Motivations and satisfaction of North Dakota deer hunters during a temporal decline in deer populations

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Abstract: Achieving state wildlife agency biological goals for deer (*Odocoileus* spp.*)* management may often conflict with hunter desires. Concomitantly, better information is needed to optimize agency deer herd management goals with hunters' social goals. In 2016, we surveyed 3,000 North Dakota, USA, resident deer hunters using a self-administered mail survey to gain a better understanding of motivations, satisfaction, and hunter demographics that may be used to inform hunter recruitment and retention (HRR) efforts during a period of reduced statewide deer populations. With deer-gun license availability strictly limited, we explored the possibility that some gun hunters may have been engaging in archery deer hunting as a substitute activity. We also explored motivations for deer hunting in North Dakota by segregating respondents into *n* = 2 groups: those who preferred deer hunting with a gun vs. those who preferred archery equipment. We then compared ratings of 8 hunting motivations (meat, trophy, nature, excitement, social, skills, challenge, and solitude) by preferred hunting implement and gender differences. We further defined primary motivation by their selection of the most important motivation for participation in North Dakota deer hunting. A majority (58%) of archery hunter applicants preferred to hunt deer with a gun; 42% preferred a bow. Respondents who preferred hunting with archery equipment were slightly more motivated by nature aspects of the hunt whereas those who preferred hunting with a gun placed slightly more value on social aspects. Among motivation ratings, social was rated similarly by females and males, and females rated meat as significantly more important for hunting deer. We used logistic regression to test for differences in satisfaction in relation to deer hunter attributes; probability of satisfaction increased with harvest success, preference for hunting with archery equipment, and nature and social motivations for hunting. A proportion of deer-gun hunters who were restricted by lower license availability via lottery may have turned to archery deer hunting as an alternative. Therefore, typical HRR messages aimed at archery hunters (e.g., nature, challenge) may not resonate as well with North Dakota archery deer license applicants who appeared to be less challenge-oriented than socially-oriented.

Key words: archery, deer, hunter, motivations, North Dakota, *Odocoileus* spp., satisfaction, survey

Despite relatively high public acceptance of hunting (Duda et al. 2010, Ryan and Shaw 2011, Decker et al. 2015, Byrd et al. 2017), the total number of licensed hunters in the United States has been in decline. For example, from 2011 to 2016, overall hunting participation and number of big game hunters aged 16 years and older decreased by approximately 16% and 20%, respectively (U.S. Department of the Interior and U.S. Department of Commerce 2018). Such decreases in hunter participation are concerning for state wildlife agencies that largely depend on hunters for financial support through federal taxes on arms and ammunition and hunting license sales to effectively manage wildlife populations (Organ et al. 2012, Winkler and Warnke 2012). Others have raised concerns over reduced ability to control free-ranging ungulate populations and associated human–wildlife conflicts (Bissonette et al. 2008, Williams et al. 2013, Kilpatrick et al. 2014, Boulanger and Curtis 2016), negative impacts to natural ecosystems (Waller and Alverson 1997, Côté et al. 2004, Jenkins et al.

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2014), and diminished hunting culture in rural areas (Larson et al. 2013). Decreased hunting participation prompted hunter recruitment and retention (HRR) related research to investigate why people hunt and strategies for reversing this downward trend (Enck et al. 2000, Boxall et al. 2001, Adams et al. 2004, Larson et al. 2014). In addition, natural resource agencies and nongovernmental organizations responded by increasing recruitment, retention, and reactivation, or R3, outreach programming (Council to Advance Hunting and the Shooting Sports 2017). In recent years, some scholarly efforts focused on emerging groups within the hunting population, such as nontraditional-path hunters (Tidball et al. 2014, Quartuch et al. 2017, Stedman et al. 2017), female hunters (McFarlane et al. 2003, Metcalf et al. 2015, George 2016, Gigliotti and Metcalf 2016), and other demographic groups (Byrne et al. 2017). Although females comprise approximately 50% of the human population, they represent 10% of hunters nationwide (U.S. Department of the Interior and U.S. Department of Commerce 2018), and information on female hunters remains sparse (Heberlein et al. 2008, Metcalf et al. 2015, George 2016, Gigliotti and Metcalf 2016).

Another group that warrants consideration for HRR efforts is archery hunters, who comprise 32% of hunters nationwide (U.S. Department of the Interior and U.S. Department of Commerce 2018), and who overwhelmingly pursue deer (*Odocoileus* spp.) as their preferred game species (Responsive Management 2017). The number of archery hunters had been increasing since the 1970s (Gladfelter et al. 1983), but in recent years, appears to have stabilized (Responsive Management 2016). Hypothesized reasons for the historical increase in archery hunters include liberal archery deer seasons (e.g., longer seasons, ability to hunt earlier in the year in warmer temperatures, ability to harvest a deer of either sex), a more private experience with fewer hunters, and quiet and improved technology that make shooting bows easier than traditional recurve or longbows (Kurzejeski et al. 1999). Archery hunters are avid in that a large proportion (75%) participate in bowhunting each year (Responsive Management 2017) and are more specialized in their sport compared to gun hunters. Bryan

(1977) introduced the concept of recreation specialization, which comprises a continuum from general to specific, with specialization defined by equipment used, skills, technique, and preference for setting. When compared to gun hunting, archery hunting success often requires more extensive shooting practice, greater time invested in scouting for deer, and mastery of equipment (Miller and Graefe 2000). However, a large majority of archery deer hunters also hunt with firearms (Duda and Bissell 2001, Responsive Management 2017), which has implications for HRR efforts. Duda and Bissell (2001) suggest that archery HRR efforts should focus on increasing activity of current bowhunters, enticing inactive bowhunters to return to a more active status, and inducing more gun hunters to take up archery hunting (Duda and Bissell 2001). However, HRR efforts geared toward deer hunters may be problematic for managers when deer populations and available deer licenses are limited. Human dimensions information on archery hunters is generally lacking (Kurzejeski et al. 1999), but some research has addressed motivations and satisfaction of bowhunters at the national (Duda et al. 2000), state (Boulanger et al. 2002), and urban community (Weckel et al. 2011) levels.

