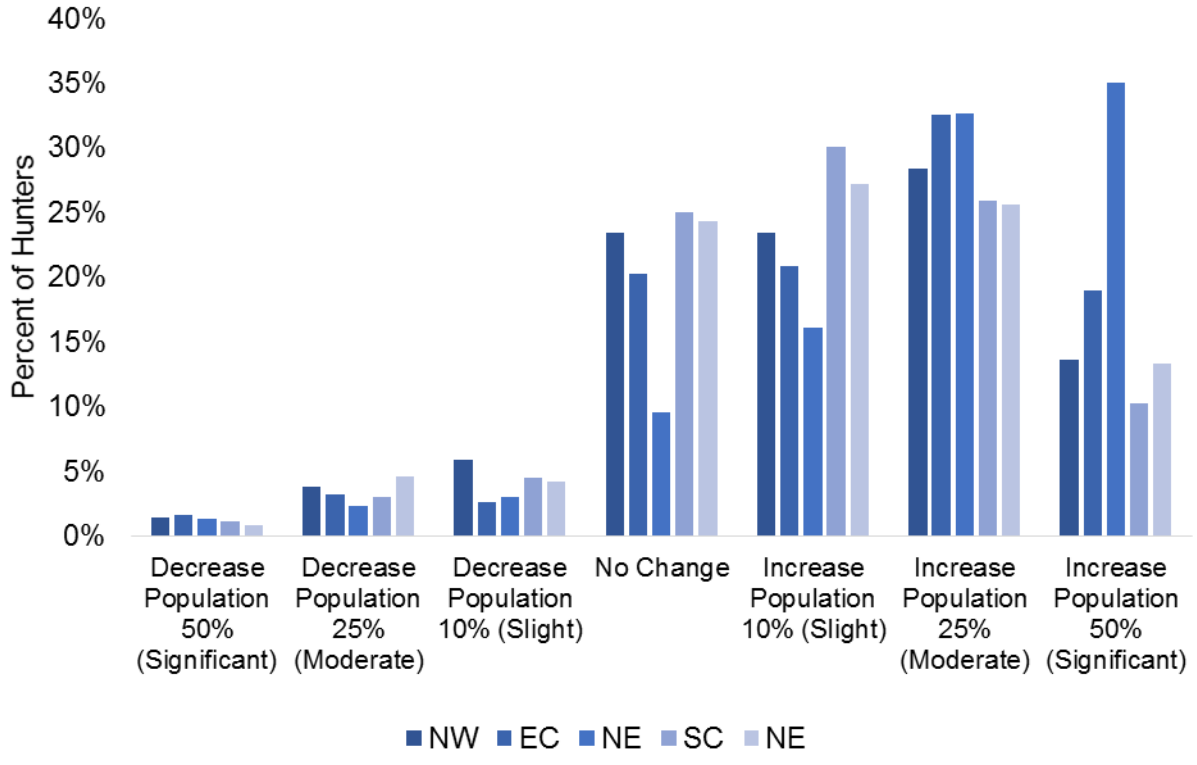


Figure 3. Future Minnesota deer management preferences, relative to 2014, 2015, or 2016 levels, by area.

