Human Dimensions of Deer Hunters in North Dakota's Badlands Region

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INTRODUCTION

Deer hunting is a culturally important activity in North Dakota (Black et al. 2017). The North Dakota Game and Fish Department (NDGF) typically receives around 85,000 deer gun lottery applications from resident hunters each year. In most years, the demand for deer licenses is much higher than the number of licenses available. As a result, bow hunting license sales have increased on average 7% each year since at least 2000, because hunters readily switch to bow hunting when they do not draw a license in the lottery.

The popularity of bow hunting in the Badlands region of North Dakota has increased considerably in recent years. During the 2020-2022 bow hunting seasons the NDGF observed hunter densities in the Badlands up to 4 times the statewide average. During the sample period, the NDGF also received a sharp increase in feedback from both gun and bow hunters reporting concerns about hunter congestion, smaller deer populations, and fewer mature bucks. A surge in the number of bow hunters in the Badlands introduces the potential for both social and biological issues.

The impact of bow harvest on the deer population has always been assumed to be biologically insignificant. This is reflected in the bow hunting regulations. In North Dakota, like many other states, bow hunting regulations are designed to provide opportunity. The NDGF issues resident hunters a statewide archery hunting license that permits hunters to take any deer of their choice, anywhere in the state, across a 122-day season. Effectively, this means the NDGF does not have control over spatially distributing hunting pressure according to biologically sustainable harvest targets. The inability to control hunting pressure in a unit where deer populations are in decline may result in biological issues. Sharp, uncontrolled increases in the number of bow hunters concentrated at specific units may have negative biological effects that further deplete the deer population (Riley et al. 2003).

The potential for social issues arises when hunters experience dissatisfaction with their hunting experience. The NDGF places significant emphasis on hunter satisfaction in its harvest management objectives. This is because hunter satisfaction is closely tied to both the success of the harvest and the overall quality of the hunting experience (Miller and Graefe 2001), with both factors being influenced by hunter density. Consequently, if hunter densities exceed a site's social carrying capacity, resulting in overcrowding, it may lead to discontent among hunters, jeopardize relationships with producers, and impact hunter’s perceptions of the NDGF.

In recent years, the NDGF has received considerable feedback from both bow and gun hunters in the Badlands. Several prevailing themes have emerged. These include: an overabundance of bow hunters; declines in mule deer populations (and specifically, the number of mature bucks); and growing frustration among gun hunters who may wait years to draw a Badlands deer hunting license in the lottery, while bow hunters participate annually. However, there is uncertainty about whether a vocal minority is influencing these sentiments or if it accurately represents the broader Badlands deer hunting community. To address this uncertainty, a study of hunters' perceptions about hunting in the Badlands and their support for potential management actions was

performed. Any potential regulation change will require concessions by hunters, so the NDGF sought feedback from important stakeholder groups. Stakeholder groups were represented by bow hunters, rifle hunters, and landowners. The NDGF partnered with stakeholders to develop the general objectives for this study.

The fundamental goal for this study was to evaluate hunter perceptions about overcrowding in the Badlands to better understand social issues and assess support for potential changes to hunting regulations to resolve biological issues. More specifically, we had the following objectives:

1. Formally quantify hunting pressure in the Badlands.
2. Understand hunters' willingness to tolerate other hunters.
3. Determine which hunting regulation changes hunters are most amenable to.

METHODS

A Review of the Indicators and Standards Framework

Deer hunting is the most popular form of hunting in North Dakota. Not all deer hunters, however, share the same set of preferences and attitudes about the activity. Some hunters desire nothing more than the opportunity to be with friends and family, and hunting success is secondary. Other hunters need to harvest a mature buck for the experience to be a success. Accordingly, deer hunter satisfaction is dependent on their own unique set of values (e.g., the type of hunting experience they desire, their definition of success). Because values-based determinations about satisfaction are inherently subjective, it can be challenging for wildlife agencies to apply objective solutions to management problems (Decker et al. 2001). An approach that has been used ubiquitously to resolve values-based management conflicts is the *Indicators and Standards Framework* (Vaske et al. 2002).The indicators and standards framework has predominantly centered around three key concepts which include: perceived conflict, perceived crowding, and encounter norm tolerances.