Increased understanding of hunter motivations is a critical step to maximize hunter experiences and provide opportunities, such as HRR programs, that cater to multiple segments of the hunting population (Decker and Connelly 1989, Connelly et al. 1996, Henderson 1996, McFarlane et al. 2003, Gigliotti and Metcalf 2016). Motivations related to hunting may vary according to type of hunting, location, time period, or gender, and these differences would suggest that outreach communications and hunting opportunities that resonate well with some segments of hunters may not be well-received by others (Jackson et al. 1989, Decker et al. 2006, Gigliotti and Metcalf 2016). Decker and Connelly (1989) suggested that specific reasons for recreational hunting is related to 3 primary motivational orientations of hunters: achievement (meeting a standard of importance such as getting shots or harvesting deer), affiliative (companionship with friends and family), and appreciative (appreciation of the outdoors). Some resource managers may

still operate under the traditional notion that harvest success and satisfaction are equivalent (Gigliotti 2000), but human dimensions research has repeatedly demonstrated that hunters glean satisfaction from multiple motivations in addition to harvesting game, such as enjoying nature, social encounters, challenge, and other aspects of the hunt (Hendee 1974, McCullough and Carmen 1982, Vaske et al. 1986, Hammitt et al. 1990). In a review of hunter motivations, Woods and Kerr (2010) found that nature (e.g., valuing being in the outdoors and the beauty of nature), social (e.g., valuing time spent with friends and family), excitement, and meat acquisition ranked highest. There is evidence to suggest that men and women may have different motivations for hunting, with women preferring to hunt to obtain meat and men tending to hunt for more sporting reasons (Duda 2001, Gigliotti and Metcalf 2016). Top motivations for engaging in archery deer hunting have been described as enjoying nature and challenge aspects of the hunt (Duda et al. 2000, Boulanger et al. 2002). Archery hunters have also been described as being less socially motivated than other hunters (Duda and Bissell 2001).

Deer populations may be perceived as having positive or negative effects on people. Effects may include satisfaction or dissatisfaction with deer-related recreation, disease, vehicle collisions, or damage to property, agriculture, and biodiversity (Campa et al. 2011, Conover 2011). Studies of satisfaction are popular among resource managers because results can inform improvement of hunting experiences (Metcalf et al. 2015). These studies suggest a positive relationship between seeing or encountering deer and hunter satisfaction, providing evidence that seeing deer is highly valued by hunters (Decker et al. 1980, McCullough and Carmen 1982, Enck and Brown 2008, Schroeder et al. 2014). At lower deer densities, however, declining deer sightings per unit of hunter effort may result in higher hunter dissatisfaction and a disincentive for continued hunter participation (Heberlein and Kuentzel 2002, Van Deelen and Etter 2003). Hunting success (i.e., harvest) is also a strong predictor of hunter satisfaction among studies (Stankey et al. 1973, Langenau 1981, Gigliotti 2000, Pang 2017). Thus, it likely remains important to maintain some probability of viewing and harvest success to retain some

degree of hunter satisfaction. These tasks may be difficult for resource managers who must balance hunter and other stakeholder preferences for opportunities against landowner tolerance (e.g., depredation on livestock feed) and capability of the resources to sustain viable populations while benefitting ecosystems (Manfredo et al. 2004).

Background of deer hunting in North Dakota

In recent years, white-tailed deer (*O. virginianus*) and mule deer (*O. hemionis*) populations in nearly all areas of North Dakota had been declining due to efforts by the North Dakota Game and Fish (NDGF) department to control deer depredation on livestock feed by dramatically increasing the number of available antlerless deer-gun licenses, and this was compounded by 3 consecutive severe winters (2008–2010; Stillings et al. 2013). Concomitantly, habitat loss due to shelterbelt (Burke 2016) and Conservation Reserve Program (Stillings et al. 2016, Otto et al. 2018) removal and land fragmentation due to energy development (Kolar et al. 2017) may have negatively affected some North Dakota deer populations. Sporadic epizootic hemorrhagic disease outbreaks also contributed to reduced deer numbers in some parts of the state (Kreil 2013, Pybus et al. 2014). In response to decreased deer populations, NDGF reduced the number of statewide resident lottery deer-gun licenses by 71% between the peak of license availability in 2008 to 2015, preventing many deer-gun hunters from drawing an annual license (Stillings et al. 2013, 2016).

The popularity of archery deer hunting had increased in North Dakota since the 1960s, with the number of archery deer licenses sold doubling between 2000 and 2015 (23,710 resident archery deer licenses sold in 2015; Stillings et al. 2016). Although not everyone who buys a hunting license participates in hunting during that season, participation rates among North Dakota archery deer hunters had been relatively high (89%; Taylor et al. 2013). Archery deer hunting provided an additional recreational opportunity beyond the regular firearms deer season in North Dakota; unlike deer-gun and muzzleloader licenses, archery deer licenses were not limited by lottery. The North Dakota deer archery season was

relatively long, generally lasting from late August or early September through the first week of January, and hunters were allowed to take a single deer of any age or sex in any area (Stillings et al. 2016). North Dakota archery deer hunters were permitted to use a longbow, recurve bow, or compound bow during this study, but crossbow equipment was prohibited except for a minority of hunters who qualified for a permit based on a disability that prevented the hunter from drawing a bow. There are some differences between bow and crossbow technology (Duda and Bissell 2001), with the latter possibly being more efficient for harvesting deer (Ditchkoff et al. 2001), but these equipment types were not separated in this report.

