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Examining Deer Hunter Demographics, Perceptions, And Factors Influencing Satisfaction And Success During A Time Of Statewide Deer Population Decline

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EXAMINING DEER HUNTER DEMOGRAPHICS, PERCEPTIONS, AND FACTORS INFLUENCING SATISFACTION AND SUCCESS DURING A TIME OF STATEWIDE DEER POPULATION DECLINE

by
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This thesis, submitted by Kristen Black in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Kristen Black

July 14, 2017

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ABSTRACT

North Dakota's white-tailed deer (*Odocoileus virginianus)* and mule deer (*O. hemionus*) populations have declined significantly since their peak in 2008-2009. This may be due to heavy harvest pressure in an effort to reduce deer depredation on agricultural crops, a series of harsh winters, habitat fragmentation or loss, predation, and disease. In 2009, about 144,400 deer gun hunting licenses were allocated through a lottery system by the North Dakota Game and Fish Department (NDGF). Interest in deer hunting in North Dakota is high, with more than 69,700 resident and non-resident hunters applying for the 43,275 licenses available for the 2015 deer-gun hunting season by a lottery system. In 2014 the NDGF became interested in learning more about the demographic composition, desires of deer hunters in the state, and in exploring potential regulatory changes. To these ends NDGF contracted with the University of North Dakota Biology Department to conduct a human dimensions survey of North Dakota deer hunters. The objectives of this study were to 1.) collect North Dakota deer hunter demographics; 2.) assess factors influencing satisfaction and harvest success in four groups of hunters: firearms, archery, muzzleloader, and landowner/gratis; 3.) evaluate the potential effects of NDGF converting to a completely computer-based licensing and surveying system; and 4.) determine public perceptions of deer population decline in the state. A questionnaire was distributed to 4,000 randomly selected North Dakota resident deer license applicants from the 2015–2016 deer hunting season during April of 2016. From the completed and returned questionnaires, NDGF will be able to make informed decisions about regulation changes for future deer hunting seasons.

CHAPTER 1

COMPREHENSIVE STATE REPORT

2016 North Dakota Deer Hunter Survey Executive Summary

In 2014, the North Dakota Game and Fish Department (NDGF) commissioned a statewide survey of resident deer hunters in an effort to become better-informed about demographic composition, components of a successful hunt, and perceptions about deer population decline in the state. The results of this study may be used in consideration for potential changes to statewide deer hunting regulations in future hunting seasons. This report is a compilation of responses from North Dakota (ND) resident deer hunters. Youth hunters and those under 18 were not sampled due to issues relating to parental consent, and hunters over the age of 79 years were excluded because hunting participation at these ages declines precipitously.

The objectives of this study were as follows:

1) Assess the current satisfaction levels of ND resident deer hunters with their hunting experiences;
2) collect ND resident deer hunter demographics;
3) determine perceptions of deer population decline in ND; and
4) evaluate the potential effects of NDGF converting to a computer-based licensing and surveying system.

Methods

Sampling

NDGF provided a list of ND resident deer license holders for the 2015 deer hunting season to the University of North Dakota (UND) Applied Research Institute (ARI). From this comprehensive sample frame, 1,000 bow license applicants, 1,000 gratis license applicants, 1,000 gun license applicants, and 1,000 muzzleloader license applicants were selected by random sample to receive a questionnaire.

Mail Survey Instrument

The survey instrument consisted of six sections:

- The first section, "Your Deer Hunting Background," focused on how many years the respondent hunted in North Dakota, the average number of days afield per year, if they ever harvested deer in North Dakota, if they hunted deer in other states, and if they hunted other types of game (objective 2).
- The second section, "Your Deer Hunting in North Dakota in 2015," focused on whether the respondent applied to hunt and/or hunted deer in North Dakota in 2015, what species they hunted and why, the equipment used, land type and location hunted, and personal satisfaction with their 2015 deer hunting experience (objectives 1 and 2).
- The third section, "Background Information," focused on hunter demographics like age, gender, education, occupation, ethnicity, as well as hunter specific demographics like when they started hunting, how they got involved, what kind of weaponry they

prefer, sources of deer hunting information, hunting organizations they are involved in, and why they hunt (objective 2).

- The fourth section, "Your Views on Deer Hunting Regulations," asked respondents about their personal satisfaction with NDGF management techniques and regulations (objective 1).
- The fifth section, "Your Communication with NDGF," asked respondents about their internet availability, proficiency, and preference for being contacted by NDGF in the future (objective 4).
- The sixth section, "Your Perceptions about Deer Populations," asked respondents for their opinions about several factors affecting deer populations including energy development, agricultural development, habitat loss, climate, NDGF management techniques, disease, and predation (objective 3).

Survey Implementation

The UND ARI distributed the questionnaires with a cover letter explaining the goals of the project and asking for volunteer participation on April 11th, 2016. Recipients were contacted up to five times during the study: once for the initial mailing (April 11th), a reminder postcard (April 18th), a second questionnaire and cover letter stressing the importance of responding (May 2nd), a final reminder post card (May 9th), and a follow-up phone survey for nonrespondents (June 7th). The follow-up phone survey to nonrespondents was conducted by ARI to a random subsample of at least 50 subjects. These recipients were asked 12 selected questions from the questionnaire to assess nonresponse bias.

It should be noted that all hunters surveyed received the same questionnaire, and that they were not instructed to respond to the questionnaire as a specific hunter type (i.e., bow, gratis deer-gun, regular deer-gun, muzzleloader). Therefore, some responses may seem inconsistent to the license type.

Findings Highlight

Bowhunters

A total of 409 questionnaires were returned (41% response rate). About 2% (n=7) of the respondents had applied to the lottery but never hunted deer in North Dakota and were not included in the analysis. Of the nonrespondent phone call recipients, all had hunted deer in North Dakota and were included in the analysis for comparison to respondents to assess nonresponse bias.

Respondent–Nonrespondent Comparison

- Respondent and nonrespondent bowhunters hunted deer an average of 20 and 17 years in ND, respectively.
- Respondent and nonrespondent bowhunters spent an average of 14 and 12 days afield per season, respectively.
- Most respondents (91%) and nonrespondents (96%) harvested a deer in ND.
- Most bowhunter respondents (75%) and nonrespondents (73%) applied for a gun license, a few (13% and 8%, respectively) applied for a muzzleloader license, even fewer (2% of respondents, no nonrespondents) applied for a gratis license, and about 23% of respondents and 27% of nonrespondents did not apply for any license in the lottery.

- Most respondents (69%) and nonrespondents (65%) were unsuccessful at drawing a gun, muzzleloader, or gratis license in the lottery. Only about 30% of respondents and 35% of nonrespondents drew a gun license, 2% of respondents drew a muzzleloader license, and <1% of respondents drew a gratis license.
- About 58% and 50% of bowhunter respondents and nonrespondents, respectively, preferred to hunt with a gun while 42% and 50%, respectively, preferred a bow, and none preferred a muzzleloader.
- Most bowhunter respondents (87%) and nonrespondents (79%) hunted at least one day in ND during the 2015 season.
- Bowhunter respondents hunted an average of 14 days on public land for mule deer and 10 days for white-tailed deer; about 18% harvested a mule deer and 38% harvested a white-tailed deer. They hunted an average of 7 days on PLOTS land for mule deer and 6 days for white-tailed deer; no one reported harvesting a mule deer, but 28% harvested a white-tailed deer. They hunted an average of 10 days on private land for free (not PLOTS) for mule deer and 13 days for white-tailed deer; 29% harvested a mule deer and 51% harvested a white-tailed deer. They hunted an average of 4 days on private land for a fee for mule deer and 4 days for white-tailed deer; no one reported harvesting a mule deer but 57% harvested a white-tailed deer.

  Nonrespondent bowhunters hunted an average of 9 days on public land and 24% harvested a deer. They hunted an average of 14 days on PLOTS land and 17% harvested a deer. They hunted an average of 11 days on private land for free (not PLOTS) and 78% harvested a deer. They hunted an average of 19 days on private

land for a fee and 5% harvested a deer. (Identification of deer species was not asked of nonrespondents.)

- When asked about their overall hunting experience in 2015, bowhunter respondents gave an average satisfaction rating of 3.6 out of 5 (1=very dissatisfied, 5= very satisfied) and nonrespondents gave an average of 4.0. About 15% of respondents and 12% of nonrespondents reported some degree of dissatisfaction.
- Most bowhunter respondents and nonrespondents were male (94% for both categories).
- Most bowhunter respondents and nonrespondents were between the ages of 25 and 44 years (44% and 58%, respectively) while some were between the ages of 45 and 64 years (34% and 21%, respectively), a few were between the ages of 18 and 24 years (11% and 21%, respectively), and 10% of respondents were between 65 and 79 years (no nonrespondents reported being 65 years or older).
- The largest education class of respondent bowhunters (31%) had an undergraduate degree, 25% had some college education but no degree, some (21%) had a high school diploma, some (21%) had a graduate degree, and a few (3%) had some high school education but no diploma.

  The largest education class of nonrespondent bowhunters (35%) had a high school diploma, 29% had some college education but no degree, some (27%) had an undergraduate degree, a few (6%) had a graduate degree, and about 4% had some high school education but no diploma.

- When asked about NDGF's techniques for deer population management, respondent bowhunters gave an average satisfaction rating of 6.1 out of 10 (1=very dissatisfied, 10=very satisfied) and nonrespondents gave a 6.5. About 27% of respondents and 25% of nonrespondents reported some degree of dissatisfaction.
- Most respondent and nonrespondent bowhunters would have been willing to apply for licenses from the NDGF website (81% and 87%, respectively), some would not (11% and 12%, respectively), and a few were unsure (8% and 2%, respectively).

Hunting Record

- Most bowhunters reported they hunted more (31%) or the same amount (31%) in the last five years.
- Most (80%) bowhunters did not hunt deer in other states in the last five years.
- Bowhunters reported also hunting other big game (38%), upland game (82%) waterfowl (47%), other migratory game birds (22%), furbearers (74%), and other game (23%); 9% do not hunt other game.
- Of the bowhunters that did not hunt (n=53), most (81%) reported it was because they did not draw a license of their choice, some (11%) reported it was because there were too few deer, a few (4%) reported it was because they were concerned about crowding from other hunters, even fewer reported it was because they did not have a place to hunt (2%) or they were concerned about conflicts with landowners (2%), and about 11% listed other reasons.

- The hunting units with the highest frequency of use by bowhunters were 2B (11%), 3C (8%), and 2G1 (5%). The units with the lowest frequency of use by bowhunters were 4F, 2L, and 2D (all <1%).
- Most (57%) bowhunters reported hunting with a bow every time. Additionally, they reported never hunting with a rifle (53%), shotgun (89%), muzzleloader (96%), or handgun (96%). They also reported not hunting over bait (62%), not hunting other game at the same time (65%), and not helping youth hunters (76%). Most bowhunters did report helping adult hunters (68%) and hunting with a partner (78%).

Background Information

- Most (60%) bowhunters began hunting between the ages of 12 and 17 years. Some began hunting when they were less than 12 years old (15%) or between 18 and 24 years (15%), fewer (10%) between 25 and 44 years, <1% between 45 and 64 years, and no one reported starting above the age of 65 years.
- Most (77%) bowhunters were first mentored in deer hunting by a male family member, some (16%) by a friend, a few (5%) went alone, even fewer (2%) by a female family member, and <1% were mentored by a hunting group or club.
- Most bowhunters reported getting their information about deer hunting from friends or family (97%), books (54%), magazines (66%), the NDGF website (67%), NDGF Deer Hunting Guide (58%), and TV programs (62%). They reported not usually getting their information from social media (38%), hunting clubs (8%), or a deer hunting course (8%). Equal numbers of bowhunters reported not getting information from the internet (50% for both).

- About 14% of bowhunters were members of deer hunting or deer management groups at the local, state, or national level. General local groups (6%) and the North Dakota Bowhunters Association (5%) were the most popular.
- Most bowhunters applied for a gun license every year (81%) and a bow license every year (68%). Only about 18% reported applying for a muzzleloader license every year.
- Most bowhunters listed nature (34%), family (21%), meat (17%), or excitement (11%) as the most important motivation for hunting. Very few listed skills (1%), trophies (4%), challenge (6%), or solitude (6%) as the most important motivation.
- The largest occupational group of bowhunters (21%) worked in construction/labor while the smallest (<1%) worked in tourism. About 15% of bowhunters worked in business, 14% worked in agriculture, 8% worked in customer service, 7% worked in energy development, 7% worked in health care, 6% worked in transportation, 4% worked in the military, 3% worked in education, 3% worked in legal, 3% worked in natural resources, and 8% worked in other areas.
- Most (33%) bowhunters lived in rural areas, while about 28% lived large cities populated by more than 50,000 people, 16% lived in areas populated by less than 5,000 people, 12% lived in areas populated by 5,001–25,000 people, and 12% lived in areas populated by 25,000–50,000 people.
- Most (99%) bowhunters were Caucasian, with very few in other ethnicity categories. About 1% were Native American, while <1% were Hispanic, Black, or Asian.

Satisfaction

- On a 5-point scale (1=very dissatisfied, 5=very satisfied), bowhunters reported an average of 2.9 satisfaction level with the ability to get a license of their choice, 4.1 with season dates, 4.2 with clarity of hunting regulations, and 4.3 with hunting equipment allowed. About 16% reported some degree of dissatisfaction with one or more of the aforementioned aspects of their hunting experience.
- Of those that reported dissatisfaction (n=399), about 30% of bowhunters reported it was because there were not enough licenses available, 18% reported it was because they did not see enough deer, 14% reported it was because they were unable to get the license type they wanted, 14% reported it was because they did not have access to private land, 2% reported it was because they were not able to hunt in the area of their choice, 2% reported it was because of conflicts with other hunters, 2% reported it was because of lack of access to public land, and 1% reported it was because of conflicts with landowners.

Communication with NDGF

- About 93% of bowhunters had access to the internet at home, 7% did not, and <1% were unsure.
- Most (72%) bowhunters reported using the internet for personal use daily, about 14% use it weekly, 8% use it monthly, and 6% never use it.
- Bowhunters reported an average internet proficiency of 7.8 out of 10 (1=not proficient, 10=very proficient). 11% reported some degree of deficiency.

- Most (66%) bowhunters would prefer to receive information from NDGF by email, many (51%) by postal mail, about 23% by text, 16% by phone app, 16% by public announcement, and 5% by phone call.

Perceptions About Deer Populations

- Most (57%) bowhunters felt that harvest pressure on deer has had an impact on their hunting experience, while about 27% reported it had not, and 17% were unsure.
- Most (59%) bowhunters felt that harsh winter weather has had an impact on their hunting experience, while about 32% reported it had not, and 9% were unsure.
- Most (68%) bowhunters felt that habitat loss has had an impact on their hunting experience, while about 24% reported it had not, and 8% were unsure.
- About 48% of bowhunters felt that habitat fragmentation has had an impact on their hunting experience, 43% reported it had not, and 10% were unsure.
- From those who answered that habitat fragmentation had negatively impacted their hunting experience (n=137), about 49% reported it was because they saw fewer deer as a result of fragmentation, 45% reported it was because of competition for licenses in the lottery, 23% reported it was because of crowding from other hunters, and 20% gave other reasons.
- Most (88%) bowhunters claimed to be familiar with CWD, while 9% were not, and 3% were unsure.
- Most (93%) bowhunters reported that the presence of CWD in ND had not caused them to deer hunt less, while 2% reported it had, and 5% were unsure.

- Of those who reported being negatively affected by CWD (n=8), all of them (100%) reported it was because there were fewer deer to hunt.
- About 44% of bowhunters claimed to be familiar with EHD, while about 47% were not, and 9% were unsure.
- Most (81%) bowhunters reported that the presence of EHD in ND has not caused them to deer hunt less, while about 2% reported that it had, and 17% were unsure.
- Of those who reported being negatively affected by EHD (n=9), all of them (100%) reported it was because there were fewer deer to hunt.
- About 31% of bowhunters reported habitat loss as the factor most responsible for deer population decline in the state; 21% reported harsh winter weather, 19% reported NDGF deer population management practices, 14% reported predation, 8% reported disease, and 7% reported habitat fragmentation.

Gratis Hunters

A total of 464 questionnaires were returned (46% response rate). About 1% (n=5) of the respondents had applied to the lottery but never hunted deer in North Dakota and were not included in the analysis. Of the nonrespondent phone call recipients, 2% (n=1) had not hunted deer in North Dakota and were not included in the analysis for comparison to respondents to assess nonresponse bias.

Respondent–Nonrespondent Comparison

- Respondent and nonrespondent gratis hunters had hunted deer an average of 33 and 24 years in ND, respectively.

- Respondent and nonrespondent gratis hunters had spent an average of 8 and 7 days afield per season, respectively.
- Most respondents (99%) and nonrespondents (96%) had harvested a deer in ND.
- Some gratis hunter respondents (29%) and nonrespondents (20%) also applied for a gun license, a few (4% and 8%, respectively) applied for a muzzleloader license, and 3% and 4% of respondents and nonrespondents, respectively, did not apply for another license in the lottery.
- Most respondents (98%) and nonrespondents (84%) were successful at drawing a license in the lottery. About 78% of both respondents and nonrespondents drew a gratis license; 19% and 6%, respectively, drew a gun license; 1% of respondents, and no nonrespondents drew a muzzleloader license.
- About 95% of gratis hunter respondents and 94% of nonrespondents preferred to hunt with a gun while 4% of respondents and nonrespondents preferred a bow, and about 1% of respondents and 2% of nonrespondents preferred a muzzleloader.
- Most gratis hunter respondents (93%) and nonrespondents (90%) hunted at least one day in ND in 2015.
- Gratis hunter respondents hunted an average of 5 days on public land for mule deer and 9 days for white-tailed deer. 60% harvested a mule deer and about 38% harvested a white-tailed deer. They hunted an average of 3 days on PLOTS land for mule deer and 4 days for white-tailed deer. 33% harvested a mule deer and 25% harvested a white-tailed deer. They hunted an average of 6 days on private land for free (not PLOTS) for mule deer and 7 days for white-tailed deer. About 46% harvested a mule

deer and 60% harvested a white-tailed deer. They did not report hunting any days on private land for a fee for mule deer but did hunt an average of 8 days for white-tailed deer. 70% harvested a white-tailed deer. Nonrespondent gratis hunters hunted an average of 1 day on public land and about 2% harvested a deer. They did not report hunting at all on PLOTS land. They hunted an average of 6 days on private land for free (not PLOTS) and about 82% harvested a deer. They hunted an average of 2 days on private land for a fee and about 14% harvested a deer. (Identification of deer species was not asked of nonrespondents.)

- When asked about their overall hunting experience in 2015, gratis hunter respondents gave an average satisfaction rating of 3.8 out of 5 (1=very dissatisfied, 5= very satisfied) and nonrespondents gave a 4.5. About 10% of respondents and 5% of nonrespondents reported some degree of dissatisfaction.
- Most gratis hunter respondents and nonrespondents were male (84% of both groups).
- Most (49%) gratis hunter respondents were between the ages of 45 and 64 years, some (35%) were between the ages of 65 and 79 years, a few (14%) were between the ages of 25 and 44 years, and about 3% of respondents were between 18 and 24 years.

  Most gratis nonrespondents were either in the 25 to 44-year age class (43%) or the 45 to 64-year age class (25%). Some (20%) were between the ages of 65 and 79, and a few (10%) were between 18 and 24 years.
- The largest education class of respondent gratis hunters (26%) had an undergraduate degree, about 25% had some college education but no degree, some (23%) had a high school diploma, some (23%) had a graduate degree, and a few (3%) had some high

school education but no diploma. The largest education class of nonrespondent gratis hunters (35%) had an undergraduate degree, some (29%) had a high school diploma, about 22% had some college education but no degree, a few (6%) had a graduate degree, and 2% had some high school education but no diploma.