Perceived Crowding Indicator and Standard

Indicators are specific, measurable variables that reflect the current situation about some values-based concept. For example, deer hunting pressure in the Badlands is an obvious indicator variable of interest. In the parlance of the indicators and standards framework, hunting pressure translates perfectly to *perceived crowding*. Hunting pressure, like crowding, involves a value judgment that the specified number of other hunters is too many. The term perceived crowding is often used to emphasize the subjective or evaluative nature of the concept.

Heberlein and Vaske (1977) developed a relatively simple measure of perceived crowding that asks individuals to indicate how crowded the area was at the time of their visit. The responses are captured on a 9-point scale (Figure 1). Values on the scale ≤ 2 describe hunting scenarios that are not crowded. Values on the scale ≥ 3 all refer to hunting scenarios with some degree of crowding. The scale is intentionally skewed towards crowding values because hunters may be reluctant to say an area was crowded because crowding is an undesirable characteristic in any hunting scenario. For example, if the same question was posed as a simple yes or no type of question

(e.g., “Did you feel crowded” or “Was there too much hunting pressure”), hunters are likely to answer “No” given the negative connotations associated with crowding.

Not at all Crowded		Slightly Crowded			Moderately Crowded		Extremely Crowded	
1	2	3	4	5	6	7	8	9

Figure 1. Example of a 9-point crowding response scale (Heberlein and Vaske 1977).

A standard is the minimum acceptable condition for each indicator. Standards identify conditions that are desirable, as well as conditions that wildlife managers do not want to exceed. For example, a hypothetical standard wildlife managers might use is, “our objective is to maintain a level of perceived crowding <50%” Put differently, when half of hunters report values on the crowding scale ≥3, it suggests the standard has been violated. Standards may be set around specific objectives for management (e.g., 25%, 50%.), and existing conditions on the ground (the crowding indicator) can be compared to provide a quantitative estimate of whether the experiences provided are within the limits specified by the standard (Vaske et al., 2002).

Standards also provide a means to compare crowding at a hunting site with conditions observed by deer hunters at other locations. Repeatedly surveying hunters about perceived crowding on a consistent 9-point scale for nearly 50 years has allowed researchers to systematically document the various conditions under which hunters experience crowding. Vaske and Shelby (2008) and performed a meta-analysis that examined perceived crowding indicators across 615 different studies.

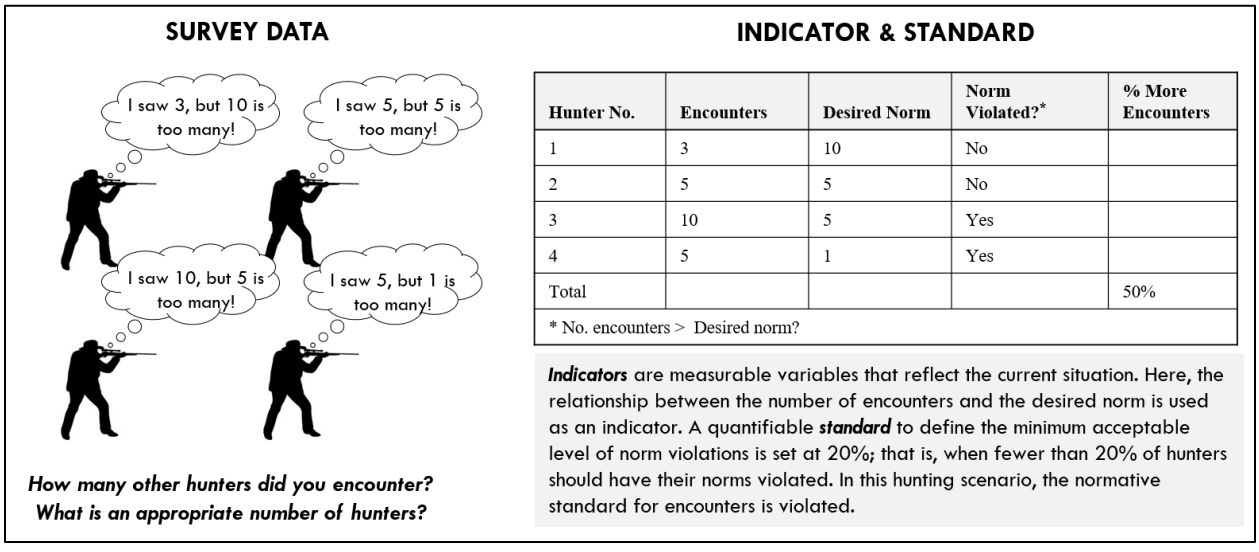
Table 1. Carrying capacity standards based on levels of perceived crowding (Vaske and Shelby 2008).