Unlike archery season, North Dakota deer-gun and muzzleloader seasons were lottery based, limited in availability by sex (antlered vs. antlerless) or species (mule deer vs. white-tailed deer), and shorter at 16.5 days beginning in the second week in November and early January, respectively (Stillings et al. 2016). Deer-gun and muzzleloader hunters, like archery hunters, were allowed a single deer per license; however, deer-gun hunters must have selected from 6 license types—antlered white-tailed deer, antlerless white-tailed deer, antlered mule deer, antlerless mule deer, any antlered deer, and any antlerless deer—and these hunters had to restrict their hunting within established deer management units. Muzzleloader hunters had to select between an antlered or antlerless deer license but were allowed to hunt statewide without unit restrictions. In 2015, 69,791 deer-gun and 11,058 muzzleloader applicants competed for 43,275 and 826 available resident licenses, respectively (Stillings et al. 2016). Regardless of deer license drawn, hunters could select from a mosaic of lands to hunt, broadly characterized within 2 groups: those allowing public hunting access (e.g., federal and state lands, Private Land Open to Sportsmen [https://gf.nd.gov/plots/guide, unpublished data, August 27, 2018]) and private lands.

There was concern among NDGF deer managers that gun hunters, frustrated by the difficulty of drawing lottery deer-gun and muzzleloader licenses, may stop hunting deer altogether or participate in archery deer hunting as a substitute activity, thus explaining, in part, increased participation in archery deer hunting (W. Jensen, NDGF, personal communication). Activity substitutability involves replacing the original activity (e.g., deer-gun hunting) with an alternative (e.g., archery deer hunting) that provides similar benefits, and hunters may seek these activities when low wildlife populations or hunting regulations inhibit hunting for a species of interest (Iso-Ahola 1986, Needham and Vaske 2013). Despite increased popularity of archery deer hunting in North Dakota, participant numbers were relatively lower, as was the probability of harvesting a deer, when compared to gun hunters. Therefore, NDGF managers had not limited archery opportunities (e.g., employ a lottery system to direct archery hunting pressure to specific hunting units; Gladfelter et al. 1983, Boulanger et al. 2002). However, limiting archery license availability remained an option to prevent overharvest in some deer management units, or to ensure fair distribution of harvest between North Dakota archery, gun, and muzzleloader deer hunters.

We surveyed North Dakota deer license applicants to provide a better understanding of these hunters and to inform HRR efforts during a period of reduced statewide deer populations. Here we report results from these efforts, including application of the multiple satisfactions concept in segmenting hunters to gain a better understanding of motivations for deer hunting by female and archery deer hunters to contribute to the growing literature of these understudied groups. We also assessed factors that may have affected overall satisfaction among North Dakota deer hunters. We predicted differences in deer hunter motivations by preference for hunting implement (i.e., gun vs. bow) and gender. We also predicted that harvest success, motivations, and preference for hunting implement would be related to hunter satisfaction with their overall personal deer hunting experiences in North Dakota during the 2015–16 seasons.

Methods
Participants
We collected data from a listing of adult 2015–16 archery (n = 23,710), muzzleloader (n = 11,058), and deer-gun (n = 69,791) license applicants in North Dakota provided by NDGF,

from which we drew a random sample of 1,000 hunters from each group between the ages of 18 and 79. If an applicant was randomly selected more than once because they applied for >1 deer hunting opportunity, the duplicate was removed and another random selection was made. Thus, all surveyed hunters in this study were unique. We did not include minors to avoid parental consent necessary for participation in the study. We decided to exclude the 0.2% of deer license holders in North Dakota who were over 79 years old, reasoning that truncating the sample in this way was a reasonable approach to minimize contact with older license holders who no longer go afield (Siemer at al. 2014, U.S. Department of the Interior and U.S. Department of Commerce 2018) and are less likely to respond to mail surveys (Goyder 1986, Herzog and Rogers 1988, Kaldenberg et al. 1994, Sheldon et al. 2007).

Survey instrument

Our survey instrument consisted of 16 pages containing 43 questions related to deer harvest, overall satisfaction, reasons for dissatisfaction, hunter demographics, hunting experiences, perceptions of deer population decline, preference for hunting implement, and motivations for deer hunting. We used a single-blind study design with a standardized questionnaire for all deer hunter subgroups. Thus, we prevented recipients from being aware that they were representing a particular group of deer hunters. We designed the self-administered mail questionnaire based on Dillman et al. (2014) and input from NDGF Big Game Biologists, and we adapted survey questions from previous related hunter survey instruments (Boulanger et al. 2002, 2006; Gigliotti 2000; Siemer et al. 2014, 2016). We pilot tested the questionnaire with 20 local deer hunters and incorporated suggestions into the final survey draft. We included with each questionnaire a cover letter stressing confidentiality, the nature of the survey, brief instructions, and contact information.