- Respondent and nonrespondent gratis hunters gave an average satisfaction rating of 6.3 and 6.7, respectively, out of 10 (1=very dissatisfied, 10=very satisfied) when asked about NDGF's techniques for deer population management. 18% of respondents and 16% of nonrespondents reported some degree of dissatisfaction.
- Most respondent and nonrespondent gratis hunters would have been willing to apply for licenses from the NDGF website (55% and 69%, respectively), some (29% of respondents, 25% of nonrespondents) would not, and a few (16% of respondents, 6% of nonrespondents) were unsure.

Hunting Record

- Most gratis hunters reported they hunted the same amount (50%) or the less (37%) in the last five years.
- Most (95%) gratis hunters did not hunt deer in other states in the last five years.
- About 22% of gratis hunters also hunted other big game, 56% hunted upland game, 29% hunted waterfowl, 10% hunted other migratory game birds, 62% hunted furbearers, 15% hunted other game, and 23% did not hunt other game.
- Of the gratis hunters that did not hunt (n=31), about 36% reported it was because there were too few deer, 16% reported it was because they did not draw a license, 10% reported it was because hunting land was too far away, and 42% listed other reasons.

- The hunting units with the highest frequency of use by gratis hunters were 2B (7%), 2E (7%), and 2C (6%). The units with the lowest frequency of use by gratis hunters were 4F, 4C, 4A, and 4D (<1% each).
- Most gratis hunters hunted with a rifle every time (86%), never hunted with a bow (78%), shotgun (89%), muzzleloader (88%), or handgun (96%). They reported not hunting over bait (82%), not hunting other game at the same time (61%), and not helping youth hunters (59%). Most gratis hunters did report helping adult hunters (66%) and hunting with a partner (80%).

Background Information

- Most (51%) gratis hunters began hunting between the ages of 12 and 17 years. Some began hunting when they were between 18 and 24 years (22%) or between 25 and 44 years (15%), a few at less than 12 years old (8%) or between 45 and 64 years (4%), and even less (<1%) above the age of 65 years or older.
- Most (72%) gratis hunters were first mentored in deer hunting by a male family member, some (18%) by a friend, a few (8%) went alone, even fewer (1%) by a female family member, and about 1% were mentored by a hunting group or club.
- Most (90%) gratis hunters reported getting their information about deer hunting from friends or family, and less so from books (30%), magazines (44%), social media (16%), NDGF website (42%), TV programs (38%), hunting clubs (8%), the internet (20%), or a deer hunting course (5%). Approximately equal numbers of gratis hunters reported they do and do not get information from the NDGF Deer Hunting Guide (48% vs. 52%, respectively).

- About 7% of gratis hunters were members of deer hunting or deer management groups at the local, state, or national level. General local groups (4%) were the most popular.
- Most (84%) gratis hunters had applied for a gun license every year, had never applied for an archery license (62%) or a muzzleloader license (71%).
- Gratis hunters listed nature (29%), family (29%), meat (19%), or excitement (11%) as the most important motivation for hunting. Few hunters listed skills (2%), solitude (3%), challenge (4%), or trophies (5%) as the most important motivation.
- Most (63%) gratis hunters worked in agriculture while the least (<1%) worked in tourism. About 9% of gratis hunters worked in business, 6% worked in construction/labor, 5% worked in health care, 5% worked in customer service, 4% worked in education, 2% worked in energy development, 2% worked in transportation, 1% worked in natural resources, 1% worked in the military, 1% worked in legal, and 2% worked in other areas.
- Most (72%) gratis hunters lived in rural areas, while about 11% lived in large cities populated by more than 50,000 people, 8% lived in areas populated by less than 5,000 people, 5% lived in areas populated by 25,000–50,000 people, and 3% lived in areas populated by 5,001–25,000 people.
- Most (99%) gratis hunters were Caucasian, with very few in other ethnicity categories. <1% were Native American, Hispanic, or Asian, and none reported being Black.

Satisfaction

- On a 5-point scale (1=very dissatisfied, 5=very satisfied), gratis hunters reported an average of 3.7 satisfaction level with the ability to get a license of their choice, 4.2

with season dates, 4.1 with clarity of hunting regulations, and 4.3 with hunting equipment allowed. About 11% reported some degree of dissatisfaction with one or more of the aforementioned aspects of their hunting experience.

- Of those that reported they were dissatisfied (n=319), about 30% of gratis hunters reported it was because they did not see enough deer, 14% reported it was because there were not enough licenses available, 10% reported it was because of conflicts with other hunters, 9% reported it was because they were unable to get the license type they wanted, 3% reported it was because they did not have access to private land, 2% reported it was because they were not able to hunt in the area of their choice, 1% reported it was because of conflicts with landowners, and <1% reported it was because of lack of access to public land.

Communication with NDGF

- About 83% of gratis hunters had access to the internet at home, 17% did not, and <1% were unsure.
- Most (54%) gratis hunters used the internet for personal use daily, about 19% used it weekly, 11% used it monthly, and 17% never used it.
- Gratis hunters reported an average internet proficiency of 7.1 out of 10 (1=not proficient, 10=very proficient). About 30% reported some degree of deficiency.
- Most (68%) gratis hunters would have preferred to receive information from NDGF by postal mail, many (43%) by email, about 20% by public announcement, 10% by text, 5% by phone app, and 4% by phone call.

Perceptions about deer populations

- Most (50%) gratis hunters felt that harvest pressure on deer has had an impact on their hunting experience, while about 34% reported it had not, and 16% were unsure.
- Most (58%) gratis hunters felt that harsh winter weather has had an impact on their hunting experience, while about 37% reported it had not, and 5% were unsure.
- Most (58%) gratis hunters felt that habitat loss has had an impact on their hunting experience, while about 37% reported it had not, and 5% were unsure.
- About 36% of gratis hunters felt that habitat fragmentation has had an impact on their hunting experience, 55% reported it had not, and 9% were unsure.
- From those who answered that habitat fragmentation had negatively impacted their hunting experience (n=113), about 57% reported it was because they saw fewer deer as a result of fragmentation, 20% reported it was because of competition for licenses in the lottery, 12% reported it was because of crowding from other hunters, and 20% gave other reasons.
- Most (88%) gratis hunters claimed to be familiar with CWD, about 7% were not, and 5% were unsure.
- Most (95%) gratis hunters reported that the presence of CWD in ND had not caused them to deer hunt less, while about 2% reported it had, and 3% were unsure.
- Of those who reported being negatively affected by CWD (n=11), about 55% of gratis hunters reported it was because there were fewer deer to hunt, 46% reported it was because they did not want to consume meat that might be infected with CWD, and 9% reported it was because they did not want to come into contact with CWD.

- About 34% of gratis hunters claimed to be familiar with EHD, while about 54% were not, and 12% were unsure.
- Most (83%) gratis hunters reported that the presence of EHD in ND had not caused them to deer hunt less, while about 1% reported that it had, and 17% were unsure.
- Of those who reported being negatively affected by EHD (n=4), 75% of gratis hunters reported it was because there were fewer deer to hunt because of EHD, and 25% reported it was because they did not want to consume meat that might be infected with EHD.
- About 25% of gratis hunters reported harsh winter weather as the factor most responsible for deer population decline in the state; 24% reported habitat loss, 21% reported predation, 16% reported NDGF deer population management practices, 9% reported disease, and 5% reported habitat fragmentation.

Gun Hunters

A total of 418 questionnaires were returned (42% response rate). About 3% (n=11) of the respondents had applied to the lottery but never hunted deer in North Dakota and were not included in the analysis. Of the nonrespondent phone call recipients, about 8% (n=5) had not hunted deer in North Dakota and were not included in the analysis for comparison to respondents to assess nonresponse bias.

Respondent–Nonrespondent Comparison

- Respondent and nonrespondent gun hunters had hunted deer an average of 25 and 12 years in ND, respectively.

- Respondent and nonrespondent gun hunters had spent an average of 6 and 7 days afield per season, respectively.
- Most respondents and nonrespondents had harvested a deer in ND (97% and 82%, respectively).
- A few gun hunter respondents (3%) and nonrespondents (6%) had also applied for a muzzleloader license, a few (1% and 4%, respectively) applied for a gratis license, and about 9% of respondents and 4% of nonrespondents did not apply for another license in the lottery.
- Most respondent (67%) and nonrespondent (58%) gun hunters were unsuccessful at drawing a license in the lottery. About 43% of respondents and 40% of nonrespondents drew a gun license, no respondents reported having drawn a muzzleloader license but 2% of nonrespondents drew one, and no respondents or nonrespondents drew a gratis license.
- About 93% of gun hunter respondents and 96% of nonrespondents preferred to hunt with a gun while 4% of respondents and 2% of nonrespondents preferred a bow, and no one reported preference for a muzzleloader.
- About 47% of gun hunter respondents did not hunt at least one day in ND in 2015. Alternatively, most (56%) nonrespondents did hunt at least one day in ND in 2015. Gun hunter respondents hunted an average of 5 days on public land for mule deer and 6 days for white-tailed deer; about 58% harvested a mule deer and 33% harvested a white-tailed deer. They hunted 4 days on PLOTS land for mule deer and for white-tailed deer; about 33% harvested a mule deer and 19% harvested a white-tailed deer.

They hunted an average of 5 days on private land for free (not PLOTS) for mule deer and 5 days for white-tailed deer; about 66% harvested a mule deer and 66% harvested a white-tailed deer. They reported not hunting on private land for a fee for mule deer and hunting an average of 5 days for white-tailed deer; 100% harvested a white-tailed deer. Nonrespondent gun hunters hunted an average of 5 days on public land and about 68% harvested a deer. They hunted an average of 6 days on PLOTS land and about 19% harvested a deer. They hunted an average of 7 days on private land for free (not PLOTS) and about 29% harvested a deer. They hunted an average of 4 days on private land for a fee and about 10% harvested a deer. (Identification of deer species was not asked of nonrespondents.)

- When asked about their overall hunting experience in 2015, gun hunter respondents gave an average satisfaction rating of 3.8 out of 5 (1=very dissatisfied, 5= very satisfied) and nonrespondents gave a 4.1. About 12% of respondents and 16% of nonrespondents reported some degree of dissatisfaction.
- Most gun hunter respondents and nonrespondents were male (82% and 77%, respectively).
- Most gun hunter respondents were between the ages of 45 and 64 years (44%) or between the ages of 25 and 44 years (30%), a few (20%) were between the ages of 65 and 79 years, and about 7% of respondents were between 18 and 24 years.

  Most gun nonrespondents were either in the 25 to 44-year age class (51%) or the 45 to 64-year age class (27%). Some (18%) were between the ages of 18 and 24, while a few (4%) were between 65 and 79 years.

- The largest education class of respondent gun hunters had an undergraduate degree (29%) or some college education but no degree (25%), some (22%) had a high school diploma, some (21%) had a graduate degree, and a few (1%) had some high school education but no diploma. The largest education class of nonrespondent gun hunters had an undergraduate degree (38%) or some college education but no degree (31%), some (28%) had a high school diploma, a few (4%) had a graduate degree, and no one reported not finishing high school.
- When asked about NDGF's techniques for deer population management, respondent gun hunters gave an average satisfaction rating of 6.2 out of 10 (1=very dissatisfied, 10=very satisfied) and nonrespondents gave a 5.7. About 23% of respondents and 29% of nonrespondents reported some degree of dissatisfaction.
- Most respondent and nonrespondent gun hunters would have been willing to apply for licenses from the NDGF website (73% and 80%, respectively), some (14% of respondents, 15% of nonrespondents) would not, and a few (13% of respondents, 6% of nonrespondents) were unsure.

Hunting Record

- Most gun hunters reported they hunted the same amount (42%) or the less (39%) in the last five years.
- Most (92%) respondents did not hunt deer in other states in the last five years.
- About 23% of gun hunters also hunted other big game, 74% hunted upland game, 34% hunted waterfowl, 13% hunted other migratory game birds, 58% hunted furbearers, 16% hunted other game, and 11% did not hunt other game.

- Of the gun hunters that did not hunt (n=215), about 94% reported it was because they did not draw a license, 2% reported it was because there were too few deer, 1% reported it was because hunting land was too far away, 1% reported it was because they were concerned about conflicts with landowners, <1% reported it was because they did not have a place to hunt, <1% reported it was because they were concerned about crowding from other hunters, and 4% listed other reasons.
- The hunting units with the highest frequency of use by gun hunters were 2J2 (8%), 3C (7%), and 3F2 (7%). The units with the lowest frequency of use by gun hunters were 2D, 2L, 4B, and 4E (0% each).
- Most gun hunters have hunted with a rifle every time (95%), never hunted with a bow (92%), shotgun (86%), muzzleloader (98%), or handgun (98%). They reported not hunting over bait (93%), not hunting other game at the same time (54%), and not helping youth hunters (68%). Most gun hunters did report helping adult hunters (75%) and hunting with a partner (90%).

Background Information

- Most (56%) gun hunters began hunting between the ages of 12 and 17 years. Some began hunting when they were between 18 and 24 years (19%) or between 25 and 44 years (14%). Fewer began at less than 12 years old (7%) or between 45 and 64 years (3%), and even fewer began (1%) above the age of 65 years.
- Most (77%) gun hunters were first mentored in deer hunting by a male family member, some (17%) by a friend, a few (4%) went alone, even fewer (2%) were

mentored by a female family member, and about 1% were mentored by a hunting group or club.

- Most gun hunters reported getting their information about deer hunting from friends or family (98%), the NDGF website (60%), or the NDGF Deer Hunting Guide (55%). Fewer reported getting their information from books (40%), social media (28%), TV programs (43%), hunting clubs (8%), the internet (32%), or a deer hunting course (5%). Approximately equal numbers reported getting and not getting information from magazines (52% and 48%, respectively).
- About 8% of gun hunters were members of deer hunting or deer management groups at the local, state, or national level. General local groups (4%) were the most popular.
- Most (92%) gun hunters applied for a gun license every year and have never bought an archery tag (64%) or applied for a muzzleloader tag (82%).
- Gun hunters listed family (42%), nature (25%), and meat (17%) as the most important motivations for hunting. Very few gun hunters listed excitement (8%), trophies (6%), challenge (3%), skills (1%), and solitude (1%) as the most important motivations.
- The largest occupation group of gun hunters (21%) worked in construction/labor while the least (2% each) worked legal or the military. About 14% of gun hunters worked in agriculture, 12% worked in business, 11% worked in health care, 11% worked in customer service, 8% worked in transportation, 5% worked in education, 4% worked in energy development, 3% worked in natural resources, and 6% worked in other areas.

- Most gun hunters lived in rural areas (34%) or in large cities populated by more than 50,000 people (28%), while about 15% lived in areas populated by less than 5,000 people, 12% lived in areas populated by 5,001–25,000 people, and 11% lived in areas populated by 25,000–50,000 people.
- Most (98%) gun hunters were Caucasian, with very few in other ethnicity categories. About 2% were Native American or Asian, and no one reported being Black or Hispanic.

Satisfaction

- On a 5-point scale (1=very dissatisfied, 5=very satisfied), gun hunters reported an average of 2.7 satisfaction level with the ability to get a license of their choice, 4.2 with season dates, 4.1 with clarity of hunting regulations, and 4.2 with hunting equipment allowed. About 17% reported some degree of dissatisfaction with one or more of the aforementioned aspects of their hunting experience.
- Of those that reported they were dissatisfied (n=322), about 51% of gun hunters reported it was because there were not enough licenses available, 17% reported it was because they were unable to get the license type they wanted, 13% reported it was because they did not see enough deer, 9% reported it was because they did not have access to private land, 4% reported it was because they were not able to hunt in the area of their choice, 3% reported it was because of lack of access to public land, 2% reported it was because of conflicts with other hunters, and 1% reported it was because of conflicts with landowners.

Communication with NDGF

- About 89% of gun hunters had access to the internet at home, 11% did not, and <1% were unsure.
- Most (66%) gun hunters used the internet for personal use daily, about 16% used it weekly, 7% used it monthly, and 11% never used it.
- Gun hunters reported an average internet proficiency of 7.1 out of 10 (1=not proficient, 10=very proficient). About 20% reported some degree of deficiency.
- Most (64%) gun hunters would have preferred to receive information from NDGF by postal mail, many (59%) by email, about 15% by public announcement, 14% by text, 11% by phone app, and 4% by phone call.

Perceptions about deer populations

- Most (57%) gun hunters felt that harvest pressure on deer has had an impact on their hunting experience, while about 24% reported it had not, and 19% were unsure.
- Most (56%) gun hunters felt that harsh winter weather has had an impact on their hunting experience, while about 38% reported it had not, and 6% were unsure.
- Most (68%) gun hunters felt that habitat loss has had an impact on their hunting experience, while about 25% reported it had not, and 7% were unsure.
- About 46% of gun hunters felt that habitat fragmentation has had an impact on their hunting experience, 44% reported it had not, and 10% were unsure.
- From those who answered that habitat fragmentation had negatively impacted their hunting experience (n=117), about 68% reported it was because they saw fewer deer

as a result of fragmentation, 46% reported it was because of competition for licenses in the lottery, 20% reported it was because of crowding from other hunters, and 17% gave other reasons.

- Most (88%) gun hunters claimed to be familiar with CWD, about 7% were not, and 5% were unsure.
- Most (93%) gun hunters reported that the presence of CWD in ND had not caused them to deer hunt less, while about 4% reported it had, and 4% were unsure.
- Of those who reported being negatively affected by CWD (n=14), 50% of gun hunters reported it was because there were fewer deer to hunt because of CWD, about 29% reported it was because they did not want to consume meat that might be infected with CWD, and 7% reported it was because they did not want to come into contact with CWD, and 14% gave other reasons.
- About 35% of gun hunters claimed to be familiar with EHD, while 54% were not, and 12% were unsure.
- Most (76%) gun hunters reported that the presence of EHD in ND had not caused them to deer hunt less, while about 3% reported that it had, and 22% were unsure.
- Of those who reported being negatively affected by EHD (n=10), 80% of gun hunters reported it was because there were fewer deer to hunt, 10% reported it was because they did not want to come into contact with EHD, and 10% reported it was because they did not want to consume meat that might be infected with EHD.
- About 33% of gun hunters reported habitat loss as the factor most responsible for deer population decline in the state; 22% reported harsh winter weather, 19% reported

NDGF deer population management practices, 13% reported predation, 8% reported disease, and 5% reported habitat fragmentation.

Muzzleloader Hunters

A total of 565 questionnaires were returned (57% response rate). About 1% (n=3) of the respondents had applied to the lottery but never hunted deer in North Dakota and were not included in the analysis. Of the nonrespondent phone call recipients, all had hunted deer in North Dakota and were included in the analysis for comparison to respondents to assess nonresponse bias.

Respondent–Nonrespondent Comparison

- Respondent and nonrespondent muzzleloader hunters had hunted deer an average of 28 and 19 years in ND, respectively.
- Respondent and nonrespondent muzzleloader hunters had spent an average of 13 and 15 days afield per season, respectively.
- Most respondents and nonrespondents had harvested a deer in ND (99% and 97%, respectively).
- Most muzzleloader hunter respondents and nonrespondents also applied for a gun license (92% and 85%, respectively), a few applied for a gratis license (12% and 11%, respectively), and about 1% of respondents and 6% of nonrespondents did not apply for another license in the lottery.
- Most (61%) respondents were successful at drawing a license in the lottery, with about 44% drawing a gun license, 10% drawing a gratis license, and 7% drawing a muzzleloader license. Alternatively, most (56%) nonrespondents were unsuccessful at

drawing a license in the lottery, with about 36% drawing a gun license, 6% drawing a gratis license, and 2% drawing a muzzleloader license.