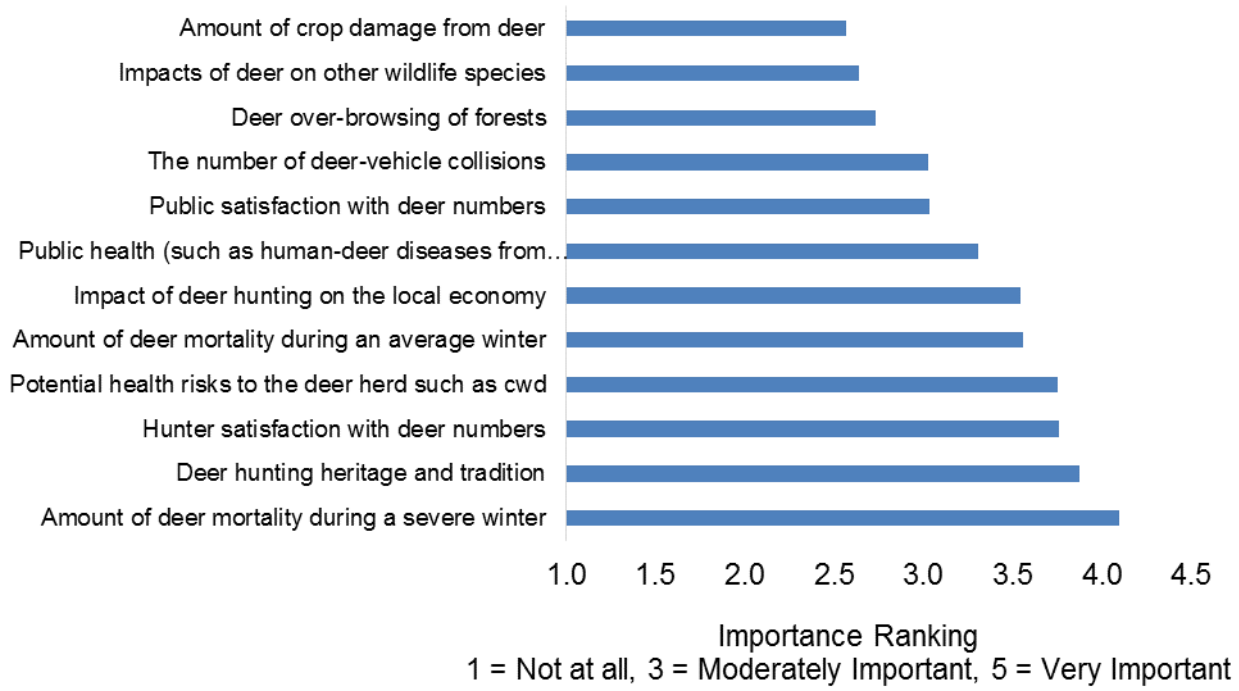
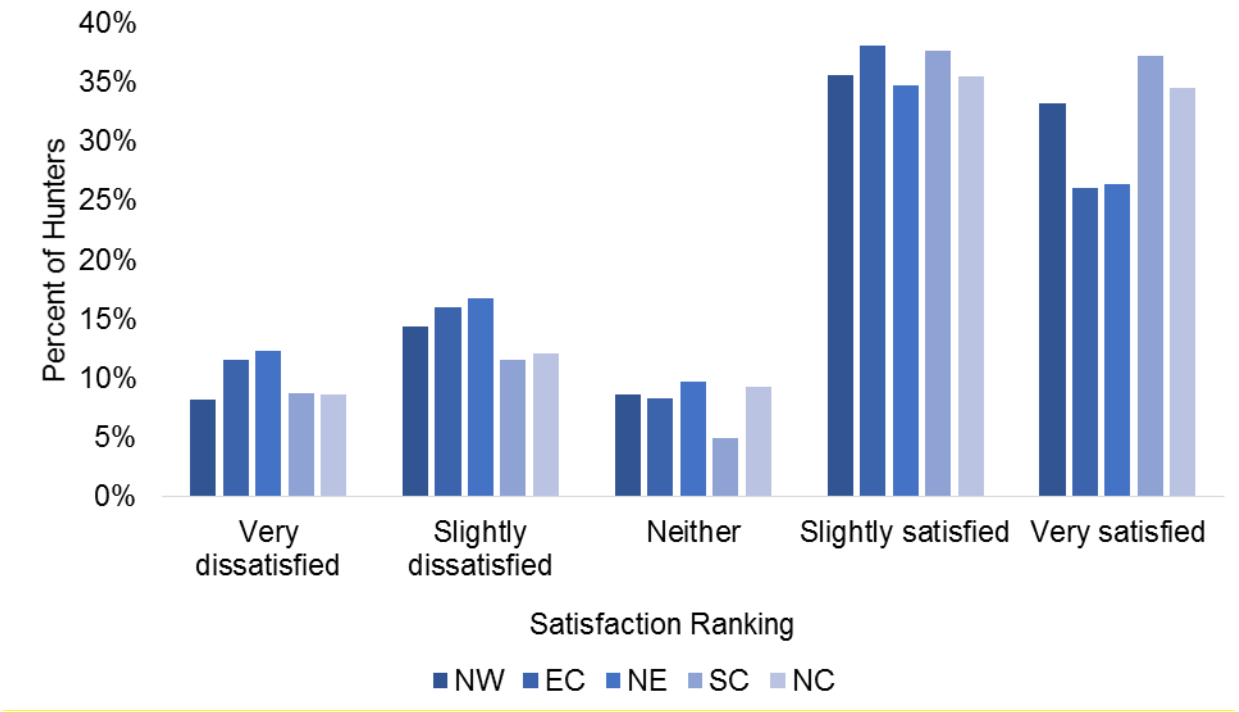
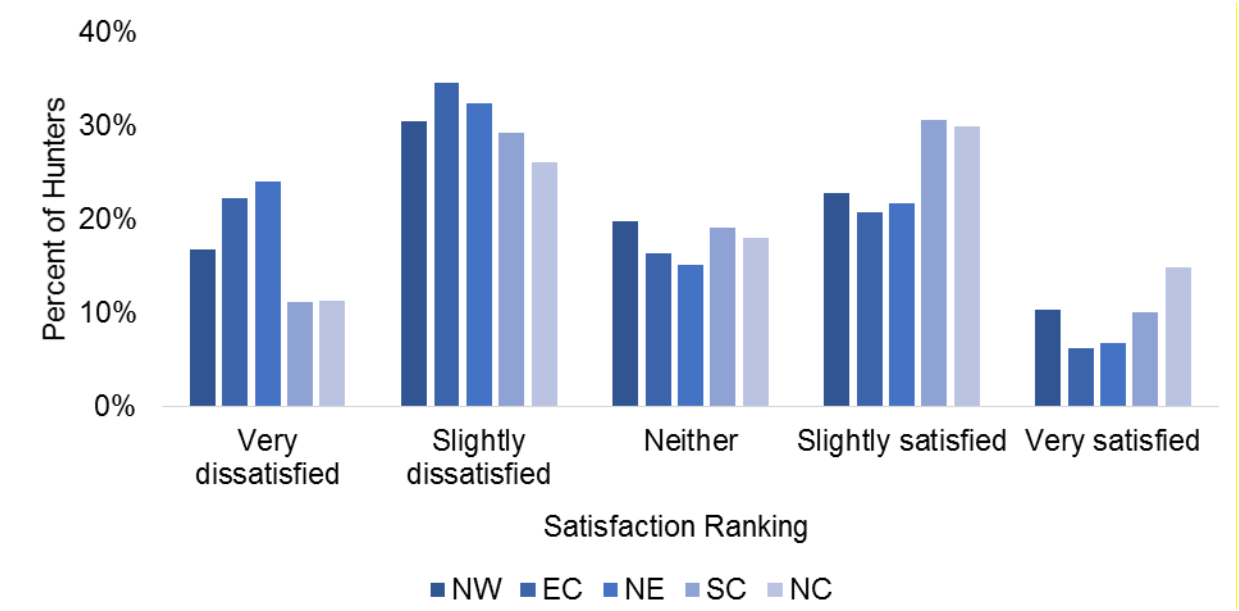