Percent feeling crowded	Capacity judgment	Comment	Total # of studies (*n* = 615)	Percent of studies
0-35%	Suppressed crowding	Crowding is likely limited by management, situational factors, or natural factors may offer unique low-density experiences.	245	40%
36-50%	Low normal	Access, displacement, or crowding problems are not likely to exist at this time. Similar to the above category, may offer unique low-density experiences.	111	18%
51-65%	High normal	These locations or activities probably have not exceeded carrying capacity but may be tending in that direction. Should be studied if increased use is expected, allowing management to anticipate problems.	107	17%
66-80%	Over capacity	These locations or activities are generally known to have overuse problems, and they are likely to be operating at more than their capacity. Studies and management necessary to preserve experiences.	99	16%
81-100%	Greatly over capacity	It is generally necessary to manage for high-density recreation. A crowding problem has typically been identified.	53	9%

The meta-analysis supported five distinct categories of standards based on the 9-point perceived crowding scale (Figure 1). The five categories were established based on the percent of respondents reporting any level of crowding (values on the scale ≥3). Across the 615 studies a minimum standard of 35% was identified. Importantly, this standard can be used to define if a hunting site is crowded–when >35% of hunters report values ≥3 on the 9-point perceived crowding scale – as well as the degree to which the site is below, at, or above carrying capacity (Table 1).

Encounter Norm Indicator and Standard

Norms are baselines that people use to evaluate behavior, or the conditions created by behavior as acceptable or unacceptable (Vaske et al. 1986, Vaske et al. 1993, Shelby et al. 1996). In effect, norms reflect what hunters believe the status quo should be. Encounter norms were initially applied in backcountry settings to evaluate the impact of seeing other recreationists, and it is common to extend encounter norms to other settings such as hunting (Shelby and Vaske 1991, Shelby et al. 1996). Hunters are asked a pair of questions: "How many other hunters did you encounter?" and "What is an appropriate number of hunters to encounter?" Encounter norms are operationalized as an indicator variable by assessing each hunter's response to the pair of questions and converting the outcome to a dichotomous yes or no variable (Figure 2). If an individual encountered more hunters than their norm the indicator variable is coded as "Yes". The total percentage of individuals who responded "Yes" reflects the portion of hunters whose encounter norms were violated. The normative standard for encounters is typically set at 20%; that is, no more than 20% of hunters should have their encounter norms violated (Vaske 2019). The encounter normative standard is violated when >20% of individuals encounter more individuals than their norm.



Hunter No.	Encounters	Desired Norm	Norm Violated?*	% More Encounters
1	3	10	No	
2	5	5	No	
3	10	5	Yes	
4	5	1	Yes	
Total				50%

* No. encounters > Desired norm?

Figure 2. Basic description of methods used to collect encounter norm indicator data, and prepare data sets for evaluation of standards.

Perceived Conflict Indicator and Standard

Conflict has been a theme in the outdoor recreation literature for decades. Recreation conflict generally falls into two main categories (Graefe and Thapa 2004). First, interpersonal conflict occurs when the physical presence or behavior of an individual or group interferes with the goals of another individual or group (Jacob and Schreyer 1980). Interpersonal conflict typically occurs directly via a face-to-face encounter (e.g., between a hunter and a hiker in the same area). Second, social values conflict occurs between groups who may not share similar norms or values about an activity (Vaske et al., 1995). Unlike interpersonal conflict, social values conflict can occur even when there is no direct contact between the groups (Carothers et al., 2001). For example, although encounters with hunters may be rare, some individuals philosophically disagree about the appropriateness of hunting.