- About 70% of muzzleloader hunter respondents and 53% of nonrespondents preferred to hunt with a gun, while 25% and 29%, respectively, preferred a bow, and 5% and 15%, respectively, preferred a muzzleloader.
- Most muzzleloader hunter respondents (76%) and nonrespondents (72%) hunted at least one day in ND in 2015.
- Muzzleloader hunter respondents hunted an average of 7 days on public land for mule deer and 8 days for white-tailed deer; about 29% harvested a mule deer and 37% harvested a white-tailed deer. They hunted an average of 4 days on PLOTS land for mule deer and 5 days for white-tailed deer; about 15% harvested a mule deer and 17% harvested a white-tailed deer. They hunted an average of 6 days on private land for free (not PLOTS) for mule deer and 11 days for white-tailed deer; about 39% harvested a mule deer and 64% harvested a white-tailed deer. They hunted an average of 6 days on private land for a fee for mule deer and 20 days for white-tailed deer; about 33% harvested a mule deer and 71% harvested a white-tailed deer. Nonrespondent muzzleloader hunters hunted an average of 10 days on public land and about 55% harvested a deer. They hunted an average of 4 days on PLOTS land and about 30% harvested a deer. They hunted an average of 9 days on private land for free (not PLOTS) and about 47% harvested a deer. They hunted an average of 3 days on private land for a fee and 17% harvested a deer. (Identification of deer species was not asked of nonrespondents.)

- When asked about their overall hunting experience in 2015, muzzleloader hunters that responded to the questionnaire gave an average satisfaction rating of 3.7 out of 5 (1=very dissatisfied, 5= very satisfied) and nonrespondents gave a 4.1. About 14% of respondents and 11% of nonrespondents reported some degree of dissatisfaction.
- Most muzzleloader hunter respondents and nonrespondents were male (93% and 88%, respectively).
- Most muzzleloader hunter respondents were between the ages of 45 and 64 years (46%) or between the ages of 25 and 44 years (36%), a few (15%) were between the ages of 65 and 79 years, and about 3% of respondents were between 18 and 24 years. Most muzzleloader nonrespondents were either in the 25 to 44-year age class (52%) or the 45 to 64-year age class (32%). Some (12%) were between the ages of 18 and 24, while a few (3%) were between 65 and 79 years.
- The largest education class of respondent muzzleloader hunters (36%) had an undergraduate degree; about 22% had some college education but no degree, some had a graduate degree or a high school diploma (21% each), and a few (2%) had some high school education but no diploma. The largest education class of nonrespondent muzzleloader hunters (33%) had an undergraduate degree, some (26%) had a high school diploma, about 21% had some college education but no degree, a few (15%) had a graduate degree, and 3% had some high school education but no diploma.
- When asked about NDGF's techniques for deer population management, respondent muzzleloader hunters gave an average satisfaction rating of 6.1 out of 10 (1=very

dissatisfied, 10=very satisfied) and nonrespondents gave a 5.3. About 29% of respondents and 39% of nonrespondents reported some degree of dissatisfaction.

- Most respondent and nonrespondent muzzleloader hunters would have been willing to apply for licenses from the NDGF website (80% and 82%, respectively), some (15% and11%, respectively) would not, and a few (5% and 6%, respectively) were unsure.

Hunting Record

- Most muzzleloader hunters reported they hunted the same amount (41%) or less (34%) in the last five years.
- Most respondents did not hunt deer in other states in the last five years (76%).
- About 60% of muzzleloader hunters also hunted other big game, 90% hunted upland game, 57% hunted waterfowl, 34% hunted other migratory game birds, 79% hunted furbearers, 33% hunted other game, and 3% did not hunt other game.
- Of the muzzleloader hunters that did not hunt (n=136), about 93% reported it was because they did not draw a license, 7% reported it was because there were too few deer, 2% reported it was because they did not have a place to hunt, 2% reported it was because they were concerned about conflicts with landowners, 2% reported it was because they were concerned about crowding from other hunters, 1% reported it was because hunting land was too far away, and 8% listed other reasons.
- The hunting units with the highest frequency of use by muzzleloader hunters were 2G, 2C, 2B, and 2G2 (6% each). The units with the lowest frequency of use by muzzleloader hunters were 2B2, 3B1, and 1 (1% each).

- Most muzzleloader hunters hunted with a rifle (79%) or a bow (76%), but never hunted with a shotgun (88%), muzzleloader (69%), or handgun (92%). They reported not hunting over bait (59%) and not helping youth hunters (57%). Most muzzleloader hunters did report hunting other game at the same time (53%), helping adult hunters (75%) and hunting with a partner (84%).

Background Information

- Most (64%) muzzleloader hunters began hunting between the ages of 12 and 17 years. Some began hunting at less than 12 years (14%) or when they were between 18 and 24 years (13%). A few muzzleloader hunters began hunting between 25 and 44 years (7%) or between 45 and 64 years (1%). No one reported beginning hunting above the age of 65 years.
- Most (78%) muzzleloader hunters were first mentored in deer hunting by a male family member, some (15%) by a friend, a few (6%) went alone, even fewer (1%) were mentored by a female family member, and <1% were mentored by a hunting group or club.
- Most muzzleloader hunters reported getting their information about deer hunting from friends or family (95%), magazines (67%), the NDGF website (66%), NDGF Deer Hunting Guide (61%), and TV programs (62%). Fewer reported getting their information from social media (63%), hunting clubs (88%), or a deer hunting course (93%). Approximately equal numbers reported they do and do not get information from books (51% and 49%, respectively) or the internet (49% and 51%, respectively).

- About 25% of muzzleloader hunters were members of deer hunting or deer management groups at the local, state, or national level. General local groups (12%) were the most popular, while the Mule Deer Foundation and the North Dakota Bowhunters Association (7% each) were also popular.
- Most muzzleloader hunters reported applying for a gun license (96%) and a muzzleloader license (85%) every year, and buying a bow license every year (63%).
- Muzzleloader hunters listed nature (29%), family (29%) as the most important motivations for hunting. A few muzzleloader hunters listed excitement (12%), meat (11%), challenge (9%), trophies (4%), solitude (4%), and skills (1%) as the most important motivations.
- The largest occupation group of muzzleloader hunters (19%) worked in construction/labor while the least worked in tourism (1%). About 18% of muzzleloader hunters worked in agriculture, 14% worked in business, 7% worked in customer service, 6% worked in health care, 6% worked in energy development, 6% worked in transportation, 5% worked in natural resources, 4% worked in education, 3% worked in the military, 2% worked in legal, and 6% worked in other areas.
- Most muzzleloader hunters lived in rural areas (38%) or in large cities populated by more than 50,000 people (24%), while about 17% lived in areas populated by less than 5,000 people, 11% lived in areas populated by 5,001–25,000 people, and 9% lived in areas populated by 25,000–50,000 people.

- Most (99%) muzzleloader hunters were Caucasian, with very few in other ethnicity categories. About 1% were Native American, and no one reported being Asian, Black, or Hispanic.

Satisfaction

- On a 5-point scale (1=very dissatisfied, 5=very satisfied), muzzleloader hunters reported an average of 2.8 satisfaction level with the ability to get a license of their choice, 4.2 with season dates, 4.2 with clarity of hunting regulations, and 4.3 with hunting equipment allowed. About 18% reported some degree of dissatisfaction with one or more of the aforementioned aspects of their hunting experience.
- Of those that reported they were dissatisfied (n=455), about 31% of muzzleloader hunters reported it was because there were not enough licenses available, 21% reported it was because they were unable to get the license type they wanted, 11% reported it was because they did not see enough deer, 8% reported it was because they did not have access to private land, 3% reported it was because of conflicts with other hunters, 3% reported it was because they were not able to hunt in the area of their choice, 3% reported it was because of lack of access to public land, and 2% reported it was because of conflicts with landowners.

Communication with NDGF

- About 91% of muzzleloader hunters had access to the internet at home and 9% did not.

- Most (67%) muzzleloader hunters used the internet for personal use daily, about 16% used it weekly, 7% used it monthly, and 10% never used it.
- Muzzleloader hunters reported an average internet proficiency of 7.3 out of 10 (1=not proficient, 10=very proficient). About 18% reported some degree of deficiency.
- Most (66%) muzzleloader hunters would have preferred to receive information from NDGF by email, many (55%) by postal mail, about 21% by text, 16% by public announcement, 13% by phone app, and 6% by phone call.

Perceptions about deer populations

- Most (66%) muzzleloader hunters felt that harvest pressure on deer had an impact on their hunting experience, while about 22% reported it had not, and 12% were unsure.
- Most (66%) muzzleloader hunters felt that harsh winter weather has had an impact on their hunting experience, while about 29% reported it had not, and 5% were unsure.
- Most (82%) muzzleloader hunters felt that habitat loss has had an impact on their hunting experience, while about 15% reported it had not, and 2% were unsure.
- About 55% of muzzleloader hunters felt that habitat fragmentation has had an impact on their hunting experience, 37% reported it had not, and 7% were unsure.
- From those who answered that habitat fragmentation had negatively impacted their hunting experience (n=334), about 38% of muzzleloader hunters reported it was because they saw fewer deer as a result of fragmentation, 34% reported it was because of competition for licenses in the lottery, 12% reported it was because of crowding from other hunters, and 17% gave other reasons.

- Most (96%) muzzleloader hunters claimed to be familiar with CWD, about 2% were not, and 2% were unsure.
- Most (97%) muzzleloader hunters reported that the presence of CWD in ND had not caused them to deer hunt less, while about 2% reported it had, and 1% were unsure.
- Of those who reported being negatively affected by CWD (n=12), about 83% of muzzleloader hunters reported it was because there were fewer deer to hunt, 8% reported it was because they did not want to come into contact with CWD, 8% reported it was because they did not want to consume meat that might be infected with CWD, and 25% listed other reasons.
- About 60% of muzzleloader hunters claimed to be familiar with EHD, while 33% were not, and 7% were unsure.
- Most (85%) muzzleloader hunters reported that the presence of EHD in ND had not caused them to deer hunt less, while about 4% reported that it had, and 11% were unsure.
- Of those who reported being negatively affected by EHD (n=21), about 91% of muzzleloader hunters reported it was because there were fewer deer to hunt, 5% reported it was because they did not want to come into contact with EHD, 5% reported it was because they did not want to consume meat that might be infected with EHD, and 5% listed other reasons.
- About 34% of muzzleloader hunters reported habitat loss as the factor most responsible for deer population decline in the state; 23% reported NDGF management

practices, 22% reported harsh winter weather, 10% reported predation, 7% reported disease, and 4% reported habitat fragmentation.

CHAPTER 2

A TYPOLOGY OF NORTH DAKOTA BOWHUNTERS DURING A TEMPORAL DECLINE IN DEER POPULATIONS

Introduction

Balancing deer (*Odocoileus* spp.) populations with biological and social carrying capacities remains a challenge to resource managers. Unlike areas of the U.S. where overabundant deer populations and associated negative effects such as ecosystem damage or loss of biodiversity (Waller and Alverson 1997, Côté et al. 2004), deer-vehicle collisions (DeNicola et al. 2000, Bissonette et al. 2008, Ng et al. 2008), and disease risk (e.g., Lyme; Raizman et al. 2013, Kilpatrick et al. 2014, Werden et al. 2014) are commonplace, white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionis*) populations in North Dakota have been declining during the last several years (Peterson 2016). Several factors may have contributed to this decline, including previous efforts by North Dakota Game and Fish (NDGF) to control deer depredation on stored livestock feed by dramatic increases in the number of antlerless deer-gun licenses. Concomitantly, habitat loss and fragmentation (e.g., due to agricultural practices and energy development, respectively), consecutive severe winters, and sporadic disease outbreaks (e.g., Epizootic Hemorrhagic Disease [EHD]) are other factors that may have led to reduced deer numbers statewide. However, interest in North Dakota deer hunting has continued to remain high, with 69,791 deer-gun hunters applying for 43,275 lottery licenses for the 2015 season, a dramatic decline from the peak in 2009 when 144,400 licenses were available and 80,449 deer-gun hunters applied for lottery licenses (NDGF 2016). In addition, 23,710 hunters purchased bow licenses for the 2015 season, up from 21,218 hunters who purchased a bow license in 2009 (NDGF 2016).

As hunting became more popular in the U.S. during the mid-1970s, hunter numbers increased with deer populations, especially in the Northeast and Midwest (Curtis and Sullivan 2001). In the 1990's, white-tailed deer and mule deer populations continued to grow, facilitated by availability of favorable habitat and approximately a decade of relatively mild winters, allowing the largest harvest in North Dakota's deer hunting history with over 100,000 allocated deer tags each year from 2001 until 2011. Since this peak, a series of environmental and anthropogenic factors have caused dramatic reductions of both white-tailed deer and mule deer numbers in North Dakota, resulting in a proportional decline in the number of lottery deer-gun licenses available.

Although there is a long-term decline in the number of hunters overall in the U.S. (U.S. Fish and Wildlife Service [USFWS] 2004, 2013), the popularity of bowhunting deer has increased both nationally (USFWS 1991, 2011) and in North Dakota since the 1960's (Jensen and Gulke 2016). Approximately 33% of licensed hunters hunt with a bow nationwide (U.S. Department of Commerce [USDC] 2011). With the increase in popularity, new technologies have expanded the accuracy and range of archery equipment (Boulanger et al. 2002). In North Dakota, bowhunting for deer provides an additional recreational opportunity beyond the regular firearms deer season, and hunters may take 1 deer of any sex or age. Bowhunting season in North Dakota is long, generally lasting from late August or early September through the first week January. In North Dakota, deer-gun licenses are available via lottery, but deer-bow license availability is not restricted. Moreover, between 2000 and 2015, North Dakota bowhunter success rate average was 37% (Range: 27% to 43%). Because of this increase in popularity and the advanced technology currently available

for bowhunters, license numbers and/or technology may need to be limited to prevent overharvest or fair distribution of the harvest. However, if bowhunters are happy with equipment restrictions, limiting harvest may be more practically achieved by restricting license numbers (Boulanger et al. 2002).

Agencies that understand hunter motivations can tailor management programs accordingly to increase hunter benefits such as satisfaction (Boulanger et al. 2002, McCullough and Carmen 1982). A previous study of U.S. bowhunter motivations and satisfaction revealed that bowhunters value relaxation, enjoying nature, and the challenge of the hunt the most, and are largely satisfied with most aspects of their hunting experience (Duda and Bissell 2001). South Dakota bowhunters valued nature, excitement, and challenge most (Boulanger et al. 2002). It is unclear how a precipitous decline in deer populations and available licenses affects satisfaction and motivations for hunting, but we hypothesized lower satisfaction levels among bowhunters in North Dakota when compared to other states (Hendee 1974, Gigliotti 2000).

Traditionally, North Dakota hunting regulations and policy have been guided, in part, by a series of statewide public meetings held by NDGF. However, turnout to these meetings are usually minimal (W. F. Jensen, NDGF, personal communication) and potentially attended by those wishing to inform policy (Brzezinski et al. 2010, Peterson and Messmer 2010). The apparent discord between North Dakota resident deer hunters and NDGF at these meetings due to decreased deer numbers and license availability provided us with an opportunity for broader human dimensions inquiry.

We conducted a mail survey, the first of its kind in North Dakota, to generate a comprehensive understanding of resident gun, bow, muzzleloader, and landowner (i.e., gratis) deer hunters. Here we present partial results from this study, focusing on bow deer license applicants, an understudied deer hunting subgroup in the U.S. (Boulanger et al. 2002, Duda and Bissell 2001). Information from this study was designed to collect baseline information during a time of reduced deer populations to benefit North Dakota resource managers, decision makers, and bowhunters by potentially informing management decisions or regulation changes to better regulate the deer resource in North Dakota. Our objectives were to collect and assess information from resident North Dakota bowhunters; specifically, 1) demographics, 2) satisfaction levels, 3) success, and 4) perceptions of why deer populations have been declining in North Dakota.

Methods

We designed the self-administered mail questionnaire based on standard current practices and other published research, and adapted survey questions from previous, related deer hunter surveys as well as input from NDGF Big Game biologists and resident deer bowhunters (Boulanger et al. 2002, Vaske et al. 2006, Dillman et al. 2014, Siemer et al. 2014). We pilot tested the questionnaire on 20 local deer hunters and incorporated suggestions into the final survey draft. In general, questions were related to deer harvest, satisfaction, demographics, hunting experiences, perceptions of deer population decline, and motivations for bowhunting. The format of the questionnaire was a 16-page booklet consisting of 43 questions. We included with each questionnaire a cover letter stressing confidentiality, the nature of the survey, brief instructions, and contact information. We also

asked recipients to complete the questionnaire and mail it back to the Applied Research Institute (ARI) at the University of North Dakota (UND), the department that was also responsible for administering our questionnaire and collecting data.

We selected a random sample of 1,000 survey instrument recipients from 23,710 North Dakota resident hunters that bought a deer-bow license in 2015. We excluded hunters under 18 or over 79 years for legal and recall bias issues, respectively (Dillman et al. 2014). Our survey instrument mailing was timed to accommodate NDGF's annual, standardized short surveys distributed to multiple hunter subgroups after the close of the 2016 hunting season. The first contact with subjects was the questionnaire and a cover letter explaining the project, which was mailed on 11 April 2016. On 18 April, a reminder postcard was mailed to all non-respondents. On 2 May, a second copy of the questionnaire was sent to all non-respondents with a reminder cover letter. On 9 May, a final reminder postcard was mailed to all non-respondents. Finally, ARI conducted 50 follow-up phone calls to mail survey nonrespondents from 7 June to 27 June, and these participants were asked a series of ten questions from the original survey to assess whether they were demographically different from the mail survey respondents. This research followed all guidelines outlined in the UND Institutional Review Board Human Subjects policies and procedures (IRB Approval No. 201603-344).

We used chi-square and Fisher's Exact Test analyses to compare variables of interest. We also developed logistic regression models (Hilbe 2009) to explain bowhunter satisfaction and deer-harvest success and ranked them using Akaike's (1973) Information Criterion (AIC; Burnham and Anderson 2002) with $\Delta AIC < 2$, $\sum_{wi} > 0.9$). To determine predictive factors of

satisfaction, we constructed three candidate models that included combinations of demographics (i.e., gender, age, motivation for hunting, residence type, and number of years hunted in North Dakota); effort (i.e., type of land hunted and region of the state hunted); and other aspects of satisfaction (i.e., satisfaction with ability to get license of choice, season dates, clarity of hunting regulations, NDGF deer management techniques, and success). We performed the same process for success, assembling 12 candidate models from seven variables that included effort (i.e., land type hunted, region of the state hunted, and number of years hunted in North Dakota); and demographics (i.e., motivation for hunting, gender, and age). To estimate the strength of model fit, we used residual deviances compared to null deviances. We analyzed all data using Statistical Package for Social Sciences (SPSS) PC version 22 (International Business Machines Corporation, Armonk, New York) or R (Version 3.3.1, www.r-project.org, accessed 14 September 2016) with $\alpha = 0.05$ for simple hypothesis tests.

Results

A total of 408 questionnaires were returned (41% response rate). From the analysis, we further excluded bowhunters who purchased a North Dakota bow license but had never hunted (n = 7; 2%). We detected no significant biases between respondent and nonrespondent phone call recipient responses; thus, we do not report data or analyses from phone survey respondents.