We completed survey mailings between April 11 and May 9, 2016 to accommodate NDGF's annual standardized short harvest surveys distributed to multiple hunter subgroups after the close of the 2015–16 deer hunting seasons. The Applied Research Institute (ARI) at the University of North Dakota (UND) mailed individuals a self-administered survey with a postage-paid return envelope, along with an accompanying cover letter that requested participation, outlined survey goals, and assured confidentiality. Following Dillman et al. (2014), we contacted each hunter a total of 4 times. After the initial letter and questionnaire, we mailed a reminder postcard, a reminder letter and replacement questionnaire, and a final reminder postcard. We received completed survey instruments from archery (n = 408; 41% response rate), muzzleloader (n = 565; 57% response rate), and gun (n = 413; 41% response rate) deer hunters and pooled these data to analyze measures of association. Using National Change of Address (NCOA$^{LINK®}$) and Coding Accuracy Support System (CASS™; United States Postal Service, Washington, D.C., USA) software, UND Campus Postal Services verified addresses for 100% deliverability prior to questionnaire mailing; therefore, ARI received no returned undeliverable questionnaires. However, we excluded from analyses deer hunters who purchased a North Dakota deer license but had never in their lifetime hunted deer in North Dakota (n = 26; 2%). The ARI also conducted systematic follow-up phone interviews with deer hunter nonrespondents beginning June 7, 2016 until a minimum sample size (n = 50) for each group was reached. To assess whether there were differences between phone and mail survey respondents, we asked a series of 13 questions from the original survey related to demographics, hunting experiences, preferences for different deer hunting seasons, and satisfactions. This research followed all guidelines outlined in the UND Institutional Review Board Human Subjects Policies and Procedures (IRB Approval No. 201603-344).

Data analysis

Recognizing that many North Dakota hunters may wish to participate in multiple deer hunting opportunities (e.g., most archery deer hunters may also be deer-gun hunters), we separated hunters into n = 3 groups based on a self-identification question that asked hunters to choose their most preferred hunting implement (gun, bow, muzzleloader) for deer hunting in North Dakota. However, limited sample size (n = 24; 5%) precluded inclusion in more comprehensive statistical analyses of deer

hunters who preferred using a muzzleloader. Accordingly, we used responses of those who preferred a gun or bow to classify North Dakota deer hunters into $n = 2$ groups: archery and gun deer hunters. We also categorized respondents into $n = 2$ groups for comparisons between genders.

Applicant attributes. Using the Statistical Program for the Social Sciences (version 24.0, SPSS, Inc., Armonk, New York, USA), we reported descriptive statistics and tested for overall differences in applicant type (bow, gun, muzzleloader) by gender, harvest success, and hunting implement preferences by using Pearson chi-square statistics with effect size measured by Cramer's *V*, denoted as minimal ≥0.1, typical ≥0.3, and substantial ≥0.5 (Vaske 2008). Except where noted, we assessed all differences at $P \leq 0.05$ in this report.

Motivations. We measured motivations by having respondents rate the importance of 8 reasons for enjoying deer hunting in North Dakota on a 7-point scale of 1 (not important) to 7 (very important) and based motivation types on previous studies (Gigliotti 2000; Backman et al. 2001; Boulanger et al. 2002, 2006; Frawley and Rudolph 2008). We considered the following motivations: 1) nature (valuing being in the outdoors and the beauty of nature); 2) social (valuing time spent with family and friends); 3) meat (valuing bringing home meat for food); 4) excitement (valuing the exhilaration that comes with hunting); 5) solitude (valuing the time spent alone while hunting); 6) challenge (valuing the challenge of hunting, tracking, and harvesting a deer); 7) trophy (valuing demonstrating hunting skills or accomplishment [e.g., harvesting a large buck]); and 8) skills (valuing the ability to use certain equipment to stalk and harvest a deer). In addition, we asked respondents to select a single choice for the most important motivation for why they enjoy deer hunting in North Dakota (hereafter referred as primary motivation) as a separate question.

We again used Pearson chi-square statistics to test for overall differences in motivations between hunting implement preferences (gun vs. bow) and between genders. For comparisons between groups of mean importance of each motivation separately, violations of normality and homogeneity of variances among motivation rating data precluded use of parametric tests.

We therefore used the Kruskal-Wallis test to analyze mean ratings of motivations by hunting implement preference and genders and measured effect size by eta (η), denoted as minimal ≥0.10, typical ≥0.243, and substantial ≥0.371 (Vaske 2008). We then compared differences between preferred hunting implements and between genders in separate tests for each motivation, with statistical significance corrected for multiple tests using the sequential Bonferroni method ($P \leq 0.02$; Drezner and Drezner 2016).

Satisfaction. We measured satisfaction by having respondents rate their level of satisfaction with their overall deer hunting experiences in North Dakota in 2015–16 based on a 5-point scale of 1 (very dissatisfied) to 5 (very satisfied). Using the Kruskal-Wallis test and η, we first analyzed mean ratings of satisfaction by hunting implement preference. However, a more commonly used statistic used by some wildlife agencies is percent of satisfied hunters (Gigliotti 2000). Therefore, we reclassified responses into 3 categories (unsatisfied, neutral, satisfied), reported descriptive statistics, and used Fisher's exact test to discern differences in satisfaction by preferred hunting implement. We then conducted a more comprehensive analysis of hunter satisfaction in relation to primary motivation, preferred hunting implement, and demographic factors using binomial logistic regression (Hilbe 2009). Our goal was to ascertain factors that explain or predict satisfaction from those hunters who reported being either satisfied or dissatisfied, so we removed the neutral category from our reclassified dataset of satisfactions to create a binary response variable. Using R (Version 3.3.2, https://www.r-project.org, R Development Core Team, Vienna, Austria), we developed and compared multifactor models using a model selection approach based on AIC as described by Burnham and Anderson (2002). We subsequently constructed a set of 10 candidate models that included combinations of the following predictor variables of interest: success of harvesting at least 1 deer (success), motivations for hunting based on respondent's top choice (primary motivation), hunting implement preference (gun vs. bow), land type hunted (private vs. publicly available), gender, age, years of deer hunting experience, a global model that included all covariates, and interaction terms. We assessed multicollinearity

Table 1. Primary motivation for enjoying North Dakota, USA deer (*Odocoileus* spp.) hunting comparing hunters' preferred implement (gun vs. bow) for deer hunting and female and male hunters (data from 2015–16 deer seasons), with number of respondents in each category given in parentheses.