Perceived conflict is operationalized as an indicator variable by assessing each hunter's response to the pair of questions: "Did you see other hunters?" and "Is seeing other hunters a problem?" Vaske et al. (1995) suggested combining the frequency of yes or no responses for each question and summarizing the total percentage of hunters for each pairwise comparison (Figure 4). The standard for perceived conflict is set at 25%; that is, no more than 25% of hunters should report interpersonal conflict.

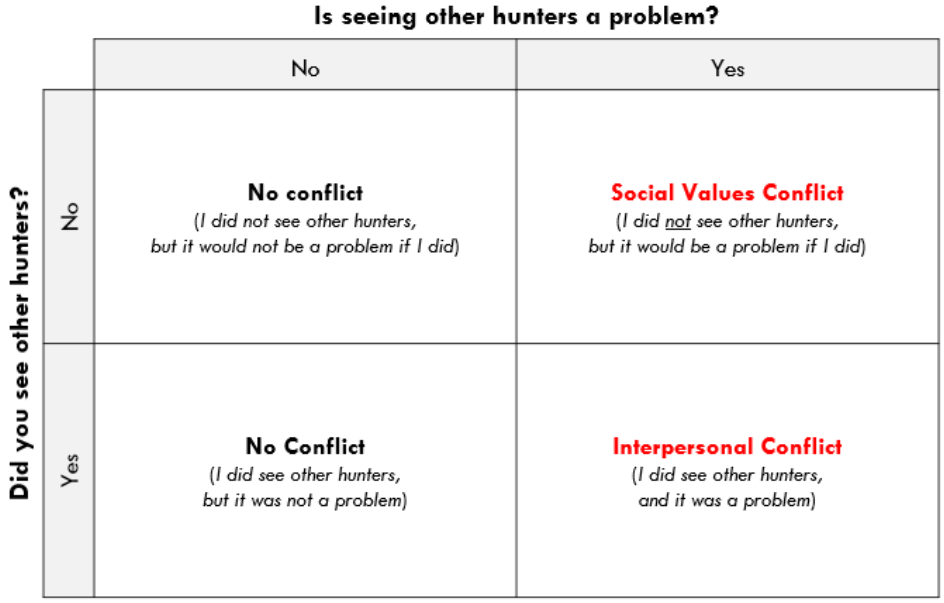


Figure 3. Pairwise comparison of hunter encounters and perceived problem to evaluate perceived conflict indicators and standards.

Sample Design

Beginning in 2018 the NDGF observed sharp increases in the number of reports made by hunters concerning hunting pressure in the Badlands. Accordingly, the period between 2018 and 2022 encompasses a range of hunter densities on hunting units in the Badlands. The sampling frame consisted of regular gun season mule deer hunters, bow hunters who reported hunting activity in the Badlands, and hunters with a gratis license for any of North Dakota's Badlands hunting units (4A, 4B, 4C, 4D, and 4E). Each hunter was assigned to a stratum according to their license

history between 2018 and 2022 (Table 2). A stratified random sample of 10,000 hunters was draw proportional to their occurrence in the sampling frame.

Table 2. Description of survey strata and corresponding response rates.

STRATUM	STRATUM DESCRIPTION	n	RETURNS	RR (%)
RES_Gun	Resident who only possessed regular gun season licenses	3,549	1,306	36.8
RES_Bow	Resident who only possessed bow season licenses	680	358	52.6
RES_Both	Resident who possessed both regular gun season and bow season licenses	3,782	1,758	46.5
NR_Bow	Nonresident bow hunter	1,101	607	55.1
	All Hunters	**9,112**	**4,029**	**44.2**

The NDGF mailed a pre-notification letter alerting hunters of the survey 1 week before the survey period began. Hunters in the sample received an initial contact via email stating the need for the study and emphasizing the importance of hunter input. Participants were provided with a URL link to a Qualtrics questionnaire through email. The unique identifier allowed one questionnaire to be completed, after which it was no longer valid. Participants were able to submit only one completed questionnaire and could not share the link with others who were not in the sample. After a 10-day period nonrespondents were mailed a second email reminder and link to the Internet questionnaire.