Hunting Record

Respondents reported bowhunting deer an average of 20 years (SE = 0.77) in North Dakota and had spent an average of 14 days (SE = 0.74) afield per season, which was more than (31%) or the same effort as (31%) they hunted in the last five years. Most bowhunters (91%) had harvested at least one deer during their North Dakota bowhunting career; 20% had hunted deer in other states in the last five years. Proportions of bowhunters also hunted upland game (82%), furbearers (74%), waterfowl (47%), other big game (38%), other migratory game birds (22%), and other game (23%), or did not hunt other game (9%).

In 2015, most bowhunters also applied for a lottery gun license (75%), and some for a lottery muzzleloader license (13%), or landowner license (2%); 23% did not apply for a lottery license and only purchased a bow license. Most bowhunters (69%) who applied for a lottery license of any type were unsuccessful in the draw. Most respondents preferred to hunt with a gun (58%); 42% preferred hunting with a bow. Although most bowhunters have historically bought a bow license every year (68%), 81% have also applied for a gun license every year.

During the 2015 season, most bowhunters (87%) hunted at least one day in North Dakota. Of the bowhunters that did not hunt in 2015 (n = 53), most (81%) selected that they did not draw a license of their choice (i.e., the hunter preferred to hunt with a gun, applied for a gun license, and was not drawn in the gun lottery so bought a bow license to have an opportunity to hunt); other reasons for not bowhunting included too few deer (11%), concern about crowding from other hunters (4%), and not having a place to hunt or concern about conflicts with landowners (2% each). Although bowhunters have access to Private Land Open to Sportsmen (PLOTS), a NDGF and landowner cooperative designed to make

additional state lands available for hunting, most bowhunters spent about 14 days hunting in public land for mule deer and about 13 days hunting private land for free (not PLOTS) for white-tailed deer. Bowhunters were most successful harvesting mule and white-tailed deer on these lands (Table 1).

Table 1. Harvest success based on land type, mean days hunted, and type of deer hunted by bowhunters in North Dakota, USA, 2015.

Type of Land Hunted	Mule Deer					White-tailed Deer				
	Mean days hunted (SE)	Harvest a deer?				Mean days hunted (SE)	Harvest a deer?			
		Yes	%	No	%		Yes	%	No	%
Public land (i.e., federal, State, county)	13.7 (±1.3)	10	18.2	45	81.8	9.6 (±0.9)	46	38.3	74	61.7
NDGF's Private Land Open to Sportsmen (PLOTS)	6.7 (±2.2)	0	0	11	100	6.1 (±1.0)	13	28.3	33	71.7
Private land for free (not PLOTS)	10.3 (±1.8)	12	29.3	29	70.7	12.8 (±0.9)	112	50.9	108	49.1
Private land for pay (e.g., leased land, access fee, shooting preserve)	4.3 (±0.7)	0	0	2	100	4.0 (±1.0)	4	57.1	3	42.9

Demographic Information

The largest proportions of North Dakota bowhunters were male (94%), Caucasian (99%), between the ages of 25 and 44 years (44%) with an undergraduate degree (31%), who lived in a rural area (33%). The largest occupational group of bowhunters worked in

construction and labor (21%), followed by business (15%), agriculture (14%), and customer service (8%). Most bowhunters (60%) began hunting between the ages of 12 and 17 years while <1% began after the age of 45. The majority of bowhunters (77%) learned how to bow-hunt from male family members; 16% learned from a friend, and 5% were self-taught. Bowhunters reported getting their information about deer hunting from friends or family (97%), the NDGF website (67%), outdoor magazines (66%), TV programs (62%), the NDGF Deer Hunting Guide (58%), and hunting books (54%). Only 14% indicated that they were part of a deer hunting or management organization and the majority of those (11%) were from a local club like the North Dakota Bowhunters Association while the remailing 3% were only part of national organizations. Age appeared to have an impact on where a hunter got their information, with greater proportions of hunters younger than 45 years using social media ($\chi^2_3 = 22.23$, $p < 0.01$) and the internet ($\chi^2_3 = 17.13$, $p < 0.01$) compared to those over the age of 45.

The survey offered recipients eight choices for most important motivation for hunting. Responses, ordered from most to least frequent, were 1) nature, valuing being in the outdoors and the beauty of nature (34%), 2) social, valuing time spent with family and friends (21%); 3) meat, valuing bringing home meat for food (17%); 4) excitement, valuing the exhilaration that comes with hunting (11%); 5) solitude, valuing the time spent alone while hunting (6%); 6) challenge, valuing the challenge of hunting, tracking, and harvesting a deer (6%); 7) trophy, valuing demonstrating hunting skills or accomplishment (e.g., harvesting a big buck; 4%); and 8) skill, valuing the ability to use certain equipment to stalk and harvest a deer (1%). We found that hunters in all age ranges mostly identified themselves

as nature hunters, but hunters in the 45–64 age category identified as challenge or excitement hunters more than any other age group, and hunters in the 25–44 age category identified as social or meat hunters more than any other age group ($\chi^2_{21} = 34.2$, $p = 0.03$). Gender was not associated with motivation ($P = 0.44$, Fisher's exact test) or an individual's satisfaction with NDGF deer management techniques ($\chi^2_2 = 1.08$, $p = 0.58$).

Satisfaction and Success

When asked about their overall hunting experience in 2015, bowhunters gave an average satisfaction rating of 3.8 (SE = 0.04) out of 5 (1 = very dissatisfied, 5 = very satisfied); about 15% reported some degree of dissatisfaction. Satisfaction with NDGF's techniques for deer population management was a somewhat lower average satisfaction rating of 3.0 out of 5, with about 27% reporting some degree of dissatisfaction. Of those who indicated they were dissatisfied, about 30% responded that it was because there were not enough licenses available (i.e., gun or muzzleloader); other reasons included not seeing enough deer (18%), inability to see enough deer (14%), inability to get the license type they wanted (14%), no access to private land (14%), inability to hunt in the area of their choice (2%), conflicts with other hunters (2%), lack of access to public land (2%), and conflicts with landowners (1%). When asked if they were satisfied with certain factors pertaining to regulations, bowhunters were mostly satisfied with hunting season dates, clarity of regulations, and equipment allowed while hunting, but dissatisfied with the ability to get a license of their choosing (Table 2).

Table 2. The satisfaction rating of bowhunters for each factor pertaining to North Dakota Game and Fish Department deer hunting regulations where 1=very dissatisfied and 5=very satisfied, USA, 2015.

Satisfaction	Ability to get a license of choice		Season dates		Clarity of regulations		Equipment allowed	
	%	*n*	%	*n*	%	*n*	%	*n*
1	18.2	72	2.0	8	0.8	3	1.5	6
2	24.5	97	6.3	25	5.6	22	4.8	19
3	21.2	84	16.2	64	14.4	57	12.9	51
4	17.2	68	25.6	101	31.1	123	26.1	103
5	18.9	75	49.9	197	48.1	190	54.6	215
Total	100.0	396	100.0	395	100.0	395	100.0	394

We determined the nature of the relationship between bowhunter harvest success, defined as harvesting at least 1 deer during the 2015 bow season, and type of land hunted, region of the state hunted, number of days spent hunting per season, number of years they had hunted in North Dakota, and their motivation for hunting. From these analyses, type of land hunted ($\chi^2_3 = 10.87$, $p = 0.01$; Table 3) and region hunted ($\chi^2_7 = 52.56$, $p < 0.01$; Figure 1) appeared to influence success.

Table 3. Harvest success and bowhunter satisfaction with hunting experience depending on what type of land they hunted deer on in North Dakota, USA, 2015.

Land Type Hunted	Whitetail				Mule			
	Successful		Unsuccessful		Successful		Unsuccessful	
	n	%	*n*	%	*n*	%	*n*	%
Public	46	26.7	80	34.8	10	43.5	45	48.9
PLOTS	13	7.6	38	16.5	0	0.0	15	16.3
Private for pay	4	63.4	3	47.4	1	52.2	2	32.6
Private for free	109	2.3	109	1.3	12	4.3	30	2.2
Total	172	100.0	230	100.0	23	100.0	92	100.0

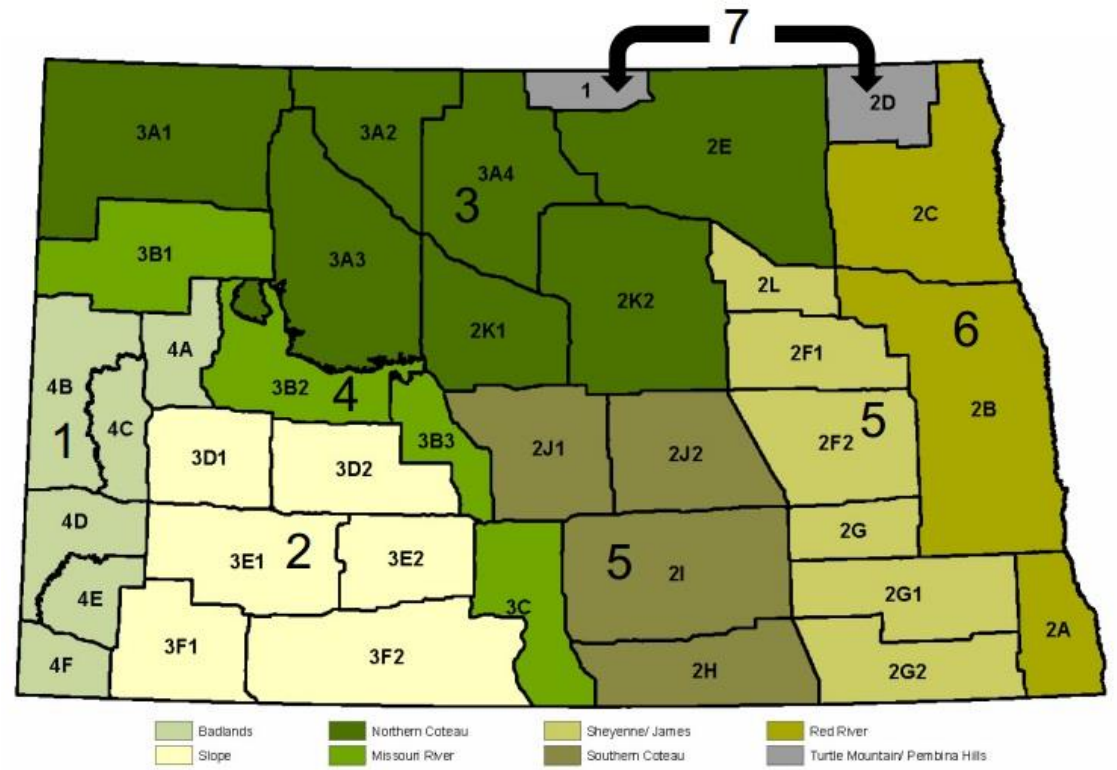


Figure 1. Region map of North Dakota, USA divided by hunting units and major management units.

Harvest success increased when hunting for white-tailed deer on private land and when hunting in regions 2 (Slope; Figure 1), 3 (Northern Coteau), 4 (Missouri River), and 5 (Southern Couteau and Sheyenne/James) toward the center of the state ($\chi^2_3 = 10.87$, $p = 0.01$). Harvest success did not appear to depend on the number of years a hunter had hunted in North Dakota ($\chi^2_6 = 10.11$, $p = 0.12$), motivation for hunting ($\chi^2_9 = 2.59$, $p = 0.98$; Table 4), or the type of land hunted for mule deer ($P = 0.12$, Fisher's exact test; Table 3).

Table 4. Harvest success and bowhunter satisfaction with hunting experience depending on their motivation for hunting deer in North Dakota, USA, 2015.

	Harvest Success				Satisfaction with Hunt			
	Successful		Unsuccessful		Satisfied		Dissatisfied	
Motivation	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Nature	56	19.4	59	17.4	72	15.3	14	27.5
Social	33	0.6	28	3.9	40	1.1	6	5.9
Meat	31	35.0	27	38.1	29	37.9	14	27.5
Excitement	18	11.3	20	12.9	23	12.1	7	13.7
Solitude	11	20.6	7	18.1	11	21.1	5	11.8
Challenge	9	0.6	7	0.6	11	1.1	2	0.0
Trophies	1	5.6	6	4.5	2	5.8	3	3.9
Skill	1	6.9	1	4.5	2	5.8	0	9.8
Total	160	100.0	155	100.0	190	100.0	51	100.0

We also determined the relationship between overall satisfaction with their 2015/2016 deer hunting season and harvest success, age, gender, satisfaction with three factors of their hunting experience (ability to get a license of their choice, season dates, and clarity of hunting regulations), satisfaction with NDGF deer management techniques, perceptions of population decline, the type of land they hunted, motivation for hunting deer, preferred weaponry, type of residence they came from, and number of years they had hunted in North Dakota. It appeared that hunter satisfaction depended on harvest success ($\chi^2_3 = 69.10$, $p < 0.01$; Table 5), ability to get the license of their choice ($\chi^2_6 = 68.85$, $p < 0.01$), season dates ($\chi^2_6 = 17.03$, $p = 0.01$), clarity of hunting regulations ($\chi^2_6 = 22.37$, $p < 0.01$), land type hunted ($\chi^2_9 = 292.33$, $p < 0.01$), region of the state hunted ($\chi^2_{18} = 44.93$, $p < 0.01$), preferred weaponry ($\chi^2_6 = 23.19$, $p < 0.01$), and satisfaction with NDGF deer management techniques ($\chi^2_3 = 77.22$, $p < 0.01$).

Table 5. Harvest success related to hunter satisfaction of deer bowhunters in North Dakota, USA, 2015.

	Harvest Success			
	Successful		Unsuccessful	
Satisfaction	***n***	**%**	***n***	**%**
Satisfied	125	91.2	39	35.8
Dissatisfied	12	8.8	70	64.2
Total	137	100.0	109	100.0

Satisfaction does not appear to depend on gender ($P = 0.59$, Fisher's exact test), age ($\chi^2_9 = 12.82$, $p = 0.17$), perception of population decline ($\chi^2_{18} = 25.23$, $p = 0.12$), motivation for hunting ($P = 0.13$, Fisher's exact test; Table 4), or the number of years a hunter has hunted in North Dakota ($\chi^2_{12} = 17.88$, $p = 0.12$). Additionally, hunters in region 6 (Red River; Figure 1) indicated that they were less satisfied with NDGF's deer management techniques than hunters in any other region ($\chi^2_{12} = 23.95$, $p = 0.02$).

Three of the ten logistic regression models met the combined weight condition of 0.95 (ΔAIC = 0–3.35; Table 6) for variables that potentially explained satisfaction.

Table 6. Model rank, variables, number of estimable parameters (K), log-likelihood (log [L]), Akaike's Information Criterion (AIC), ΔAIC, and Akaike weights (ω_i) for logistic regression models representing overall satisfaction. Models were ranked by AIC score from 10 candidate models using 12 variables.

Rank	Model Variables[a]	K	Log (L)	AIC	ΔAIC	ω_i
1	NDGF * License + Regulations + Success	6	-37.446	87.5	0.00	0.650
2	NDGF + License + Regulations + Success	5	-39.859	90.2	2.63	0.174
3	NDGF + License * Regulations + Success	5	-39.077	90.8	3.26	0.127

[a]Variables are shortened for conciseness. NDGF = satisfaction with NDGF's deer management techniques, License = satisfaction with the ability to a license of choice, Regulations = satisfaction with clarity of hunting regulations, and Success = harvest success.

All three models included satisfaction with NDGF's deer management techniques, satisfaction with the ability to get a license of choice, satisfaction with clarity of hunting regulations, and harvest success (Table 6). Model strength was adequate for these three models, with a null deviance of 140.47 for each and a residual deviance of 74.89–79.72 (53%–57% of the null). Based on best model fit (AIC = 87.5), we found that when a bowhunter was satisfied with NDGF population management and with their ability to get a license of choice, they were 17 times more likely to be satisfied with their overall experience (95% confidence interval [CI] = 14.1–19.5). Additionally, hunters who successfully harvested a deer were seven times more likely to be satisfied with their experience (CI = 6.1–8.7). The top three models explaining harvest success (AIC = 479.8–483.2) included land type and region hunted, where Region 2 (Slope; Figure 1) was the only consistently significant explanatory variable for success ($P = 0.01$). The model fit for all three models, however, was low with a null deviance of 476.30 for each and a residual deviance of 445.08–472.50 (93%–99% of the null).

Perceptions About Deer Population Decline

Most bowhunters felt that habitat loss (68%), harsh winter weather (59%), and harvest pressure on deer (57%) had a negative impact on their hunting experience. Forty eight percent of respondents reported that habitat fragmentation (e.g., road construction, urban development, and energy development) had negatively impacted their hunting experience. From those who indicated that their hunting experience was negatively impacted by habitat fragmentation, about 49% checked it was because they saw fewer deer as a result of fragmentation, 45% selected that it was because of competition for licenses in the lottery, and

23% specified it was because of crowding from other hunters. Proportions of bowhunters reported their perceived factors most responsible for deer population decline in North Dakota, and these included habitat loss (31%), harsh winter weather (21%), NDGF's deer population management practices (19%), predators (14%), disease (8%), and habitat fragmentation (7%).

Most bowhunters claimed to be familiar with chronic wasting disease (CWD; 88%), but only 7% reported that the presence of CWD in North Dakota had caused them to deer hunt less, regardless of the region of the state they hunted in. Additionally, about 44% of bowhunters claimed to be familiar with epizootic hemorrhagic disease (EHD) and most (81%) reported that the presence of EHD in North Dakota had not caused them to deer hunt less. Of those who reported being negatively affected by CWD (n = 8) or EHD (n = 9), all of them (100%) indicated it was because there were fewer deer to hunt. Region of the state was not correlated with those reporting being negatively affected by CWD ($P = 0.44$, Fisher's exact test) or EHD ($P = 0.20$, Fisher's exact test).

Discussion

Our data indicated that the majority of North Dakota bowhunters were male between the ages of 25 and 44 years, working in construction and labor or agriculture. In 1976, most hunters in the U.S. were white males between the ages of 26 and 45 years, had at least a high school education, worked a blue-collar job, and lived in an urban area but grew up in a rural area (Hendee and Potter 1976, Gilbert 1977). Most of today's deer hunters in the USA are male, slightly older than before at 43–59 years (Schorr et al. 2014), and have a slightly higher income (Hansen et al. 1994). Because North Dakota bowhunters are similar in age to those in

1976 from the USA, this may suggest that North Dakota still has active recruitment; a result of hunting still being a large part of the North Dakota tradition, and/or the recent addition of hunters moving to North Dakota from other parts of the country as a result of recent energy development. Differences that we found were that most North Dakota bowhunters had at least a college education (76.3%) and lived in a rural area or small town of less than 5,000 (49.3%). Although most hunters are still male, participation by females in the U.S. is increasing (Snepenger and Ditton 1985). We found that 6.5% of North Dakota bowhunters are female, while the U.S. average is about 11% (USDC 2011). This difference may be explained because the sex ratio in North Dakota is skewed toward men compared to the sex ratio for the U.S. (USDC 2010), and may also be the reason that new hunters were taught mostly by male family members or friends.