Figure 4. Mean hunter rankings for factors to consider when setting Minnesota deer population goals, 2015-2017. Means reflect weighted averages for all deer permit areas.



(a) Killed a deer for myself or another



(b) Did not kill a deer

Figure 5. Overall Minnesota deer hunt satisfaction based on harvest success, by survey area, 2015-2017. Responses reflect satisfaction ratings from hunters who killed (a) or did not kill (b) a deer during the most recent deer season.

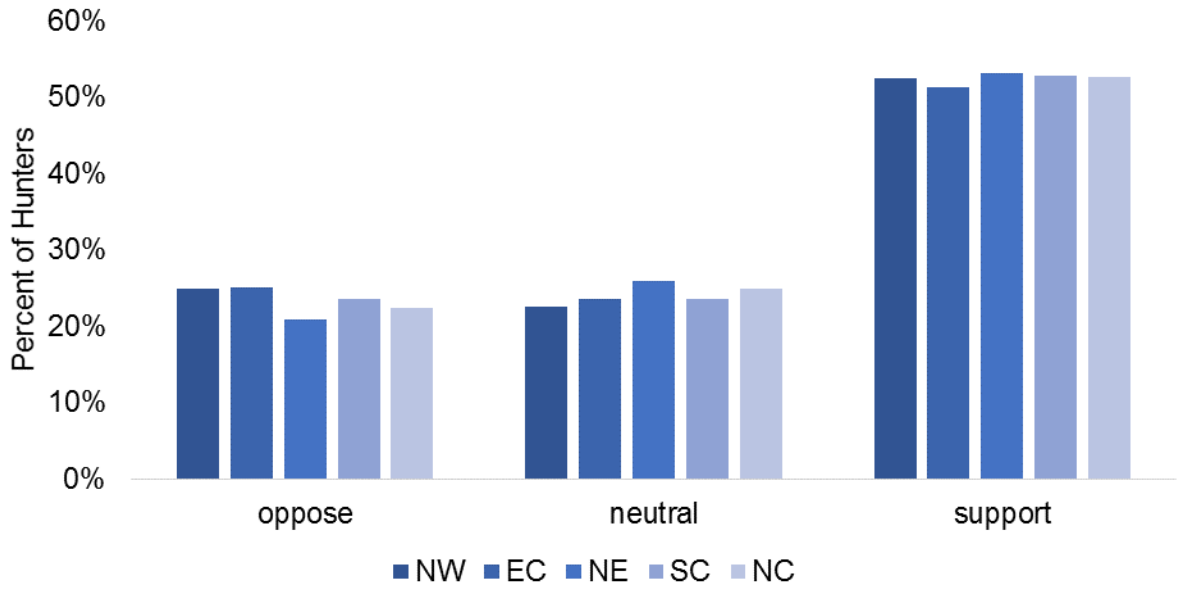


Figure 6. Support for a Minnesota statewide youth season in mid-October, by area, 2015-2017.