Primary motivation[a]	Description of motivation as measured in the survey	Hunting implement[*]		Gender[**]	
		Gun (920)	Bow (286)	Female (136)	Male (1,185)
Meat	Valuing bringing home meat for food	16%	11%	29%	13%
Trophy	Valuing demonstrating hunting skills or accomplishment (e.g., harvesting a big buck)	4%	4%	2%	4%
Nature	Valuing being in the outdoors and the beauty of nature	27%	40%	24%	30%
Excitement	Valuing the exhilaration that comes with hunting (e.g., the feeling one gets when you see deer)	10%	12%	6%	12%
Social	Valuing time spent with family and friends	35%	20%	35%	30%
Skills	Valuing the ability to use certain equipment to stalk and harvest a deer	1%	1%	2%	1%
Challenge	Valuing the challenge of hunting, tracking, and harvesting a deer	5%	8%	1%	7%
Solitude	Valuing the time spent alone while hunting	3%	5%	2%	4%

[*] $\chi^2_7 = 37.13$, $P < 0.001$, V = 0.175; significance test for group differences across all motivations.

[**] $\chi^2_7 = 42.29$, $P < 0.001$, V = 0.179; significance test for group differences across all motivations.

[a] Primary motivation was based on respondent's selection for most important reason for why they enjoy deer hunting.

using the variance inflation factor (VIF; Zuur et al. 2010), but no covariates scored a VIF ≥3.0; therefore, we did not remove predictor variables of interest from analyses. We estimated model fit by comparing residual deviances to null deviances.

Nonrespondent comparisons

We detected no differences ($P \le 0.05$) between respondents and nonrespondents among 9 out of 13 variables. Mail survey respondents were more likely to report ever harvesting a deer ($\chi^2_1 = 4.64$, $P = 0.04$, $V = 0.055$) and a preference for hunting deer with a gun ($\chi^2_2 = 12.30$, $P = 0.002$, $V = 0.092$) in North Dakota. Mail survey respondents were also more likely to report being older ($\chi^2_3 = 57.99$, $P < 0.001$, $V = 0.194$) and having more years deer hunting experience in North Dakota ($\chi^2_5 = 59.56$, $P < 0.001$, $V = 0.197$). However, the effect sizes were small, suggesting that respondents and nonrespondents may not differ in a meaningful way. Previous studies have shown strong correlations between hunter age, motivation, satisfaction, and response rate (Filion 1975, Decker and Connelly 1989, Gigliotti and Dietsch 2014), so we calculated a weight factor using our age question and applied to all other respondent data. However, weighted data only contributed negligible differences in analysis outcomes, so we present results throughout this report without weights. In sum, we believe that our samples were representative of the population. We did not include responses from phone surveys in the analyses presented here.

Results

Applicant attributes

Gender was associated with applicant type ($\chi^2_2 = 42.76$, $P < 0.001$, $V < 0.001$), with most North Dakota archery, gun, and muzzleloader deer license applicants reporting being male. Female hunters comprised 7% ($n = 26$), 19% ($n = 75$), and 7% ($n = 39$) of archery, gun, and muzzleloader applicants, respectively.

We measured harvest success among those

Table 2. Mean importance of deer (*Odocoileus* spp.) hunters' rating of each motivation comparing North Dakota, USA hunters' preferences for hunting implement (data from 2015–16 deer seasons).

Motivation[a]	Gun		Bow				
	$\overline{x}$	SE	$\overline{x}$	SE	*H*	*P*-value	Eta (η)
Meat	5.43	0.05	5.35	0.09	7.83	0.38	0.022
Trophy	4.01	0.06	4.44	0.10	11.49	0.001	0.099
Nature	6.33	0.03	6.60	0.04	20.15	<0.001	0.121
Excitement	6.20	0.03	6.37	0.05	7.39	0.007	0.073
Social	6.35	0.03	6.04	0.08	8.34	0.004	0.115
Skills	4.38	0.06	4.43	0.11	0.27	0.61	0.013
Challenge	5.19	0.06	5.79	0.09	29.63	<0.001	0.150
Solitude	5.06	0.06	5.66	0.09	25.15	<0.001	0.145

[a] Motivations were measured on a 7-point scale with 1 = "Not at all important" and 7 = "Very important."

Table 3. Mean importance of deer (*Odocoileus* spp.) hunters' rating of each motivation comparing female and male North Dakota, USA deer hunters (data from 2015–16 deer seasons).