Most North Dakota bowhunters considered themselves nature hunters (34%) followed by social hunters (21%) and meat hunters (17%) as their top motivations for bowhunting. In comparison, South Dakota bowhunters considered themselves nature hunters (34%) followed by excitement (29%) and challenge (16%) hunters (Boulanger et al. 2002). In a nationwide study, nature and challenge bowhunters ranked highest (Duda and Bissell 2001). North Dakota hunters may deviate from the national trend of motivations because of the difficult conditions often experienced during the deer hunting season. However, it remains unclear how North Dakota excitement hunters are affected by some of the highest mosquito densities in the U.S. (Anderson et al. 2015) or extreme cold, wind, or snow. In addition, literature suggests that deer hunters tend to value more than just harvest, as most hunters do not hunt for the sole purpose of obtaining meat (Decker and Connelly 1989, Duda 1993, Boulanger

2006). The most important aspects to current hunters tend to be more akin to nature and companionship (Hautaluoma and Brown 1979, Gigliotti 2000, Boulanger et al. 2006), although other studies suggest that some big game hunters in particular still define quality of a hunt in terms of succeeding in harvesting game, or having the opportunity to do so (Stankey et al. 1973, Decker et al. 1980). Similarly, we found that North Dakota bowhunters mostly identify as nature or social hunters. However, 64% also indicated that they were not satisfied unless they harvested a deer, which disagrees with the motivation for hunting that these hunters claim. This apparent discord could be because gun license availability restricts licensees from the lottery, so traditional friend and family hunting groups may be broken up by those who are and are not successful in the license lottery and are not willing to hunt with a bow.

Dissatisfaction occurs when a hunter's experience does not meet his or her expectations for a hunt (Enck and Decker 1991). In general, about 76% of North Dakota bowhunters were satisfied with their overall hunting experiences in North Dakota. In comparison, about 85% of South Dakota bowhunters were satisfied with the overall archery hunting opportunities in South Dakota (Boulanger et al. 2002). Moreover, a 91% bowhunter satisfaction level was reported nationwide, and that research suggested that high levels of satisfaction may indicate fewer negative issues related to archery deer season management (Duda and Bissell 2001. We noted satisfaction regarding NDGF deer population management at about 60%, with about 27% reporting some degree of satisfaction. Although we recognize that hunter satisfaction may stem from more than harvesting a deer (e.g., spending time in nature, seeing game, spending time in nature or with family or friends; Stankey et al. 1973),

we agree with previous research that lower deer numbers and hunting opportunities, such as those existing during the time of this study in North Dakota, may lower satisfaction levels (Needham and Vaske 2013). We found that satisfaction is largely based on harvest success and other aspects of satisfaction (i.e., satisfaction with ability to get license of choice in the lottery, with clarity of regulations, and with NDGF's deer management techniques). Bowhunters who indicated that they were dissatisfied with their hunting season reported that it was because of the inability to get the license of their choice or that there were too few deer seen, both of which would negatively impact a hunter's expectation for their hunt. This also suggests that bowhunters may engage in this activity because they could not draw a lottery deer-gun license.

Another aspect of hunter satisfaction involves game laws and regulations. When surveyed, Virginia hunters responded that their hunting experience ultimately benefitted from game laws and regulations, while a small portion indicated that some restrictions negatively impacted their hunting experience (Beattie 1981). In Michigan, hunters were more likely to report that their hunting experience was positive if they saw at least one deer while in the field (Langenau 1981). For example, 17.5% of North Dakota bowhunters cited not seeing enough deer as the primary reason for their dissatisfaction with the 2015 hunting season. However, McCullough and Carmen (1982) found that deer hunter satisfaction was based on variables not controllable by deer managers like shots taken and kill rate. We found that 18.5% of North Dakota bowhunters thought that NDGF's deer population management techniques were the most influential factor driving ND deer populations. In a study to determine archery hunters' satisfaction with local deer management, Duda and Bissell (2001)

determined that satisfaction was dependent on harvest success, seeing deer, perceived deer herd size, and the perception of a balanced harvest. To our knowledge, the extent to which the public thinks wildlife biologists influence deer populations has not been extensively studied.

A hunter's level of specialization may influence his or her hunting experience. Although firearm hunting is the most popular, archery hunting is considered more specialized and is growing in popularity (Duda and Bissell 2001, Boulanger et al. 2002). In 2001, most archery hunters in the U.S. were satisfied with their hunting experiences and with game management practices. Overall, there is a lack of published data correlating preferred weaponry with hunter demographics. Our study revealed that North Dakota bowhunter satisfaction was mostly based on harvest success and the ability to get their license of choice.

We found that success was not influenced by hunter motivation. In contrast, there was a tendency for South Dakota nature hunters to be less successful than challenge hunters (Boulanger et al. 2002). While nature hunters tend to focus less on harvest than being in nature, challenge hunters may enjoy increased patience, getting closer to game, the physical challenge, and mastering archery equipment (Duda and Bissell 2001). The aforementioned influences may be why these hunter types tended to be successful in South Dakota, but North Dakota is subject to difficult environmental conditions, potentially making it more difficult to enjoy some of the aspects associated with nature and challenge hunting. Another possibility is that finding a hunting location and getting close to deer can be a challenge relative to other states. For example North Dakota has the distinction of being the least forested state in the U.S. (Jensen 2011). Although preliminary findings suggested that success occurred more

frequently in the center regions of the state (potentially due to higher relative deer abundance), we did not find any consistent explanatory variables for harvest success; unlike Iowa an South Dakota where the number of years of experience hunting was positively correlated with harvest success (Gladfelter et al. 1983, Boulanger et al. 2002).

To our knowledge, bowhunter perceptions of deer population decline have not been studied previously and could be a factor for determining satisfaction. Although we did not find relationships between perceptions of population decline and satisfaction, this does not mean opinions about these issues are unimportant. We found that 18.5% of North Dakota bowhunters thought that NDGF's deer population management techniques were the most influential factor driving North Dakota deer populations. Habitat loss and fragmentation was the most commonly cited reason to which bowhunters attributed deer population decline. Between 2005 and 2008, more than 850,000 ha of native grasslands in North Dakota were converted to ethanol-corn cropland, resulting in a major loss of Conservation Reserve Program (CRP) grasslands and wildlife habitat (Fargione et al. 2009). Additionally, the amount of land enrolled in CRP in North Dakota has dropped from a high of about 1,375,000 ha in 2009 to 567,000 ha in 2016; a 59% decline. The perception of bowhunters regarding the importance to CRP to deer is supported by recent research conducted in the northern Great Plains (Grovenburg et al. 2011*a*, 2011*b*, 2012). Habitat fragmentation due to energy development is a relatively new issue for wildlife and wildlife managers in North Dakota and around the country. North Dakota's first oil boom occurred in the early 1980s, followed by a second between 2007 and 2013, when over 7,000 wells were drilled in the western portion of the state (NDSWC 2014). In western Wyoming, mule deer were observed altering their home

ranges and wintering grounds to use areas farther away from oil well drilling sites over the course of the three-year study (Sawyer et al. 2006). It has been suggested that in North Dakota when habitat is highly fragmented, coupled with high coyote (*Canis latrans*) numbers, fall fawn recruitment may be reduced (Ciuti et al. 2014).

Harsh winter weather was the next highest-ranked reason bowhunters held liable for population decline. Again, this perception is supported by recently conducted regional research. An evaluation of 13 telemetry studies in Minnesota, North Dakota and South Dakota found that landscape configuration, precipitation, and temperature were the primary drivers impacting white-tailed deer fawn survival in the Northern Great Plains (Eric Michel, South Dakota State University, personal communication). Additionally, the amount of cover available is important when considering winter weather avoidance strategies. In the nearby forested habitat of North-Central Minnesota, higher mortality rates of white-tailed deer were correlated with deeper snow (DelGiudice et al. 2002, Brinkman et al. 2005, Proffitt et al. 2008). Areas of deep snow act as traps, making it difficult for deer to maneuver and creating an easy target for predators which are more adept at functioning in deep snow (Proffitt et al. 2008). Deer bow hunters responded at a rate of 14% attributing the population decline to predation. Historically, North Dakotans have tried to eradicate and/or control all wild canid predators. Between 1898 and 1961, the state spent more than $2.2 million dollar on bounties for wolves (*Canis lupus*), coyotes, and red fox (*Vulpes vulpes*) (William Jensen, NDGF, personal communication). Although there is still strong sentiment against coyotes, it would appear that vast majority of bow hunters understand the importance of quality habitat, and that the susceptibility of deer to predation may be limited.

When asked about bowhunter perceptions of CWD and EHD, most replied that they were familiar with both diseases but that neither had caused them to hunt less. No one we surveyed in this study indicated that they had stopped hunting because of disease-related reasons. A study of recreational deer hunters from Alberta, Canada revealed that deer hunters may have differing opinions about the management of CWD based on whether they are from a more urban or more rural area (Zimmer et al. 2012). Hunters from urban areas indicated that they would hunt somewhere else if their preferred area contained CWD-infected deer and would decline hunting when more licenses were available in the CWD-impacted areas. We did not find similar results, instead concluding that there was no correlation between residence type or location and perception of disease. In a previous study of hunter perceptions about CWD in four Midwestern states, North Dakota deer hunters were shown to be the most likely to stop hunting given the knowledge of CWD in the environment where they were hunting (Vaske and Lyon 2011). A study of hunters in eight different states conducted in 2002 revealed that even if CWD had been detected in 50% of the deer population throughout the state, 59% of resident hunters would still hunt in North Dakota (Needham et al. 2004). Because of the relatively low number of confirmed CWD cases in North Dakota (n=8 mule deer and 1 white-tailed deer) since its first appearance in 2009, and the fact that all of those cases were all found in one hunting unit (Unit 3F2, Region 2, Slope), it is reasonable that most bowhunters do not feel they are at risk.

Management Implications

Satisfaction levels, motivations, and behaviors that explain harvest success can be gleaned from survey research targeting hunting subgroups. Our goal was to learn about resident North

Dakota bowhunters to benefit NDGF biologists, decision makers, and the bowhunters themselves. We provided baseline information from this study to help guide policy and be valuable for deer hunters to better understand the growing bowhunter community. Moreover, this study served to inform outreach improvements between NDGF and the public about factors that contribute to deer population decline (e.g., weather, habitat loss and fragmentation). From the responses provided, bowhunters are well informed, and attuned as to the primary drivers influencing deer numbers and recreational opportunities in North Dakota. With most North Dakota bowhunters being satisfied with their overall hunting experience, establishing additional limits for deer bow 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 deer-bow licenses to adjust for harvest goals.

CHAPTER 3

SATISFACTION, SUCCESS, AND PERCEPTIONS OF NORTH DAKOTA DEER-GUN HUNTERS DURING A TEMPORAL DECLINE OF DEER POPULATIONS

Introduction

Deer (*Odocoileus spp.*) continue to be an important resource for humans and are the most popular large game animal in the U.S. and Canada (Hewitt 2015). In N.D., deer hunting generates approximately $159 million in in state-wide revenue (U.S. Fish and Wildlife Service 2012). However, N.D. white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) populations have declined dramatically since 2009 (Peterson 2016) due to previous efforts by N.D. Game and Fish (NDGF) to control deer depredation on stored livestock feed by substantial increases in the number of antlerless deer-gun licenses. Additionally, consecutive severe winters, habitat loss and fragmentation (e.g., due to agricultural practices and energy development, respectively), and occasional disease outbreaks (e.g., Epizootic Hemorrhagic Disease [EHD]) have also led to reduced deer numbers throughout the state.

Despite the recent deer population decline, interest in deer hunting in N.D. remains high, with 69,791 resident and nonresident deer-gun hunters applying for 43,275 lottery licenses for the 2015 hunting season, down from 144,400 licenses available to 80,449 applicants in 2009 (W. F. Jensen, NDGF, personal communication). N.D.'s deer-gun hunting license allocation system is a lottery, meaning not all hunters who applied for a license will get one. Due to the vulnerability of deer to the gun in an open agricultural/prairie landscape,

the number of these licenses is limited to accommodate and conserve the deer population in the state. Moreover, deer-gun hunters represent the largest hunter group in N.D.; thus, this group is important for driving deer management and policy. Should deer populations continue to decline in N.D., there may be a need to further limit licenses; these changes, however, may be controversial.

Except for recent years, hunter populations in the U.S. have steadily fallen over time (Enck et al. 2000, Riley et al. 2003, Ryan and Shaw 2011, Larson et al. 2013, U.S. Department of the Interior and U.S. Department of Commerce 2014). Part of this decline was due to lack of hunter recruitment and retention efforts by fish and wildlife agencies and increased urbanization (Berry 1980, Bettencourt and West 2010). Urbanization plays two roles in hunter decline; loss of habitat for housing and development, and people being more distanced from outdoor recreation opportunities (Alig et al. 2004). However, the current movement by game managers to increase hunter recruitment and retention has, in part, succeeded in increasing the number of hunters in the U.S. by targeting social structures that influence a person's drive to hunt like social support, access to land and equipment, and public portrayal of hunting (Larson et al. 2014). Additionally, the recent locavore trend has prompted urbanites to engage in subsistence hunting as an alternative to buying meat from local markets (Rudy 2012; Tidball et al. 2014*a*, Tidball et al. 2014*b*). Moreover, there has been an influx of female hunters in recent years due to an interest by natural resource managers in determining more effective recruitment techniques for female hunters (Gigliotti and Metcalf 2016). Women, however, represent only 11% of the total number of hunting participant's in the U.S. (USDI and USDC 2014), and information related to female hunters

is reported to be sparse (Heberlein et al. 2008). Given women represent 50% of the human population, women represent an obvious segment for possible recruitment (McFarlane et al. 2003).

The North Dakota Game and Fish Department had little information regarding state-wide gun hunters, and sought to better understand demographics, including gender and residence type differences, and satisfaction, success, and perceptions of deer population decline to better manage the deer resource. Satisfaction is based on how a hunter's expectations for a hunt are met or not (Enck and Decker 1991). Managing hunter expectations can help elevate satisfaction rates by identifying what hunters want to experience on a hunt and educating them about the realities of certain hunting aspects (Hammitt et al. 1989). Several studies suggest that hunter effort is linked to satisfaction (Holsworth 1973, Van Deelen and Etter 2003, Weckerly et al. 2005). When effort is low and harvest is high, satisfaction is high, thereby maintaining hunter retention (Weckerly et al. 2005). When agencies understand hunter motivations and perceptions regarding deer management, they can tailor management programs to increase hunter satisfaction and improve recruitment and retention (Boulanger et al. 2002, Gigliotti and Metcalf 2016, McCullough and Carmen 1982) and increase outreach efforts if there are misperceptions regarding deer ecology or management (Miller and Shelton 2000, Needham and Vaske 2008, Harper et al. 2015).

We conducted a state-wide mail survey, the first of its breadth in N.D., to learn more about resident deer-gun hunters to benefit NDGF managers and decision makers and for the hunters themselves. The questionnaire was designed to provide baseline information on

resident N.D. deer-gun hunters, and to help NDGF determine how best to cater to various segments of deer hunters in N.D. during a time of reduced deer hunting opportunities. Our objectives for this study were to 1) provide baseline demographics, including differences among gender and residence type; 2) identify factors related to satisfaction and success; and 3) examine hunter perceptions of deer population decline in N.D. We hypothesized lower satisfaction levels among deer-gun hunters in N.D. when compared to other states, but at the time of this study, it was unclear how a dramatic decline in deer populations and available licenses affected hunter satisfaction and motivations.

Methods

Our sample frame for this study included resident 2015 deer-gun (centrefire) applicants between the ages of 18 and 79. We excluded hunters under the age of 18 to avoid a costly and time-consuming step of obtaining parental permission. We excluded hunters 80 and older because participation declines precipitously when hunters reach older ages; for example, the reported national hunting participation rate for those aged 75 years and older is only 2 percent (USDI and USDC 2014). Within this frame, we randomly sampled 1,000 applicants after pilot testing the questionnaire with 20 resident deer hunters. The survey instrument was 16 pages and included 43 questions designed using input from NDGF biologists and literature (Boulanger et al. 2002, Vaske et al. 2006; Dillman et al. 2014, Siemer et al. 2014). We asked questions about deer hunting experiences, satisfaction and harvest success (hereafter defined as the harvest of at least one deer), hunter demographics, motivations for hunting, and perceptions of deer population decline.

To administer the questionnaire, we used a 4-wave mailing system based on Dillman et al. (2014) beginning on April 11, 2016 to accommodate NDGF's annual harvest surveys at the close of the 2015-2016 season. The first mailing included the questionnaire and a cover letter detailing study importance and confidentiality. Spaced a week apart, we then sent a reminder postcard to non-respondents, a second copy of the questionnaire with reminder cover letter, and a final reminder postcard. One month later, we conducted a nonresponse check by randomly sorting the list of gun hunters and conducting follow-up phone interviews to a sample of 60 non-respondents. We asked non-respondents 12 key questions from the questionnaire that focused on topics related to demographics and success. This research was conducted under the guidelines specified in the UND Institutional Review Board Human Subjects policies and procedures (IRB Approval No. 201603-344).

We compared means using independent samples *t*-tests and used chi-square and Fisher's Exact Test analyses to discern differences among groups, including those between gender and residence types. In the questionnaire, participants were asked to identify their place of residence as "rural" or "city of less than 5,000" to "city of 50,001 or more". Anyone who identified as living anywhere but "rural" was considered "urban". We developed logistic regression models (Hilbe 2009) to explain differences in motivations and beliefs between the two groups. We then ranked these models based on Akaike's (1973) Information Criterion (AIC; Burnham and Anderson 2002), reporting models for which $\Delta AIC < 2$ or $\sum_{wi} > 0.9$. To determine strength of model fit, we compared residual to null deviances. We analyzed all data using Statistical Package for Social Sciences (SPSS) PC version 22 (International

Business Machines Corporation, Armonk, New York) and R (Version 3.3.1, www.r-project.org, accessed 14 September 2016) with $\alpha = 0.05$ for simple hypothesis tests.

Results

A total of 413 surveys were returned (41% response rate) consisting of 137 rural respondents and 268 urban respondents (two did not respond to this question). About 2% (n=6) of the respondents had applied to the lottery but never hunted deer in N.D. and were not included in the analysis.

Nonresponse Bias

We used nonresponse phone interviews to obtain 60 gun hunter responses. We found no statistical difference ($P > 0.05$) between nonresponse phone surveys and mail-based surveys for seven of the 12 questions asked from the original questionnaire. Phone survey respondents had hunted about twice as many years (25 years) in N.D. than mail survey respondents (12 years; t = 8.22, $P < 0.01$) but there was no difference in the number of days each spent hunting (t = 0.56, $P = 0.58$). A greater proportion of mail survey respondents had harvested a deer in N.D. than phone survey respondents ($\chi^2_3 = 75.82, P < 0.01$, Fisher's Exact Test). Both groups reported preferring to hunt with a gun ($\chi^2_5 = 0.43$, P = 0.52), and about half of each group hunted at least one day during the 2015 deer-gun season ($\chi^2_5 = 2.40$, P = 0.12). Phone survey respondents hunted more on public land ($\chi^2_3 = 11.63$, P < 0.01) while mail survey respondents hunted mostly on private land ($\chi^2_3 = 18.11$, P < 0.01) and both groups reported mostly not hunting on Private Land Open To Sportsmen (PLOTS; $\chi^2_3 = 0.05$, P = 0.83), a state-sponsored program designed to make private land available to hunters. We did not find any significant differences between the two groups when asked about

satisfaction with their overall hunting experience (t = -0.54, $P = 0.59$) or when asked about satisfaction with NDGF's deer management techniques (t = 1.18, $P = 0.35$). There was no difference between age range of the two groups ($P = 0.58$, Fisher's Exact Test). A larger proportion of mail survey respondents are from an area self-identified as a city ($\chi^2_3 = 7.27$, $P = 0.01$) rather than a rural area.

Hunting Record

Despite a decreased availability of N.D. deer-gun licenses in recent years, most (91%) respondents reported not hunting deer outside the state. Hunters spent time hunting deer the same amount (42%) or less (39%) in the past five years. Fifty-seven percent of applicants did not hunt deer during 2015, mostly because they did not draw a gun license from the lottery (94%), there were too few deer around (2%), or other reasons (4%). Most (96%) gun hunters reported preferring to hunt with a gun while the other 4% reported preferring a bow.