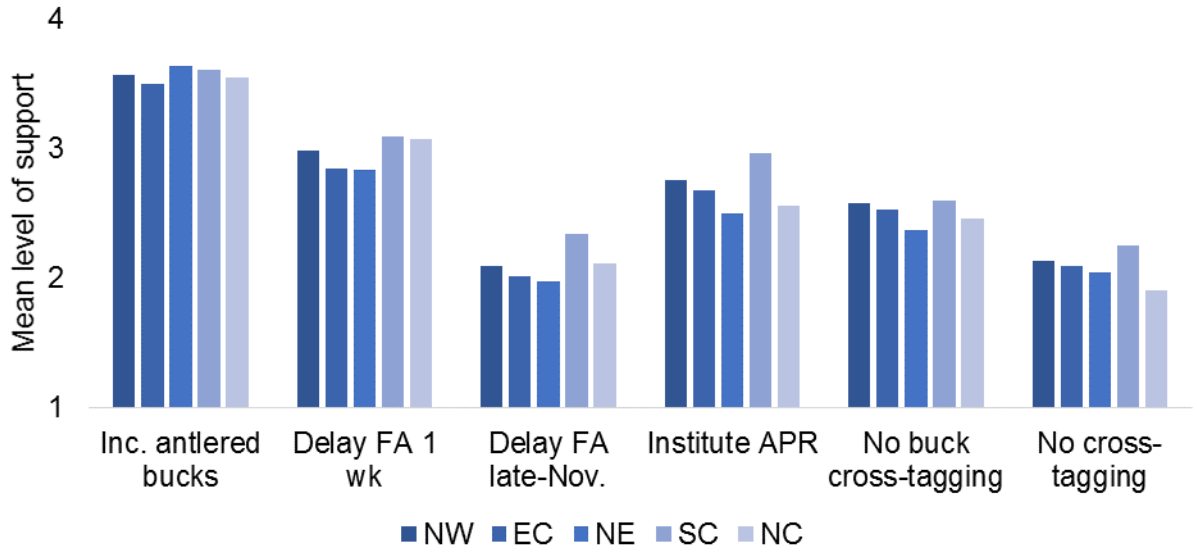


Figure 7. Support for specific Minnesota regulatory alternatives, by area, 2015-2017. Mean is based on the scale: 1 = strongly oppose, 2 = slightly oppose, 3 = neither, 4 = slightly support, 5 = strongly support.