Motivation[a]	Female		Male				
	$\overline{x}$	SE	$\overline{x}$	SE	*H*	*P*-value	Eta (η)
Meat	6.01	0.11	5.35	0.05	24.88	<0.001	0.127
Trophy	3.41	0.17	4.23	0.05	21.18	<0.001	0.134
Nature	6.14	0.09	6.43	0.03	14.44	<0.001	0.093
Excitement	5.77	0.11	6.30	0.03	25.53	<0.001	0.157
Social	6.31	0.09	6.27	0.03	0.92	0.92	0.010
Skills	4.01	0.17	4.47	0.05	6.40	0.01	0.075
Challenge	4.21	0.17	5.50	0.05	53.95	<0.001	0.230
Solitude	4.28	0.17	5.33	0.05	38.06	<0.001	0.178

[a] Motivations were measured on a 7-point scale with 1 = "Not at all important" and 7 = "Very important."

North Dakota archery, gun, and muzzleloader hunters who spent at least 1 day hunting deer during the 2015–16 deer season. Harvest success was associated with applicant type (χ^2_2 = 19.62, $P < 0.001$, $V = 0.148$), with most archery (55%), gun (69%), and muzzleloader (70%) applicants reporting success of harvesting at least 1 deer during the 2015–16 deer hunting season. However, the effect size was small.

Preference for hunting implement was also associated with applicant type (χ^2_4 = 195.88, $P < 0.001$, $V < 0.001$), with most archery, gun, and muzzleloader applicants preferring to hunt with a gun. Among archery hunter applicants, 58% (n = 206) preferred to hunt deer with a gun and 42% (n = 150) preferred to hunt with a bow. Among gun hunter applicants, 96% (n = 380) preferred hunting with a gun and 4% (n = 14) preferred hunting with a bow. No surveyed gun or bow applicants preferred to hunt with a muzzleloader. Among muzzleloader applicants, 25% (n = 130), 70% (n = 364), and 5% (n = 24) preferred to hunt with a bow, gun, or muzzleloader, respectively.

Motivations

Primary motivations for deer hunting using aggregated data from all North Dakota archery, gun, and muzzleloader hunters included social (30%), nature (29%), meat (15%), and excitement (11%). Preference for hunting implement was associated with primary motivation (χ^2_7 = 37.13, $P < 0.001$, $V = 0.175$), with notable differences

including archery hunters being more likely to select nature and gun hunters more likely to select social reasons for deer hunting (Table 1). Top primary motivations for enjoying North Dakota archery deer hunting included nature (40%), social (20%), and excitement (12%), while gun hunters selected social (35%), nature (27%), and meat (16%; Table 1). Among motivation ratings, meat and skills were rated similarly by archery and gun deer hunters (Table 2). Archery deer hunters rated trophy, nature, excitement, challenge, and solitude as significantly more important than gun hunters. Gun hunters rated social aspects for deer hunting as significantly more important than archery hunters. These differences, however, were minimal as determined by the eta effect statistic (Table 2).

Gender was also associated with primary motivation ($\chi^2_7 = 42.29$, $P < 0.001$, $V = 0.179$), with notable differences including females being more likely to hunt for obtaining meat and males being more likely to hunt for excitement and challenge reasons (Table 1). Top primary motivations among females for enjoying North Dakota deer hunting included social (35%), meat (29%), and nature (24%), while males selected social (30%), nature (30%), and meat (13%; Table 1). Among motivation ratings, social was rated similarly by females and males, and females rated meat as significantly more important for hunting deer (Table 3). Otherwise, males ranked all other remaining motivations as significantly more important than females. However, these differences were minimal as determined by the eta effect statistic (Table 3).

Satisfaction

Mean satisfaction ratings did not differ ($H = 0.80$, $P = 0.67$) between those who preferred deer hunting with archery ($\bar{x} = 3.77$, SE = 0.07), gun ($\bar{x} = 3.69$, SE = 0.05), or muzzleloader ($\bar{x} = 3.82$, SE = 0.23) equipment. We also found no association between categorized satisfaction responses (unsatisfied, neutral, satisfied) and preference for hunting implement ($P = 0.73$, Fisher's exact test). Among those who preferred to hunt with a bow, 66% ($n = 165$) reported some degree of satisfaction, 23% ($n = 58$) were neutral, and 11% ($n = 28$) reported some degree of dissatisfaction. Among those who preferred

to hunt with a gun, 62% ($n = 363$) reported some degree of satisfaction, 24% ($n = 143$) were neutral, and 14% ($n = 83$) reported some degree of dissatisfaction. Among those who preferred to hunt with a muzzleloader, 71% ($n = 12$) reported some degree of satisfaction, 18% ($n = 3$) were neutral, and 12% ($n = 2$) reported some degree of dissatisfaction.

The top 3 logistic regression models for satisfaction had a combined weight of 90% (Table 4), but top model fit was modest with a null deviance of 545.57 and a residual deviance of 473.88. In the single, top-ranked model (AIC = 496.3, second-ranked model: ΔAIC = 2.66), satisfaction was best explained by harvest success ($\hat{\beta} = 1.714$, SE = 0.24, $P < 0.001$), preferred hunting implement (bow vs. gun; $\hat{\beta} = 0.53$, SE = 0.27, $P = 0.05$), and nature ($\hat{\beta} = 0.995$, SE = 0.34, $P = 0.004$) and social ($\hat{\beta} = 1.170$, SE = 0.36, $P = 0.001$) motivations. We found that the odds of satisfaction for successful hunters were 5.5 times that of unsuccessful hunters (CI = 3.5–8.9). We found that the odds of satisfaction for archery deer hunters were 1.7 times that of gun hunters (CI = 1.0–2.9). Among primary motivations, the odds of satisfaction for nature and social hunters were 2.7 (CI = 1.4–5.3) and 3.2 (CI = 1.6–6.5) times that of baseline meat hunters, respectively.