Hunter Demographics

The largest proportions of N.D. deer-gun hunters were male (81%), Caucasian (98%), between the ages of 45 and 64 years (44%) with at least some college education (72%), who lived in a rural area (34%) or large city of over 50,000 (28%). The largest occupational group of deer-gun hunters worked in construction and labor (21%), followed by agriculture (14%), business (12%), and health care (11%). Most deer-gun hunters (55%) began hunting between the ages of 12 and 17 years while 4% began after the age of 45. Most deer-gun hunters (75%) learned how to hunt from male family members; 17% learned from a friend, and 4% were self-taught. Nineteen percent of deer-gun hunters in N.D. were female. A majority of deer-gun hunters reported getting their information about deer hunting from friends or family

(98%), the NDGF website (60%), and the NDGF Deer Hunting Guide (55%). Only 8% indicated that they were part of a deer hunting or management organization and the majority of those (50%) were from local gun clubs.

Urban and rural differences. When comparing among deer-gun hunters by residence type, we found that urban hunters hunted more types of game than rural hunters ($\chi^2_3 = 7.80$, $P < 0.01$), are more likely to have finished college ($P < 0.01$, Fisher's Exact Test), were more satisfied with the way NDGF manages deer populations ($\chi^2_3 = 3.91$, $p<0.05$), and were more familiar with Chronic Wasting Disease (CWD; $\chi^2_5 = 6.02$, $P < 0.05$) than rural hunters. More rural hunters reported being female ($\chi^2_1 = 5.62$, $P = 0.02$), and being unfamiliar with EHD ($\chi^2_5 = 7.59$, $P = 0.02$). Both groups of hunters indicated that they identify mostly as social hunters (43% rural, 41% urban), but rural hunters reported a secondary motivation of meat (21%) while urban hunters are secondarily motivated by nature (30%, $P = 0.03$, Fisher's Exact Test). Finally, a majority of rural hunters used regions 3 (32%, Northern Coteau) and 5 (22%, Southern Coteau and Sheyenne/James) to hunt deer while urban hunters used primarily regions 1 (60%, Badlands) and 2 (40%, Slope).

Although there was no relationship ($\chi^2_7 = 11.60$, $P = 0.11$) between gender and motivation for hunting within the rural hunter group, men from urban areas identified social and nature factors as primary reasons for hunting while urban women identified social factors and meat as their primary reasons ($P = 0.03$, Fisher's Exact Test). Women from urban areas tended to be in a younger age group (25–44 years old) than men (45–64 years old) from urban areas ($P < 0.01$, Fisher's Exact Test) but there was no significant difference in age

between genders in rural hunters. Men (86%) and women (77%) from both groups were moderately satisfied with their hunting experiences.

Motivations

We asked N.D. deer-gun hunters why they enjoy deer-gun hunting, rating the importance of each motivation. We also asked hunters to select their single most important reason for enjoying deer-gun hunting. Based on their top pick, ordered from most to least frequent were 1) social, valuing time spent with family and friends (42%); 2) nature, valuing being in the outdoors and the beauty of nature (25%); 3) meat, valuing bringing home meat for food (17%); 4) excitement, valuing the exhilaration that comes with hunting (8%); 5) trophy, valuing demonstrating hunting skills or accomplishment (e.g., harvesting a big buck; 3%); 6) skill, valuing the ability to use certain equipment to stalk and harvest a deer (3%); 7) solitude, valuing the time spent alone while hunting (1%); 8) challenge, valuing the challenge of hunting, tracking, and harvesting a deer (1%). We found a significant relationship between motivation and gender ($\chi^2_7 = 21.25$, $P < 0.01$) where both men and women primarily identified as social hunters but men gave a secondary motivation of nature and women identified meat as their secondary motivation. There was no evidence of a relationship between motivation and residence type ($\chi^2_7 = 7.43$, $P = 0.39$).

Satisfaction

When asked about their overall personal deer hunting experience during the 2015 N.D. deer-gun season, hunters reported an average satisfaction rating of 3.8 (SE=0.08) out of 5 (1=very dissatisfied, 5= very satisfied). About 65% of N.D. deer-gun hunters reported some degree of satisfaction while 12% reported some degree of dissatisfaction. We found no

difference between satisfaction ratings of male and female hunters ($\chi^2_1 = 0.09$, $P = 0.76$). We found a significant difference between satisfaction of overall hunting experience and harvest success ($\chi^2_1 = 11.56$, $P < 0.01$), with a higher proportion of successful hunters being satisfied. On a 5-point scale, hunters reported an average of 1.7 (SE=0.07) satisfaction level with the ability to get a license of their choice, 3.2 (SE=0.05) with season dates, 3.1 (SE=0.05) with clarity of hunting regulations, and 3.2 (SE=0.05) with hunting equipment allowed. About 17% reported some degree of dissatisfaction with one or more of the aforementioned aspects of their hunting experience. Of those that responded they were dissatisfied, 51% reported it was because there were not enough licenses available, 17% indicated it was because they were unable to get the license type they wanted, and 13% reported it was because they did not see enough deer. Additionally, when asked about the way NDGF manages deer hunting in N.D., deer-gun hunters gave an average satisfaction rating of 6.1 (SE=0.11) out of 10 (1=very dissatisfied, 10=very satisfied), with about 23% reporting some degree of dissatisfaction.

We used a series of 14 models comprised of seven variables (success, satisfaction with NDGF management, motivation, gender, residence type, satisfaction with ability to get a license of choice, and satisfaction with season dates) to predict satisfaction of deer-gun hunters. Our highest ranked model included satisfaction with NDGF ($P < 0.01$), the ability to get a deer-gun license ($P = 0.87$), season dates ($P = 0.86$), and success ($P = 0.09$; Table 7).

Table 7. Deer-gun hunter predictive variables for satisfaction.

Rank	Model Variables	K	Log (L)	AIC	ΔAIC	ω_i
1	Success + NDGF + License + Season	5	-34.47	79.6	0.00	0.37
2	Success + NDGF + License + Season + Residence	6	-34.13	81.1	1.56	0.17
3	Success + NDGF + License * Season	6	-34.43	81.7	2.17	0.12
4	Success * NDGF + License + Season	6	-34.47	81.8	2.25	0.12

[a]Variables are shortened for conciseness. Success = harvest success, NDGF = satisfaction with NDGF's deer management techniques, License = satisfaction with the ability to a license of choice, Season = satisfaction with deer hunting season dates, and Residence = being from a rural or urban town or city.

The variables included in this survey explained some of the variation in satisfaction, but a larger fraction of variation could not be accounted for (null deviance = 82.46, residual deviance = 68.95). Based on the top model (AIC = 79.6), we found that when a deer-gun hunter was satisfied with NDGF management, they were about six times more likely to be satisfied with their overall experience (95% confidence interval [CI] = 1.7–23.2).

Success

When asked about harvest, 33% reported being successful at harvesting a white-tailed deer and 3% reported harvesting a mule deer. No difference ($\chi^2_1 = 1.37$, $P = 0.24$) existed between gender and harvest. We used a series of ten models comprised of seven variables (hunted public land, hunted private land, hunted PLOTS land, residence type, region of the state hunted, years hunted in N.D., and gender) to predict success of deer-gun hunters. Region, land type, gender, and number of years hunted contributed to the highest scoring model (AIC = 202.1; Table 8).

Table 8. Deer-gun hunter predictive variables for success

Rank	Model Variables	K	Log (L)	AIC	ΔAIC	ω_i
1	Region + Land + Years + Gender	12	-87.99	202.1	0.00	0.58
2	Region + Land	10	-91.46	204.4	2.30	0.18
3	Region + Land + Years + Gender + Residence	13	-87.98	204.4	2.35	0.18

[a]Variables are shortened for conciseness. Region = region of the state hunted based on the map in Figure 1; Land = land type hunted including public, private, or PLOTS; Years = total years hunted in N.D., Gender = respondent identified as male or female, and Residence = being from a rural or urban town or city.

Region 2 (Slope; Figure 1) was the most hunted region (41%) and had the greatest proportion of harvest success (22%). There was no evidence that any differences in residence type contribute to predicting success ($\chi^2_1 = 0.02$, $P = 0.89$). The highest ranked model explaining harvest success included land type hunted, region of the state hunted, years hunted, and gender, with hunting PLOTS ($P < 0.01$) and Region 1 (Slope; $P < 0.01$) having significant relationships with success. When using PLOTS, hunters were, on average, about 13% more likely to be successful than when hunting on public land (CI = 4.9% – 33.9%), and were about 26% less likely to be successful in Region 1 (Badlands) than in Region 2 (Slope) where respondents hunted the most and were the most successful (CI = 9.8% – 67.8%). Some of the variation in success could be explained by the variables observed in the survey, but a large proportion of variation could not be accounted for (null deviance = 210.1, residual deviance = 176.0).

Perceptions of Deer Population Decline

Deer-gun hunters reported that habitat loss (67%), harsh winter weather (55%), and harvest pressure on deer (57%) had a negative impact on their hunting experience. Forty six percent of respondents reported that habitat fragmentation (e.g., road construction, urban development, and energy development) had negatively impacted their hunting experience.

From those who indicated that their hunting experience was negatively impacted by habitat fragmentation, about 44% reported it was because they saw fewer deer as a result of fragmentation, 30% selected that it was because of competition for licenses in the lottery, and 13% specified it was because of crowding from other hunters. Proportions of hunters reported the factors they perceived most responsible for deer population decline in N.D., and these included habitat loss (32%), harsh winter weather (21%), NDGF's deer population management practices (18%), predators (12%), disease (7%), and habitat fragmentation (5%). We found no relationship between region hunted and what factor they most attributed to deer population loss ($P = 0.30$, Fisher's Exact Test).

Most deer-gun hunters claimed to be familiar with CWD (87%), but only 3% reported that its presence in N.D. had caused them to deer hunt less. The region of the state a respondent hunted in was not related to their knowledge or perception about CWD ($\chi^2_{12} = 8.80$, $P = 0.72$). Additionally, about 34% indicated that they were familiar with EHD; 3% reported that the presence of EHD in N.D. had caused them to deer hunt less. Of those who reported being negatively affected by CWD (n = 14), 50% indicated that it was because there are fewer deer to hunt, about 29% marked that it was because they did not want to consume meat that might be infected with CWD, and 7% reported it was because they did not want to come into contact with CWD. Of those who reported being negatively affected by EHD (n = 10), 80% indicated it was because there are fewer deer to hunt, 10% reported it was because they did not want to come into contact with EHD, and 10% marked that it was because they did not want to consume meat that might be infected with EHD. There was no relationship

between the region of the state they hunted in and their perceptions of EHD ($\chi^2_{12} = 20.31$, $P = 0.06$).

Discussion

Understanding hunter demographics and perceptions for deer hunting experiences are crucial in helping management agencies make decisions within the realm of biological and social carrying capacities and can help motivate hunter retention (Hansen 2011). According to our findings, most N.D. deer-gun hunters were white males between the ages of 45 and 64 years, working in construction and labor, agriculture, or business, and had at least some college education. About forty years ago, most hunters in the U.S. were white males between the ages of 26 and 45 years, had at least a high school education, and worked a blue-collar job (Hendee and Potter 1976, Gilbert 1977). Today, deer hunters in the U.S. are male and slightly older than before at 43–59 years (Schorr et al. 2014). Although it is unclear whether N.D. may be following national trends of difficulty in recruiting youth and college students because of reported barriers such as anxiety, apathy, boredom, or lack of time (Everett and Gore 2015, Kurtz 2015), we hypothesize that active recruitment in N.D. may be lacking due to the difficulty of obtaining a lottery deer-gun license. Historically, further recruitment difficulties in N.D. may have been compounded by resident emigration and a depressed economy between 1982 and 1998, resulting in a 34% decline in annual birth rates during these years (Jensen et al. 1999).

We found that almost one out of five N.D. deer-gun hunters are female, which is higher than the U.S. average (11%; USDC 2011); however, it is unclear why this difference exits. Despite a clear majority of male hunters, female participation in hunting in the U.S. is

rising (Snepenger and Ditton 1985, Gigliotti and Metcalf 2016), due, in part, to retailers catering more toward women's needs as far as being able to purchase hunting clothing and equipment tailored to a woman's body (George 2016). Other factors that may have contributed include the addition of youth deer-gun seasons and hunter education instruction programs restricted to women (Jensen et al. 1999). Although female and male hunters are primarily motivated by social aspects of a hunt, female hunters are secondarily motivated by obtaining meat while male hunters are secondarily motivated by nature. These results are similar to other studies that also found female hunters were more motivated by obtaining meat (Duda 2001, Metcalf et al. 2015, Gigliotti and Metcalf 2016) and suggest that the traditional gender role portraying women as providers of nourishment may contribute to this dichotomy (Rudy 2012, Metcalf et al. 2015, Gigliotti and Metcalf 2016). Based on our results, female deer-gun hunters appeared to be similar to male hunters in terms of satisfaction and success.

When examining differences and similarities between hunters from urban and rural areas, we found that urban hunters hunt more types of game than rural hunters. This could be due, in part, to the locavore trend making free-range, local, preservative-, and cruelty-free food more desirable as a result of recent media attention given to the meat industry being revealed as inhumane and unsustainable (Rudy 2012, Tidball et al. 2014*a*, Tidball et al. 2014*b*). Compared to urban hunters, we reported that rural hunters were more likely to be female, which might be due to hunting being more socially supported, regardless of gender, in rural areas (Heberlein et al. 2008).

Most N.D. deer-gun hunters considered themselves social hunters followed by nature hunters and meat hunters as their top motivations for hunting. The most important motivations for U.S. hunters tend to be similar among studies, with nature and social being the most reported (Hautaluoma and Brown 1979, Gigliotti 2000, Boulanger et al. 2006). Literature suggests that deer hunters value more than just harvest success, as most hunt for more reasons beyond obtaining meat (Decker and Connelly 1989, Duda 1993, Boulanger et al. 2006). Conversely, some studies have suggested that a proportion of big game hunters still define quality of a hunt by whether they successfully harvested game, or had the opportunity to do so (Stankey et al. 1973, Decker et al. 1980). We found that N.D. deer-gun hunters were more likely to be satisfied if they were successful at harvesting a deer. This attitude toward harvest success appears contrary top reported motivations for deer hunting. In N.D., a reduction of gun license availability may restrict traditional social hunting groups when some members of the hunting party are unsuccessful in drawing a lottery license.

About 65% of N.D. deer-gun hunters were satisfied with their overall hunting experiences in N.D. Regionally, our results are similar to Wyoming's 66% satisfaction rating for 2015 by deer-gun hunters (Sheridan 2016) and high compared to Wisconsin's 28% in 2015 (Dhuey and Lohr 2015). Comparisons to other states, however, may be misleading due to differences in game laws, deer and hunter densities, and climate, to name a few. Our results suggest a relatively high satisfaction rate among deer-gun hunters who drew a lottery hunting license, despite research to the contrary suggesting that decreased deer numbers and hunting opportunities, such as those existing during the time of this study in N.D., may lower satisfaction levels (Needham and Vaske 2013). Although N.D. deer-gun hunter satisfaction

was mostly based on harvest success, we noted that other aspects of satisfaction contribute to overall satisfaction. Deer-gun hunters who indicated that they were dissatisfied with their 2015 hunting experience reported that it was because there were too few deer-gun licenses available and because of the inability to get the license of their choice, both of which could negatively impact a hunter's expectation for their hunt (Heberlein and Kuentzel 2002). Although limiting deer licenses may reduce potential conflict from overcrowding, which has been documented to make hunters less satisfied (Heberlein 1992, Heberlein and Kuentzel 2002), only 0.5% of N.D. deer-gun hunters expressed concern about overcrowding. Nonetheless, limited license availability in N.D. at the time of this study may increase satisfaction for those hunters who were successful in drawing a lottery license and hunted during the 2015 gun-deer season.

Hunting on private land appeared to be associated with deer harvest success, and other studies have yielded similar results (Mozumder et al. 2007, Stedman et al. 2008). Although reasons for being more successful on private land in N.D. are unclear, we hypothesize retrospectively that this could be because hunting on private land is more controlled by the owner who can manage for a specific type of hunting experience, or because some private land hunting facilities charge a fee and increase odds of harvest success.

In general, there is a paucity of research addressing hunter attitudes toward reasons for deer population decline, which makes comparison with other studies difficult. Habitat loss was the most commonly selected reason that deer-gun hunters held responsible deer population decline. More than 850,000 ha of native grasslands in N.D. were converted to

ethanol-corn cropland between 2005 and 2008, causing major losses of Conservation Reserve Program (CRP) grasslands and wildlife habitat (Fargione et al. 2009). Additionally, there was a 59% decrease in the amount of land enrolled in CRP in N.D. from a high of about 1,375,000 ha in 2009 to 567,000 ha in 2016. To a lesser degree (5%), N.D. hunters selected habitat fragmentation (e.g., energy development, road development) as being responsible for deer population decline. Since the early 1980's, N.D. experienced two major energy booms, resulting in over 7,000 oil wells being drilled in the western part of the state (North Dakota State Water Commission, 2014). Based on limited research, these anthropogenic activities may negatively impact deer populations. For example, mule deer in Wyoming significantly altered their home ranges to avoid oil well drilling (Sawyer et al. 2006). In western N.D., results are pending on whether gas and oil development are affecting mule deer (Kolar et al. 2015).

In our study, 18% of N.D. deer-gun hunters cited NDGF population management techniques as the main driver of deer population rise and decline. An additional aspect of hunter satisfaction may be associated with state game laws and regulations. In a survey studying hunters in Virginia, for example, most respondents indicated that their hunting experiences had been improved by game laws and regulation that were in place (Beattie 1981). In Michigan, hunters reported a positive hunting experience if they saw at least one deer, regardless of harvest success (Langenau 1981). We noted that 13% of N.D. deer-gun hunters selected not seeing enough deer as the primary reason for their dissatisfaction. Despite being able to loosely control the deer population, McCullough and Carmen (1982)

suggested that deer hunter satisfaction was largely based on variables that natural resource managers cannot control (e.g., weather).

N.D. experiences extreme winter conditions (Fong 2017). Thus, deer-gun hunters identified harsh winter weather as the second-most liable aspect for population decline (22%). In addition to cold temperatures causing chill and dangerously low body temperatures (Verme 1968, Schmitz 1991), several studies have suggested deeper snow to be correlated with higher deer mortality rates and suggest that deep snow may act as a trap, making deer more susceptible to predation in combination with other factors (DelGiudice et al. 2002, Brinkman et al. 2005, Proffitt et al. 2008). Although studies suggest predation as a potential population driver when coupled with habitat fragmentation (Ciuti et al. 2014), our data suggested that only 13% of N.D. deer-gun hunters credited predation with the major reason for deer population decline. Historically, North Dakotans have tried to eradicate and/or control all wild canid predators. Between 1898 and 1961, the state spent more than $2.2 million dollar on bounties for wolves (*Canis lupus*), coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*) (Jensen pers. comm.). Although there is still strong sentiment against coyotes, it would appear that vast majority of gun hunters understand the importance of quality habitat, and that the susceptibility of deer to predation may be limited.