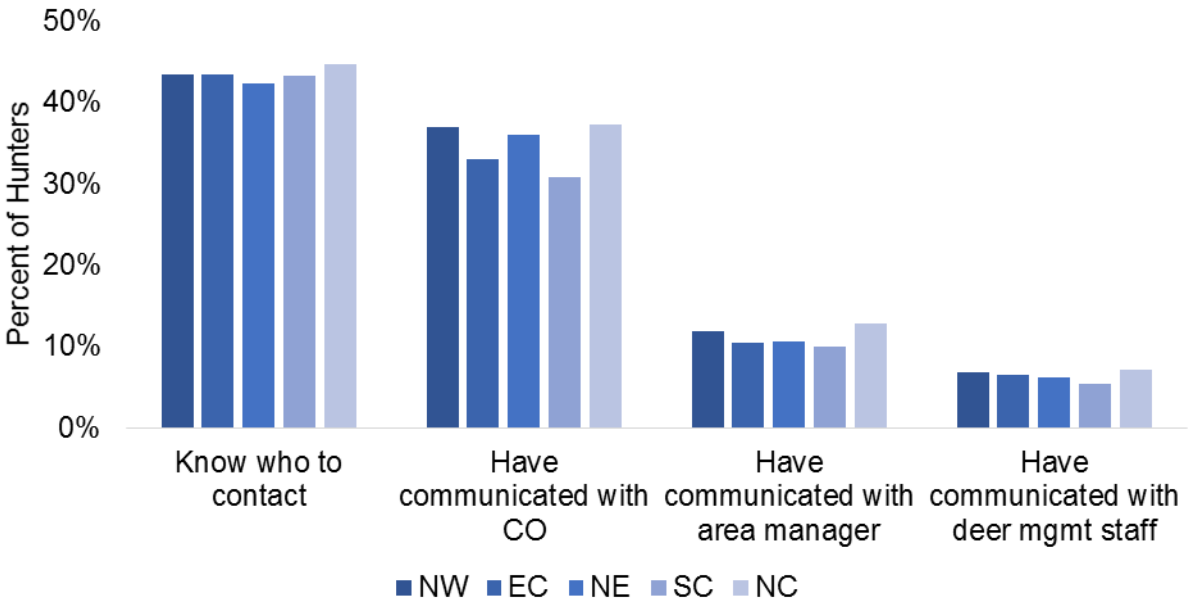


Figure 8. Communication with MNDNR as it relates to deer management, from a survey of Minnesota deer hunters, 2015-2017.

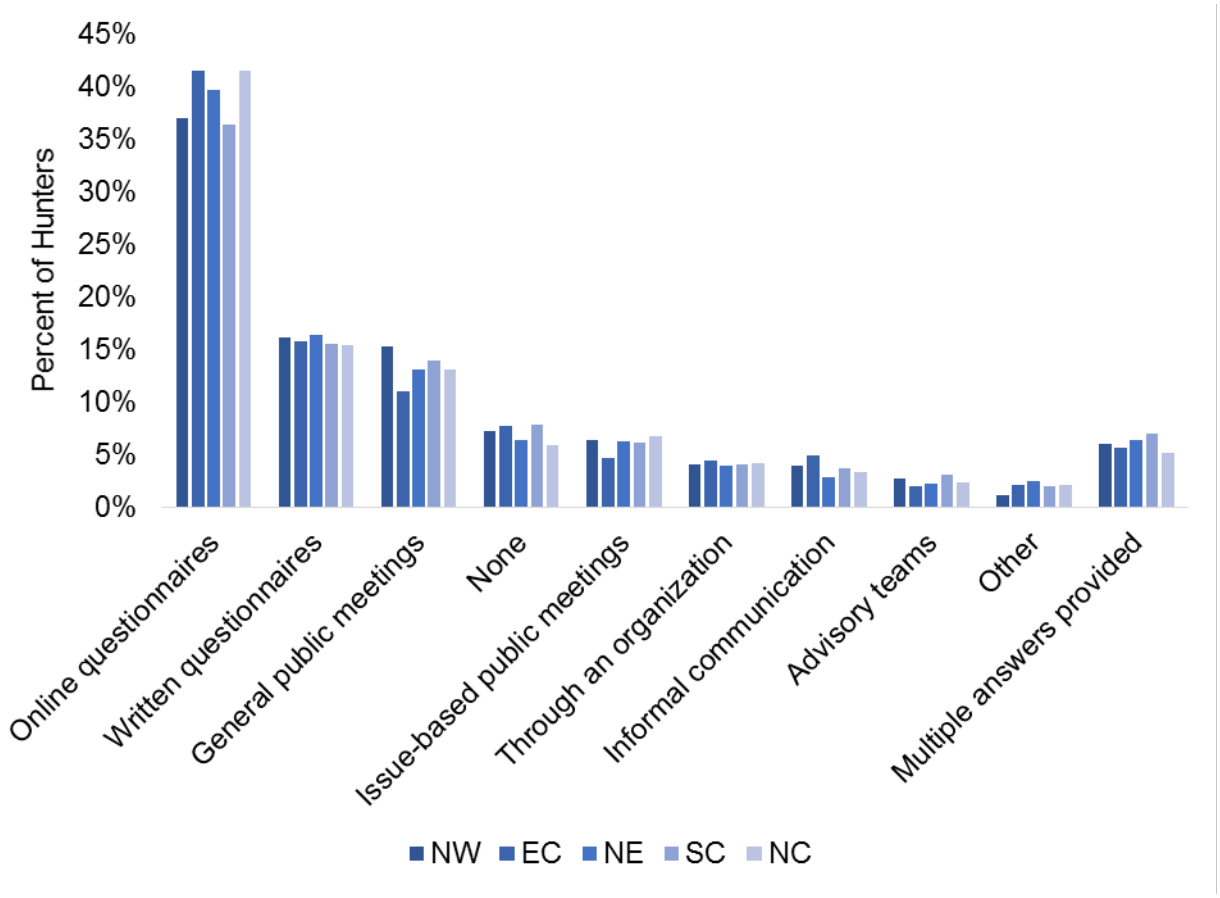


Figure 9. Preferred means to provide input to MNDNR, from a survey of Minnesota deer hunters, 2015-2017.