Discussion

Wildlife agencies must balance public interests with biological information to increase their success with making sound management decisions (Hansen 2011). Traditionally, NDGF conducted a series of statewide public meetings to receive public input on deer management, but turnout to these meetings was typically low (W. Jensen, NDGF, personal communication), and meetings of this type may be attended by an unrepresentative and vocal hunting minority wishing to inform policy (Brzezinski et al. 2010, Peterson and Messmer 2010). Therefore, we surveyed North Dakota deer hunters to provide a better understanding of these groups and to inform HRR efforts, with a focus on underrepresented groups, female and archery deer hunters.

Hunting continues to be a male-dominated sport, but the number of female hunters has increased (Duda 2001, Ryan and Shaw 2011). We found that the proportion of female deer-gun applicants in our survey was nearly double

Table 4. Binary logistic regression models for effects of harvest success, motivation for hunting, gender, preferred hunting implement, and land type hunted on satisfaction with overall personal deer (*Odocoileus* spp.) hunting experiences in North Dakota, USA, during the 2015–16 deer hunting seasons. Model rank, variables, number of estimable parameters (K), log-likelihood (log [L]), Akaike's Information Criterion (AIC), ΔAIC, and Akaike weights (ω$_i$) for top 5 logistic regression models. Models were ranked by AIC score from 10 candidate models.

Rank	Model variables	K	Log (L)	AIC	ΔAIC	ω$_i$
1	Success, motivation[a], gender, implement[b]	11	-236.94	496.3	0.00	0.654
2	Success, motivation, gender, implement, land type[c]	13	-236.19	499.0	2.66	0.173
3	Success, motivation, gender, implement, land type, age, experience	17	-232.37	499.8	3.46	0.116
4	Success, motivation, gender, implement, land type, success*land	15	-235.19	501.2	4.88	0.057
5	Success, motivation, gender, implement, land type, success*motivation	20	-234.60	510.7	14.32	0.001

[a] Meat, trophy, nature, excitement, social, skills, challenge, and solitude hunter categories
[b] Preference for deer hunting with firearms vs. archery equipment
[c] Publicly available land vs. private land

the national average. The NDGF managers discerned an increase in the number of female deer-gun hunters from 1988 to 1997, reasoning that the introduction of a youth deer season, female-only gun safety training, and female hunter training via the Becoming an Outdoors Woman (BOW; Heberlein et al. 2008) program may have contributed to this increase during that time (Jensen 1999). In recent years, however, conditions have changed in North Dakota. For example, while it has been suggested that women who participate in programs like BOW may benefit from a social support system and learned skills necessary to retain females as hunters (Duda 2001, Metcalf et al. 2015), this program was discontinued in North Dakota in 2017 due to lack of efficacy (B. Schaffer, NDGF, personal communication). Heberlein et al. (2008) suggested that new female hunters are better recruited via socialization through male hunters. For example, women may use hunting to reinforce their roles in their male relationships (e.g., romantic, familial, or friendly; George 2016). Therefore, we speculate that the rural nature of North Dakota (Weber et al. 2014) paired with overall participation by both males and females may explain the relatively higher proportion of female deer-gun hunters. Black (2017) found that most North Dakota archery, gun, and muzzleloader deer hunters lived in rural areas during the time of this study. Hunting remains an important activity in rural culture (Larsen et al. 2013), and a majority of active hunters live in

rural areas (U.S. Department of the Interior and U.S. Department of Commerce 2018). Moreover, North Dakota falls within the highest-ranking regions for hunting participation in the United States (U.S. Department of the Interior and U.S. Department of Commerce 2018). North Dakota had also experienced an oil boom in recent years (Weber et al. 2014), making it the fastest-growing state in the nation in 2012 (U.S. Census Bureau 2012), but it is unknown how these events influenced license sales among female hunters. Finally, we considered whether female spouses or partners were entering the North Dakota deer-gun lottery to increase the chances of drawing limited licenses for illegal use by other hunters, but we do not have data to support this notion.

Using aggregate motivation data and segregating these data by hunting implement preference and gender, we found respondents' top primary motivations for why they enjoy deer hunting in North Dakota to be combinations of social, nature, meat, and excitement. Our findings closely matched those of Woods and Kerr's (2010) review of hunter motivations. As predicted, we found gender differences among motivations when using 2 types of measures: hunter selection of primary motivation and separate ratings of the importance of each of the 8 motivations. We reported that females were slightly more likely to hunt for meat, which has been demonstrated in previous studies (Adams and Steen 1997, Duda 2001, Metcalf et al. 2015, Gigliotti and Metcalf 2016). Based on

motivation ratings, our findings aligned with Gigliotti and Metcalf (2016), who reported that males were slightly more likely than females to hunt for sporting reasons, such as excitement, challenge, and trophy aspects.

We also noted differences among North Dakota deer hunters' primary motivations based on preferred hunting implement. For example, those who preferred hunting with archery equipment reported nature as their top reason for hunting, followed by social and meat motivations; social aspects ranked highest among gun hunters. These differences were corroborated by examining mean importance of deer hunters' ratings of each motivation. In comparison, South Dakota archery deer hunters considered themselves nature hunters followed by excitement and challenge hunters (Boulanger et al. 2002). In a nationwide study, nature and challenge motivations ranked highest among bowhunters (Duda et al. 2000). Although a majority of archery deer hunters also hunt with firearms (Duda and Bissell 2001, Responsive Management 2017), we found that most (58%) North Dakota archery deer hunter applicants preferred to hunt deer with a gun. Therefore, we suspect that North Dakota archery hunters ranked social motivation as their second choice because of the crossover effects from gun hunters, who tend to rank social aspects highly (Gigliotti 2000, Backman et al. 2001, Frawley and Rudolph 2008). If gun license availability is restricted via lottery, gun hunters may be turning to archery deer hunting to retain, in part, traditional friend and family hunting groups that were otherwise broken up by those who were not successful in the gun license lottery.