Most N.D. deer-gun hunters were familiar with CWD, but not EHD; neither disease had caused them to hunt less. Our results contrast a previous study of hunter perceptions of CWD in four Midwestern states where N.D. deer hunters were most likely to stop hunting given the knowledge of CWD in the environment where they were hunting (Vaske and Lyon 2011). In another study, 59% of resident hunters would continue to hunt in N.D. even if

CWD had been detected in 50% of the statewide deer population (Needham et al. 2004). Because the range of CWD is limited to one area of the state (Unit 3F2, Region 2, Slope), it may be reasonable to suggest that most N.D. deer-gun hunters do not feel they are at risk of coming into contact with this disease.

Appendix
Questionnaire

Deer hunting in North Dakota:
A survey of deer hunter activities and views

UNIVERSITY OF NORTH DAKOTA

NORTH DAKOTA GAME AND FISH

DEER HUNTING IN NORTH DAKOTA:
A survey of deer hunter activities and views

Research conducted for the
North Dakota Game and Fish Department

by the

Biology Department at the
University of North Dakota

It is the responsibility of the North Dakota Game and Fish Department (NDGF) to manage the state's deer population within the tolerance of landowners, the desires and expectations of deer hunters, and the amount of habitat on the landscape. In an effort to fulfill that responsibility, we are asking you to complete the enclosed questionnaire. We would like to learn about your participation, motivations, and opinions about deer hunting in North Dakota.

Your name was selected at random from a list of 2015 North Dakota deer hunting applicants. Your identity will be kept confidential and the information you provide will never be associated with your name. Please complete this questionnaire and return it as soon as possible. Seal the booklet with the white re-sealable label and drop it in any mailbox. *Return postage has already been paid*! **Your participation in this study is voluntary** but we urge you to answer these questions so we can better serve the public while managing North Dakota's deer population.

THANK YOU FOR YOUR HELP!

1. **How many total years have you hunted deer in North Dakota?** (*If you have never hunted deer in North Dakota, write "0".*)

   ☐ years → IF "0", STOP HERE AND RETURN QUESTIONNAIRE.

2. **Over the last 5 years, what is the <u>average number of days per year</u> you have spent hunting during the deer season in North Dakota?** *(If you have not hunted deer in the last 5 years, write "0".)*

   ☐ days hunting deer during the season

3. **Do you hunt deer in North Dakota more or less days per year than you did 5 years ago?** *(Please check [√] one box.)*

   ☐ More
   ☐ Less
   ☐ Remained the same
   ☐ Does not apply to me because I have deer hunted less than 5 years in ND

4. **Have you hunted deer in other states during the last 5 years?** *(Please check [√] all that apply.)*

   ☐ Yes, <u>mule</u> deer → Please specify states: _____
   ☐ Yes, <u>white-tailed</u> deer → Please specify states: _____
   ☐ No

5. **Have you <u>ever</u> harvested a deer in North Dakota?** *(Please check [√] all that apply.)*

   ☐ Yes, <u>mule</u> deer → IF YES, were the <u>majority</u> antlered or antlerless?
      ☐ Antlered ☐ Antlerless ☐ Equal numbers of antlered and antlerless
   ☐ Yes, <u>white-tailed</u> deer → IF YES, were the <u>majority</u> antlered or antlerless?
      ☐ Antlered ☐ Antlerless ☐ Equal numbers of antlered and antlerless
   ☐ No

6. **What other types of game have you hunted or applied to hunt in North Dakota in the past 5 years?** *(Please check [√] all that apply.)*

   ☐ Other Big Game (i.e., elk, moose, pronghorn, bighorn sheep)
   ☐ Upland Game (e.g., turkey, pheasant, sharp-tailed grouse, rabbits, tree squirrels, partridge)
   ☐ Waterfowl (i.e., ducks, geese, swans)
   ☐ Other Migratory Game Birds (i.e., doves, woodcock, crows, snipe, sandhill cranes)
   ☐ Furbearers (e.g., coyote, fox, mountain lion, raccoon)
   ☐ Other (e.g., prairie dogs, squirrels)
   ☐ None

7. **During 2015, did you apply to the North Dakota lottery for a gun, muzzleloader, or gratis deer license?** (*Please check [√] all that apply.*)

☐ Yes → ☐ Gun ☐ Muzzleloader ☐ Gratis

☐ No

7b. If successful, which license type did you draw from the lottery? (*Please check [√] one box.)*

☐ Gun ☐ Muzzleloader ☐ Gratis

☐ Not successful

8. **While deer hunting in North Dakota, which weapon do you prefer to use?** *(Please check [√] one box.)*

☐ Gun

☐ Bow

☐ Muzzleloader

9. **Did you hunt deer at least one day in North Dakota during 2015?**

☐ Yes →IF YES, skip to question 11

☐ No → IF NO, in what year did you last hunt deer in ND?

Year: ☐

10. **If you did not hunt deer in North Dakota during 2015, why?** *(Please check [√] all that apply.)*

☐ I was unable to draw a license

☐ There were too few deer around

☐ I did not have a place to hunt

☐ Hunting land is too far away from me

☐ I was concerned about conflicts with landowners

☐ I was concerned about crowding from other hunters

☐ Other (please specify): _____

****IF YOU DID NOT DEER HUNT IN 2015, PLEASE SKIP TO QUESTION 15****

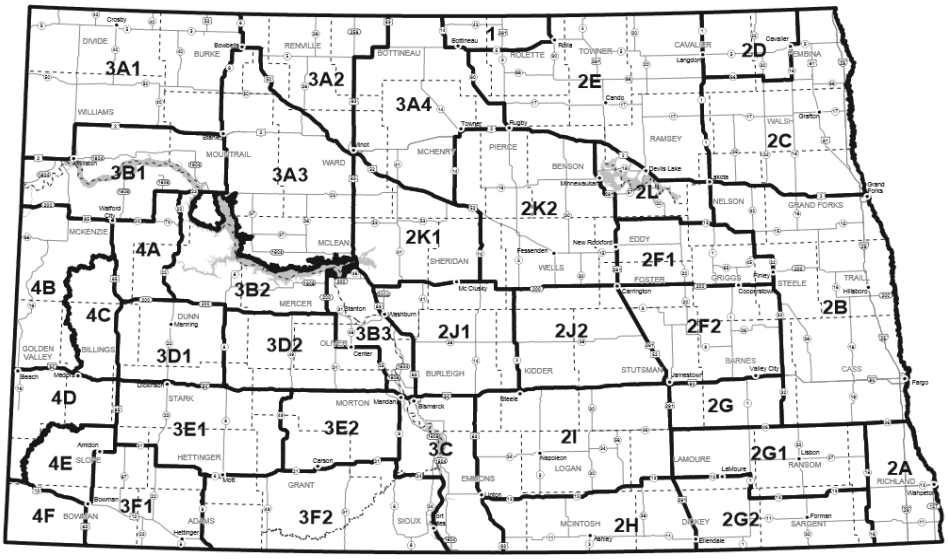
11. **Please indicate the number of days you hunted deer in North Dakota on each of the following land types during the 2015 deer season. Then check /√/ "Yes" or "No" to indicate whether you harvested a deer on one of those land types during the 2015 deer season. Please include all days you hunted with any weapon.** (If you did not hunt a particular type of land or deer species, write "0" on that line.)

Land Type	Mule Deer		White-tailed Deer	
	Days hunted	Harvest a deer?	Days hunted	Harvest a deer?
Public land (i.e., federal, state, county)	_____	____ Yes ____ No	_____	____ Yes ____ No
NDGF's Private Land Open to Sportsmen (PLOTS)	_____	____ Yes ____ No	_____	____ Yes ____ No
Private land for free (not PLOTS)	_____	____ Yes ____ No	_____	____ Yes ____ No
Private land for pay (e.g., leased land, access fee, shooting preserve)	_____	____ Yes ____ No	_____	____ Yes ____ No

12. **In which North Dakota county/hunting unit did you spend *the majority of your time* hunting deer during the 2015 season?** *(If you do not know the county name, write in a city near where you hunted.)*

North Dakota County: _____

Hunting unit: _____



Hunting Units

13. How often did you use the following hunting methods or equipment while hunting deer in North Dakota in 2015? *(Please check [√] one box for each method.)*

Methods or Equipment	Frequency of use during your deer hunts in 2015			
	Never	Sometimes	Often	Every Hunt
Hunting with a rifle				
Hunting with a shotgun				
Hunting with a muzzleloader				
Hunting with a bow				
Hunting with a handgun				
Hunting over bait				
Hunting deer and other game at the same time during overlapping seasons (Other game:_____)				
Helping a youth hunter (ages 12–15) to hunt deer				
Helping another adult hunter to hunt deer				
Hunting with a partner				

14. Please indicate your level of satisfaction or dissatisfaction with your overall personal deer hunting experiences in North Dakota in 2015. *(Please circle only one number.)*

Very dissatisfied Very Satisfied

1 2 3 4 5

BACKGROUND INFORMATION

15. At what age did you start hunting deer? *(Please check [√] one box.)*

- ☐ Less than 12 years old
- ☐ 12–17 years old
- ☐ 18–24 years old
- ☐ 25–44 years old
- ☐ 45–64 years old
- ☐ 65+ years old

16. **Who took you deer hunting for the first time?** *(Please check [√]one box.)*

- ☐ Male family member
- ☐ Female family member
- ☐ Friend or mentor outside of family
- ☐ An outdoors or hunting group (e.g., guided hunt, local rod and gun club, Becoming an Outdoors Woman)
- ☐ Hunted alone the first time; no one took you hunting
- ☐ Other (please specify): _____

17. **How frequently do you use each of the following to find information about deer hunting?** *(Please check [√] one box per source.)*

Source	Never	Sometimes	Often	Always
Friends or family				
Deer hunting books				
Deer hunting magazines				
Social media (e.g., Facebook)				
NDGF website				
NDGF Deer Hunting Guide (printed version)				
Deer hunting TV programs/DVDs/Videos				
Hunting club				
Internet (other than NDGF website or social media sites)				
Deer hunting course				
Other (please specify): _____				

18. **Do you belong to any local, state, or national organizations related to deer hunting or deer management?**

☐ Yes → IF YES, which organizations? (*Please check [√] all that apply.)*

- ☐ Local rod & gun club/hunting organization
  (Please specify):_____
- ☐ North Dakota Bowhunters Association
- ☐ Quality Deer Management Association
- ☐ Whitetails Unlimited
- ☐ National Deer Alliance
- ☐ Pope and Young Club
- ☐ Boone and Crockett Club
- ☐ Mule Deer Foundation
- ☐ Other national club: _____

☐ No

19. **How often do you apply for or purchase each of the following deer license types?** *(Please check [√] one box for each license type.)*

License Type	Never	Sometimes	Often	Every Year
Gun				
Bow				
Muzzleloader				

20. Please rate the importance from 1 (not at all important) to 7 (very important) for each of these possible reasons for why you enjoy hunting deer. (*Please circle one number for each item.*)

Reason for Hunting	Not at all important						Very important
a.) To bring meat home for food	1	2	3	4	5	6	7
b.) To bring home trophies (e.g., large or mature bucks)	1	2	3	4	5	6	7
c.) To enjoy nature and the outdoors	1	2	3	4	5	6	7
d.) For the excitement that hunting provides	1	2	3	4	5	6	7
e.) To enjoy time spent with family and friends	1	2	3	4	5	6	7
f.) To demonstrate hunting skills and accomplishment	1	2	3	4	5	6	7
g.) For the challenge associated with "outsmarting" a deer and facing the elements	1	2	3	4	5	6	7
h.) To experience solitude	1	2	3	4	5	6	7

20b. Overall, which statement in the table above best describes the most important reason for why you enjoy deer hunting? (*Please circle only one response.*)

a b c d e f g h

21. What is your occupation type? If retired, what <u>was</u> your occupation type? *(Please circle one answer choice OR check [√] one box.)*

Agriculture	Customer Service	Education	Business
Energy Development	Health Care	Natural Resources	Legal
Tourism	Construction/Labor	Transportation	Military

☐ Prefer not to answer

☐ Other (please specify): _____

22. What is your gender? *(Please check [√] one box.)*

☐ Male ☐ Female ☐ Prefer not to answer

23. What is your age? *(Please check [√] one box.)*

☐ 18–24 ☐ 25–44 ☐ 45–64 ☐ 65–79

KEEP GOING!
YOU'RE OVER
HALF-WAY FINISHED!!

24. How would you describe the area in which you currently live? *(Please check [√] one box.)*

☐ Rural
☐ City of less than 5,000 people
☐ City of 5,001 to 25,000 people
☐ City of 25,001 to 50,000 people
☐ City of 50,001 people or more

25. What is your ethnicity? *(Please check [√] all that apply.)*

☐ White
☐ Hispanic or Latino
☐ Black or African American
☐ Native American or American Indian
☐ Asian or Pacific Islander
☐ Other (please specify): _____
☐ Prefer not to answer

26. What is your highest level of education? *(Please check [√] one box.)*

☐ Some high school but did not graduate
☐ High school diploma or GED
☐ Some college but no degree
☐ College undergraduate degree
☐ Graduate degree
☐ Prefer not to answer

YOUR VIEWS ON DEER HUNTING REGULATIONS

The following questions will help NDGF managers understand hunters' views on the structure of deer hunting seasons in North Dakota. This information will serve as one source of input when managers consider potential changes in deer hunting regulations. (See North Dakota Deer Hunting Guide for current regulations.)

27. How satisfied or dissatisfied are you with the way NDGF manages deer hunting in North Dakota? *(Please circle a number on the scale.)*

Very dissatisfied Very satisfied

1 2 3 4 5 6 7 8 9 10

28. How satisfied or dissatisfied were you with each of the following aspects of the 2015 deer hunting season in North Dakota? *(Please check [√] one box per line.)*

	Very satisfied	Moderately satisfied	Neither satisfied nor dissatisfied	Moderately dissatisfied	Very dissatisfied
Ability to get a license of your choice					
Season dates					
Clarity of regulations					
Legal hunting equipment					

29. If you feel some degree of dissatisfaction with your deer hunting experience in North Dakota in 2015, which of the following aspects *contributes most* to your dissatisfaction? *(Please check [√] ONLY one box.)*

- ☐ Not enough deer licenses available
- ☐ Not able to get the license type of my choice
- ☐ Not able to hunt in the area of my choice
- ☐ Conflicts with other hunters
- ☐ Conflicts with landowners
- ☐ Too few deer seen
- ☐ Lack of access to private land
- ☐ Lack of access to public land

YOUR COMMUNICATION WITH NDGF

In the future, NDGF may be communicating by email rather than through the U.S. Postal Service. NDGF wants to make sure this change in their sampling protocol will accurately represent the opinions of all deer hunters in the state. To accomplish this goal, NDGF needs to understand the demographics of deer hunters that do and do not have access to the internet.

30. Do you have access to the internet at home?

☐ Yes ☐ No ☐ Not sure

31. How often do you use the internet for personal use?

☐ Never ☐ Monthly ☐ Weekly ☐ Daily

32. On a scale of 1–10, how proficient are you in finding information on the internet? *(Please circle one number on the scale.)*

Not proficient Very proficient

1 2 3 4 5 6 7 8 9 10

33. Would you be willing to apply for lottery deer hunting licenses only from the NDGF website instead of by paper application?

☐ Yes ☐ No ☐ Not sure

34. How would you like to receive information from NDGF in the future? *(Please check [√] all that apply.)*

☐ Postal mail
☐ Email
☐ Phone call
☐ Text message
☐ Phone app
☐ Public announcements

YOUR PERCEPTIONS ABOUT DEER POPULATIONS

The number of deer gun licenses offered by NDGF has declined dramatically in recent years. This decline is likely the result of an aggressive harvest strategy of antlerless deer between 2000 and 2009 to reduce deer depredation on agricultural land in addition to a series of severe winters, loss or fragmentation of habitat, and diseases. Your answers to these questions will help NDGF managers understand hunters' perceptions of these potential impacts on deer populations in North Dakota.

35. Has harvest pressure on antlerless deer had an impact on your personal deer hunting experiences in North Dakota? *(Please circle one number on the scale OR check [√] one of the boxes.)*

Very negative impact Very positive impact ☐ No

1 2 3 4 5 6 7 8 9 10 ☐ Not sure

36. Has severe winter weather in recent years had an impact on your personal deer hunting experiences in North Dakota? *(Please circle one number on the scale OR check [√] one of the boxes.)*

Very negative impact Very positive impact ☐ No

1 2 3 4 5 6 7 8 9 10 ☐ Not sure

37. Has habitat loss (e.g., loss of CRP, removing shelter belts, draining wetlands, etc.) had an impact on your personal deer hunting experiences in North Dakota? *(Please circle one number on the scale OR check [√] one of the boxes.)*

Very negative impact Very positive impact ☐ No

1 2 3 4 5 6 7 8 9 10 ☐ Not sure

38. Has dividing or fragmenting habitat into smaller areas (e.g., roads, wind turbines, urban development, gas or oil extraction, etc.) had an impact on your personal deer hunting experiences in North Dakota? *(Please circle one number on the scale OR check [√] one of the boxes.)*

Very negative impact Very positive impact ☐ No

1 2 3 4 5 6 7 8 9 10 ☐ Not sure

38b. IF YOU ANSWERED IN THE NEGATIVE RANGE (1–5) for #38, why? *(Please check [√] all that apply.)*

☐ I feel crowded by too many hunters

☐ I feel there is more competition for lottery licenses

☐ I see fewer deer as a result of dividing or fragmenting habitat

☐ Other: _____

38c. IF YOU ANSWERED IN THE POSITIVE RANGE (6–10) for #38, why? (*Please use the space provided below.)*

_____

39. Are you familiar with Chronic Wasting Disease (CWD) in deer? *(Please check [√] one box.)*

☐ Yes ☐ No ☐ Not sure

40. Has the presence of CWD in North Dakota caused you to hunt deer less?

☐ Yes ☐ No ☐ Not sure

40b. IF YES, why?

- ☐ There are fewer deer to hunt because of CWD
- ☐ I do not want to risk coming into contact with CWD
- ☐ I have concerns about eating deer meat because of CWD
- ☐ Other: _____

41. Are you familiar with Epizootic Hemorrhagic Disease (EHD) in deer?

☐ Yes ☐ No ☐ Not sure

42. Has the presence of EHD in North Dakota caused you to hunt deer less?

☐ Yes ☐ No ☐ Not sure

42b. IF YES, why?

- ☐ There are fewer deer to hunt because of EHD
- ☐ I do not want to risk coming into contact EHD
- ☐ I have concerns about eating deer meat because of EHD
- ☐ Other: _____

43. Please indicate the degree to which <u>YOU</u> think each factor has affected deer populations in North Dakota. *(Please circle one number for each factor.)*

Factor	Very negatively affected				Very positively affected
a.) Habitat loss (e.g., loss of CRP, removing shelter belts, draining wetlands, etc.)	1	2	3	4	5
b.) Dividing or fragmenting habitat (e.g., roads, wind turbines, urban development, gas or oil extraction, etc.)	1	2	3	4	5
c.) NDGF population management practices	1	2	3	4	5
d.) Disease (e.g., CWD, EHD)	1	2	3	4	5
e.) Predators (e.g., coyotes, mountain lions)	1	2	3	4	5
f.) Severe winters	1	2	3	4	5

43b. Overall, which statement in the table above best describes the factor you think is most responsible for the recent decline in North Dakota's deer population? (*Please circle only one response.*)

a b c d e f

THANK YOU FOR YOUR PARTICIPATION!

(Please use the space provided below if you wish to offer additional comments on deer hunting in North Dakota.)

To return this questionnaire, simply seal it with the clear stickers (included) on the long edge of the booklet and drop it in the nearest mailbox.

Postage has already been paid!

If you have questions about this survey, please contact Kristen Black (404-561-9029, k.black@und.edu) of the Biology Department at the University of North Dakota.

If you would like information or have questions regarding Chronic Wasting Disease or other deer hunting-related issues, please contact North Dakota Game and Fish Department through their website: http://gf.nd.gov/about-us/contact-us.

REFERENCES

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. Pages 267–281 *in* B. N. Petrov and F. Csaki, editors. Second international symposium on information theory. Akademiai Kiado, Budapest, Hungary.

Alig, R. J., J. D. Kline, and M. Lichtenstein. 2004. Urbanization on the US landscape: Looking ahead in the 21st century. Landscape and Urban Planning 69:219–234.

Anderson, J. F., A. J. Main, P. M. Armstrong, T. G. Andreadis, and F. J. Ferrandino. 2015. Arboviruses in North Dakota, 2003–2006. American Journal of Tropical Medicine and Hygiene 92:377–393.

Beattie, K. H. 1981. The influence of game laws and regulations on hunting satisfaction. Wildlife Society Bulletin 9:229–231.

Berry, B. J. L. 1980. Urbanization and counterurbanization in the United States. The Annals of the American Academy of Political and Social Science 451:13–20.

Bettencourt, L., and G. West. 2010. A unified theory of urban living. Nature 467:912–913.

Bissonette, J. A., C. A. Kassar, and L. J. Cook. 2008. Assessment of costs associated with deer-vehicle collisions: human death and injury, vehicle damage, and deer loss. Human-Wildlife Interactions 2:17–27.

Boulanger, J. R., D. E. Hubbard, J. A. Jenks, and L. M. Gigliotti. 2002. Equipment, skills, and success of South Dakota archery deer hunters. Pages 86–94 *in* Proceedings of the First National Bowhunting Conference. R. J. Warren, editor. Archery Manufacturers and Merchants Organization, 16–18 February 2001, Comfrey, Minnesota, USA.

Boulanger, J. R., D. E. Hubbard, J. A. Jenks, and L. M. Gigliotti. 2006. A typology of South Dakota muzzleloader deer hunters. Wildlife Society Bulletin 34:691–697.

Brinkman, T. J., C. S. DePerno, J. A. Jenks, B. S. Haroldson, and R. G. Osborn. 2005. Movement of female white-tailed deer: effects of climate and intensive row-crop agriculture. Journal of Wildlife Management 69:1099–1111.

Brzezinski, D. T., J. Wilson, and Y. Chen. 2010. Voluntary participation in regional fisheries management council meetings. Ecology and Society 15:2.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodal inference. Second edition. Springer, New York, New York, USA.

Ciuti, S., W. F. Jensen, S. E. Nielsen, and M. S. Boyce. 2014. An evaluation of historical mule deer fawn recruitment in North Dakota. North Dakota Game and Fish Department, Bismarck, North Dakota, USA.

Côté, S. D., T. P. Rooney, J. P. C. Dussault, and D. M. Waller. 2004. Ecological impacts of deer overabundance. Annual Review of Ecology, Evolution, and Systematics 35:113–47.

Curtis, P. D., and K. L. Sullivan. 2001. White-tailed deer. Wildlife Damage Management Fact Sheet Series. Cornell Cooperative Extension, Ithaca, New York, USA.

Decker, D. J., T. L. Brown, and R. J. Gutiérrez. 1980. Further insights into the multiple-satisfactions approach for hunter management. Wildlife Society Bulletin 8:323–331.

Decker, D. J., and N. A. Connelly. 1989. Motivations for deer hunting: implications for antlerless deer harvest as a management tool. Wildlife Society Bulletin 17:455–463.

DelGiudice, G. D., M. R. Riggs, P. Joly, and W. Pan. 2002. Winter severity, survival, and cause specific mortality of female white-tailed deer in North-Central Minnesota. Journal of Wildlife Management 66:698–717.

DeNicola, A. J., K. C. VerCauteren, and P. D. Curtis. 2000. Managing white-tailed deer in suburban environments. Cornell Cooperative Extension, Ithaca, New York, USA.

Dhuey, B., and J. R. Lohr. 2015. Firearm Deer Hunting Questionnaire 2015. Retrieved from http://dnr.wi.gov/topic/wildlifehabitat/documents/reports/gundeer.pdf

Dillman, D. A., J. D. Smyth, and L. M. Christian. 2014. Internet, phone, mail, and mixed-mode surveys. Fourth Edition. John Wiley and Sons Inc., Hoboken, New Jersey, USA.

Duda, M. D. 1993. Factors related to hunting and fishing participation in the United States. Responsive Management, Western Association of Fish and Wildlife Agencies. Federal Aid in Sport Fish and Wildlife Restoration Grant Agreement 14-48-0009-92-1252.

Duda, M. D. 2001. The hunting mind: Women and hunting. North American Hunter. Retrieved from http://www.responsivemanagement.com/download/reports/NAHWomen.pdf

Duda, M. D., and S. J. Bissell. 2001. Bowhunting participation, trends, satisfactions and marketing options. <http://www.responsivemanagement.com/download/reports/Bowhuntingpaper-uga.pdf>. Accessed 9 July 2015.

Enck, J. W., and D. J. Decker. 1991. Hunters' perspectives on satisfying and dissatisfying aspects of the deer-hunter experience in New York. Human Dimensions Research Unit Publication Series Number 91-4. Department of Natural Resources, Cornell University, Ithaca, New York, USA.

Enck, J. W., D. J. Decker, and T. L. Brown. 2000. Status of hunter recruitment and retention in the United States. Wildlife Society Bulletin 28:817–824.

Everett, M. W., and M. L. Gore. 2015. Measuring flow in Michigan youth firearm deer hunters: Implications for measurement and practice. Society and Leisure 38:100–109.

Fargione, J. E., T. R. Cooper, D. J. Flaspohler, J. Hill, C. Lehman, T. McCoy, S. McLeod, E. J. Nelson, K. S. Oberhauser, and D. Tilman. 2009. Bioenergy and wildlife: threats and opportunities for grassland conservation. BioScience 59:767–777.

Fong, C. North Dakota Department of Emergency Services. 2017. Severe Winter Weather. Retrieved from https://www.nd.gov/des/get/severe-winter-weather/

George, S. K. 2016. Pink camouflage: reshaping the gendered nature of hunting in the twenty-first century. Society and Leisure 39:481–499.

Gigliotti, L. M. 2000. A classification system scheme to better understand satisfactions of Black Hills deer hunters: the role of harvest satisfaction. Human Dimensions of Wildlife 5:32–51.

Gigliotti, L. M., and E. C. Metcalf. 2016. Motivations of female Black Hills deer hunters. Human Dimensions of Wildlife 5:32–51.

Gilbert, A. H. 1977. Influence of hunter attitudes and characteristics on wildlife management. Transactions of the North American Wildlife and Natural Resources Conference. 42:226–236.

Gladfelter, H. L., J. M. Kienzler, and K. J. Koehler. 1983. Effects of compound bow use on deer hunter success and crippling rates in Iowa. Wildlife Society Bulletin 11:7–12.

Grovenburg, T. W., C. C. Swanson, C. N. Jacques, R. W. Klaver, T. J. Brinkman, B. M. Burris, C. S. DePerno, and J. A. Jenks. 2011*a*. Survival of white-tailed deer neonates in Minnesota and South Dakota. Journal of Wildlife Management 75:213–220.

Grovenburg, T. W., R. W. Klaver, and J. A. Jenks. 2011*b*. Spatial ecology of white-tailed deer fawns in the Northern Great Plains: implications of loss of Conservation Reserve Program grasslands. Journal of Wildlife Management 76:632–644.

Grovenburg, T. W., R. W. Klaver, and J. A. Jenks. 2012. Survival of white-tailed deer fawns in the grasslands of the Northern Great Plains. Journal of Wildlife Management 76:944–956.

Hammitt, W. E., C. D. McDonald, and F. P. Noe. 1989. Wildlife management: Managing the hunt versus the hunting experience. Environmental Management 13:503–507.

Hansen, L. P., J. Beringer, and S. Sheriff. 1994. Deer hunter information survey. Missouri Department of Conservation. P-R Project Report W-13-R-48, City, State, USA.

Hansen, L. P. 2011. Extensive management. Pages 409–452 in D. G. Hewitt, editor. Biology and management of white-tailed deer. CRC, Boca Raton, Florida, USA.

Harper, E. E., C. E. Miller, and J. J. Vaske. 2015. Hunter perceptions of risk, social trust, and management of chronic wasting disease in Illinois. Human Dimensions of Wildlife 20:394–407.

Hautaluoma, J., and P. J. Brown. 1979. Attributes of the deer hunting experience: a cluster-analytic study. Journal of Leisure Research 10:271–287.

Heberlein, T. A. 1992. Reducing hunter perception of crowding through information. Wildlife Society Bulletin 20:372–374.

Heberlein, T. A., and W. F. Kuentzel. 2002. Too many hunters or not enough deer? Human and biological determinants of hunter satisfaction and quality. Human Dimensions of Wildlife 7:229–250.

Heberlein, T. A., B. Serup, and G. Ericsson. 2008. Female hunting participation in North America and Europe. Human Dimensions of Wildlife, 13:443–458.

Hendee, J. C. 1974. A multiple-satisfaction approach to game management. Wildlife Society Bulletin 2:104–113.

Hendee, J. C., and D. R. Potter. 1976. Hunters and hunting: management implications of research. U.S. Department of Agriculture, Applications Workshop, Ashville, North Carolina, USA.

Hewitt, D. G. 2015. Hunters and the conservation and management of white-tailed deer (*Odocoileus virginianus*). International Journal of Environmental Studies 72:839–849.

Hilbe, J. M. 2009. Logistic regression models. CRC Press, Boca Raton, Florida, USA.

Holsworth, W. N. 1973. Hunting efficiency and white-tailed deer density. Journal of Wildlife Management 37:336–342.

Jensen, W. F., R. Johnson, and M. Oehler. 1999. A review of the North Dakota Game and Fish Department's white-tailed deer management plan. Project W-67-R-39.

Jensen, B. 2011. The landscape and flora of North Dakota: "An acquired taste". Pages 32–45 *in* R. Seabloom, editor. Mammals of North Dakota. North Dakota Institute for Regional Studies, North Dakota State University, Fargo, North Dakota, USA.

Jensen, B., and J. Gulke. 2016. 2015 deer bow season and harvest. Project No. W-67-R-56, Bismarck, North Dakota, USA.

Kilpatrick, H. J., A. M. Labonte, and K. C. Stafford. 2014. The relationship between deer density, tick abundance, and human cases of Lyme disease in a residential community. Journal of Medical Entomology 51:777–784.

Kolar, J. L., B. A. Stillings, and J. J. Millspaugh. 2015. Effects of oil and gas development on mule deer populations in Western North Dakota and Eastern Montana. Intermountain Journal of Sciences 21:1–4.

Kurtz, J. 2015. On the trail of student participants: Identifying barriers to hunting and developing a hunter recruitment profile for college students in Kentucky. (Unpublished M.S. thesis) Eastern Kentucky University, Richmond, KY.

Langenau Jr., E. E. 1981. Relationship between deer kill and ratings of the hunt. Journal of Wildlife Management 45:959–964.

Larson, L. R., D. J. Decker, R. C. Stedman, W. F. Seimer, M. S. Baumer, and J. W. Enck. 2013. Hunter recruitment and retention: A framework for research and action. Human Dimensions Research Unit Publication Series 13-04.

Larson, L. R., R.C. Stedman, D. J. Decker, W. F. Seimer, and M. S. Baumer. 2014. Exploring the social habitat for hunting: Toward a comprehensive framework for understanding hunter recruitment and retention. Human Dimensions of Wildlife 19:105–122.

McCullough, D. R., and W. J. Carmen. 1982. Management goals for deer hunter satisfaction. Wildlife Society Bulletin 10:49–52.

McFarlane, B. L., D. Watson, and P. C. Boxall. 2003. Women hunters in Alberta, Canada: Girl power or guys in disguise? Human Dimensions of Wildlife 8:165–180.

Metcalf, E. C., A. R. Graefe, N. E. Trauntvein, and R. C. Burns. 2015. Understanding hunting constraints and negotiation strategies: A typology of female hunters. Human Dimensions of Wildlife 20:30–46.

Miller, C. A., and P. Shelton. 2000. Perceptions of white-tailed deer abundance and management among hunters and landowners in Illinois. Wildlife Damage Management Conference Proceedings 9:265–268.

Mozumder, P., C. M. Starbuck, R. P. Berrens, and S. Alexander. 2007. Lease and fee hunting on private lands in the U.S.: A review of the economic and legal issues. Human Dimensions of Wildlife 12:1–14.

Needham, M. D., J. J. Vaske, and M. J. Manfredo. 2004. Hunters' behavior and acceptance of management actions related to chronic wasting disease in eight states. Human Dimensions of Wildlife 9:211–231.

Needham M. D., and J. J. Vaske. 2008. Hunter perceptions of similarity and trust in wildlife agencies and personal risk associated with chronic wasting disease. Society and Natural Resources 21:197–214.

Needham M. D., and J. J. Vaske. 2013. Activity substitutability and degree of specialization among deer and elk hunters in multiple states. Leisure Sciences 35:235–255.

Ng, J. W., C. Nielson, and C. C. St. Clair. 2008. Landscape and traffic factors influencing deer-vehicle collisions in an urban environment. Human-Wildlife Interactions 2:34–47.

North Dakota State Water Commission [NDSWC]. 2014. Facts about North Dakota fracking and water use. < http://www.swc.nd.gov/4dlink9/4dcgi/getcontentpdf/pb-2419/fact%20sheet.pdf>. Accessed 27 July 2015.

Peterson, C. C., and T. A. Messmer. 2010. Can public meetings accurately reflect public attitudes toward wildlife management? Journal of Wildlife Management 74:1588–1594.

Peterson, S. 2016. Mule deer recovery, statewide license numbers decline. North Dakota Outdoors 78(6):5–6.

Proffitt, K. M., J. L. Grigg, K. L. Hamlin, and R. A. Garrott. 2008. Contrasting effects of wolves and human hunters on elk behavioral responses to predation risk. Journal of Wildlife Management 73:345–356.

Raizman, E. A., J. D. Holland, and J. T. Shulke. 2013. White-tailed deer (*Odocoileus virginianus*) as a potential sentinel for human Lyme disease in Indiana. Zoonoses and Public Health 60:227–233.

Riley, S. J., D. J. Decker, J. W. Enck, P. D. Curtis, T. B. Lauber, and T. L. Brown. 2003. Deer populations up, hunter populations down: Implications of interdependence of deer and hunter population dynamics on management. Ecoscience 10:455–461.

Rudy, K. 2012. Locavores, feminism, and the question of meat. The Journal of American Culture 35:26–36.

Ryan, E. L., and B. Shaw. 2011. Improving hunter recruitment and retention. Human Dimensions of Wildlife 16:311–317.

Sawyer, H., R. M. Nielson, F. Lindzey, and L. L. McDonald. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. Journal of Wildlife Management 70:396–403.

Schmitz, O. J. 1991. Thermal constraints and optimization of winter feeding and habitat choice in white-tailed deer. Holarctic Ecology 14:104–111.

Schorr, R. A., P. M. Lukacs, and J. A. Gude. 2014. The Montana deer and elk hunting population: the importance of cohort group, license price, and population demographics on hunter retention, recruitment, and population change. Journal of Wildlife Management 78:944–952.

Sheridan, G. 2016. Annual report of big and trophy game harvest 2015. Retrieved from https://wgfd.wyo.gov/WGFD/media/content/PDF/Hunting/Harvest%20Reports/HR2015_FullReport.pdf

Siemer, W. F., J. R. Boulanger, D. J. Decker, and M. S. Baumer. 2014. Activities and satisfactions of fall turkey hunters in New York State. Human Dimensions Research Unit Publication Series 14–1. Department of Natural Resources, Cornell University, Ithaca, New York, USA.

Snepenger, D. J., and R. B. Ditton. 1985. A longitudinal analysis of longitudinal hunting and fishing indicators: 1955–1980. Leisure Sciences 7:297–319.

Stankey, G. H., R. C. Lucas, and R. R. Ream. 1973. Relationships between hunting success and satisfaction. Transactions of the North American Wildlife and Natural Resources Conference 38:235–242.

Stedman, R. C., P. Bhandari, A. E. Luloff, D. R. Diefenbach, and J. C. Finley. 2008. Deer hunting on Pennsylvania's public and private lands: A two-tiered system of hunters? Human Dimensions of Wildlife 13:222–233.

Tidball, K. G., M. M. Tidball, and P. Curtis. 2014*a*. Extending the locavore movement to wild fish and game: Questions and implications. Natural Sciences Education 42:185–189.

Tidball, K. G., M. M. Tidball, L. R. Larson, P. Curtis, L. Poindexter, and R. C. Stedman. 2014*b*. Locavore preferences for wild fish and game: Implications for wildlife-based recreation in New York State. Human Dimensions Research Unit Publication Series 14-6.

U.S. Department of Commerce [USDC]. 2011. Bureau of the Census. National survey of fishing, hunting, and wildlife associated recreation. <https://www.census.gov/prod/2012pubs/fhw11-nat.pdf>. Accessed 23 June 2015.

U.S. Fish and Wildlife Service [USFWS]. 1991. National survey of fishing, hunting, and wildlife-associated recreation. <http://www.census.gov/prod/1/gen/interior/fhw91-us.pdf>. Accessed 2 February 2017.

U.S. Fish and Wildlife Service [USFWS]. 2004. National hunting license report. <http://wsfrprograms.fws.gov/Subpages/LicenseInfo/HuntingLicCertHistory.pdf>. Accessed 23 June 2015.

U.S. Fish and Wildlife Service [USFWS]. (2012). National survey of fishing, hunting, and wildlife-associated recreation. Retrieved from http://www.census.gov/prod/2012pubs/fhw11-nat.pdf

U.S. Fish and Wildlife Service [USFWS]. 2013. National hunting license report. <http://wsfrprograms.fws.gov/Subpages/LicenseInfo/HuntingLicCertHistory20042013.pdf>. Accessed 23 June 2015.

U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. (2014). 2011 national survey of fishing, hunting, and wildlife-associated recreation. Retrieved from http://www.census.gov/prod/www/fishing.html

Van Deelen, T. R, and D. R. Etter. 2003. Effort and the functional response of deer hunters. Human Dimensions of Wildlife 8:97–108.

Vaske, J. J., M. D. Needham, P. Newman, M. J. Manfredo, and J. Petchenik. 2006. Potential for conflict index: hunters' responses to chronic wasting disease. Wildlife Society Bulletin 34:44–50.

Vaske, J. J., and K. M. Lyon. 2011. CWD prevalence, perceived human health risks, and state influences on deer hunting participation. Risk Analysis 31:488–496.

Verme, L. J. 1968. An index of winter weather severity for northern deer. Journal of Wildlife Management 32:566–574.

Waller, D. M., and W. S. Alverson. 1997. The white-tailed deer as a keystone herbivore. Wildlife Society Bulletin 25:217–226.

Weckerly, F. W., M. L. Kennedy, and S. W. Stephenson. 2005. Hunter-effort-harvest-size relationships among hunt types of white-tailed deer. Wildlife Society Bulletin 33:1303–1311.

Werden, L., I. K. Barker, J. Bowman, E. K. Gonzales, P. A. Leighton, L. R. Lindsay, and C. M. Jardine. 2014. Geography, deer, and host biodiversity shape pattern of Lyme disease emergence in the Thousand Islands archipelago of Ontario, Canada. PLOS ONE 9:e85640.

Zimmer, N. M. P., P. C. Boxall, and W. L. Adamowicz. 2012. The impacts of chronic wasting disease and its management on recreational hunters. Canadian Journal of Agricultural Economics 60:71–92.