It is unclear to us why challenge did not rank higher overall among archery hunters given its higher ranking in previous studies. Moreover, long North Dakota archery deer hunting seasons may offer some hunters additional challenges, including extreme wind, some of the coldest temperatures in the United States (Chiu et al. 2014), and high mosquito densities (Anderson et al. 2015). Inherent challenges associated with archery deer hunting include getting closer to game, physical challenge, increased patience, and mastery of archery equipment necessary to be proficient (Duda et al. 2000). While difficult to compare across studies due to differences in season limitations, habitat, and deer

populations, to name a few, we note that North Dakota has the distinction of being the least forested state in the United States (Jensen 2011). This fact may reflect a less challenging archery hunt for those who have access to limited cover in shelterbelts and riparian forests available in North Dakota, that limit deer movements and may provide an advantage to the hunter. North Dakota archery hunters may have had more opportunity to see and harvest deer when deer populations were rebounding from limited gun license opportunities. Challenge aspects of the hunt among archery hunters may also have simply ranked lower due to the dilution effect of respondents who hunt with both gun and bow.

We reported that a majority of archery, gun, and muzzleloader deer hunters were satisfied with their overall personal deer hunting experiences in North Dakota during the 2015–16 season. As mentioned, North Dakota deer license applicants who are successful in drawing a tag may have more opportunity to see and harvest deer when deer populations are rebounding from limited license opportunities. Moreover, limiting deer licenses may reduce potential conflicts from overcrowding from other hunters, which is known to reduce satisfaction (Heberlein 1992, Heberlein and Kuentzel 2002). We reported that a majority of North Dakota gun, bow, and muzzleloader deer hunter applicants were successful in harvesting at least 1 deer during the 2015–16 season, and logistic regression modelling revealed that satisfaction was associated with success, further supporting the notion that harvest success remains a predictor of hunter satisfaction (Stankey et al. 1973, Langenau 1981, Gigliotti 2000, Pang 2017). However, we also reported that nonharvest satisfactions were also important (Hendee 1974, McCullough and Carmen 1982, Vaske et al. 1986, Hammitt et al. 1990). For example, our model further revealed that North Dakota nature and social hunters appeared to be more satisfied when compared to meat hunters who tend to be more goal-orientated and rely on harvest success. Should North Dakota deer populations remain in decline, a challenge for North Dakota managers will be balancing the needs of hunters and outreach messages based on differences in motivations and satisfaction reported by deer hunters.

Most North Dakota archery deer hunters reported being satisfied, and it has been

suggested that high levels of satisfaction may indicate few negative issues related to archery deer season management (Duda et al. 2000). North Dakota archery hunters likely enjoyed the liberal archery deer season with assured ability to purchase a bow license. However, satisfaction ratings among North Dakota archery deer hunters ranked lower than those reported among archery deer hunters in South Dakota (85%; Boulanger et al. 2002) and nationwide (91%; Duda et al. 2000) studies. Although direct comparisons of satisfaction between archery hunter studies is difficult due to differences in management, deer populations, and climate, to name a few, we were not surprised to see a lower satisfaction level in North Dakota given the decline in deer abundance. Moreover, satisfaction of North Dakota archery hunters who hunted in 2015–16 may also have been affected by unsuccessful attempts at drawing a gun license in previous years or an inability to hunt with traditional hunting partners.

Our logistic regression model provided evidence that North Dakota deer hunters who preferred to hunt with archery equipment were more satisfied than those who prefer to hunt with a gun. The degree of specialization between these 2 groups may further explain these differences. Among hunters in Pennsylvania, USA, for example, archery and rifle deer hunters had the highest and lowest mean degree of specialization, respectively, when compared to other hunters (Miller and Graefe 2000). The authors noted that most archery deer hunters consider elements of success to include extensive shooting practice, scouting for deer, and mastery of archery equipment, which may have contributed to the high specialization score; lower specialization score for rifle hunters indicated that their activity was undertaken with less equipment and preparation when compared to archery and other hunters. Gun hunters may have seen archery hunting as more demanding to participate in and be successful, and thus be less satisfied than those hunters who preferred to hunt deer with archery equipment.

Management implications

Questions pertaining to satisfactions provide wildlife managers with an understanding of their performance in delivering deer hunting opportunities. Like other state wildlife agencies,

NDGF is interested in attracting additional female hunters because of the potential to offset declining hunter participation. With most North Dakota male and female deer hunters being satisfied with their overall hunting experience, given circumstances at this time, establishing additional limits for archery deer season appeared unnecessary. Should deer numbers continue to decline, however, NDGF has an established lottery system in place that would permit an equitable distribution in archery deer licenses to adjust for harvest goals. Female hunter numbers are increasing, and along with males in this study were found to hunt for primarily meat, nature, and social reasons. Thus, messages that portray hunting as a nature activity, centered on friends and family with an opportunity to acquire high-quality and free-range food, may be effective. To that end, the locavore movement may appeal to new male and female hunters and potentially improve the image of hunting. Continued monitoring of human dimensions information among North Dakota deer hunters will continue to be an integral part of the deer management process.

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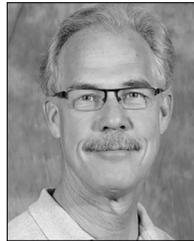
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