Questionnaire Design

The questionnaire utilized for surveying hunters was developed in collaboration with the NDGF and their stakeholders. The questionnaire was designed to gather data about indicator variables associated with perceived crowding, encounter norms, and perceived conflicts. Data for indicator variables were collected at different hunting scales: access sites or roadsides, traveling to a hunting site, and close by while hunting. Each of the hunting scales were nested within four distinct hunting contexts, which included: gun hunters, bow hunters, other hunters (e.g., elk or grouse), and recreationists (e.g., hikers). This resolution of data collection permitted independent evaluations of indicators and standards for a variety of different hunting scenarios.

RESULTS

Given this study's focus on understanding the hunters' perceptions of hunting pressure in the Badlands, interpretational differences in the results are expected depending on the strata to which a hunter belongs. Thus, understanding basic information about Badlands deer hunters offers context to the results presented throughout this report.

Demographic variables were collected from information provided by the NDGF (e.g., license purchase history, age), as well as license type preference self-reported by hunters. Hunters across the four strata were more alike than different across most variables. We suggest a key difference between the strata is the number of opportunities to hunt in the Badlands. During the 5-year period between 2018 and 2022, RES_Gun hunters possessed the fewest licenses on average (mean = 1.83 licenses), followed by NR_Bow hunters (mean = 2.25 licenses), RES_Bow hunters

(mean = 3.63 licenses), and RES_Both hunters (mean = 5.47 licenses). Given the accessibility of bow licenses and the difficulty to draw regular gun season license in the lottery, a significant proportion of RES_Both hunters are likely focusing on bow hunting. Moreover, 70% of RES_Both hunters readily purchase bow hunting licenses when they are unsuccessful in the lottery. Thus, when interpreting the RES_Both hunter stratum, it should be noted they more closely resemble RES_Bow hunters than RES_Gun hunters.

Normative tolerance

Results for norm tolerance standards are presented as a percentage of hunters who reported encountering more hunters than they would prefer. Values close to 0% indicate hunters encountered significantly fewer hunters than their preferred norm (i.e., low hunter densities) and values close to 100% indicate hunters encountered significantly more hunters than they would normally prefer (i.e., high hunter densities). Based on previous work (Vaske 2019), values >20% suggest a violation of the encounter norm standard.

The results suggest the encounter norm standard was violated across a variety of evaluation contexts and hunting scales (Figure 4). Perhaps not surprisingly, violations of the encounter norm were highest at access sites and along roadsides. In most evaluation contexts violation rates declined sharply once hunters distanced themselves from access sites and roadsides. Thus, restricting interpretations to hunt scales away from the road may provide more meaningful conclusions.

The interactions that resulted in the most significant encounter norm violation rates were interseason encounters with other hunters. For example, RES_Gun and RES_Both hunters consistently reported encountering other gun hunters (left-most panel in Figure 4); or, NR_Bow and RES_Bow hunters consistently reported encountering other bow hunters (second panel from left in Figure 4). Notably, intraseason interactions between bow hunters and gun hunters were less significant, though violations to the encounter norm standard did occur. The results suggest RES_Gun hunter encounter rates with other bow hunters were within the suggested encounter norm standard. In contrast, RES_Bow hunter's encounter rates with other gun hunters was violated across all scales. Interestingly, this suggests that RES_Bow hunters feel they encounter too many gun hunters (during the regular deer gun season, presumably), but the opposite is not true for RES_Gun hunters.

Violations of the encounter norm standard were not common for interactions with non-deer hunters (elk, grouse; second panel from right in Figure 4) or recreationists (right-most panel in Figure 4). In the small number of interactions where encounter norms were violated, effects sizes were small, and always associated with RES_Bow or NR_Bow hunters.

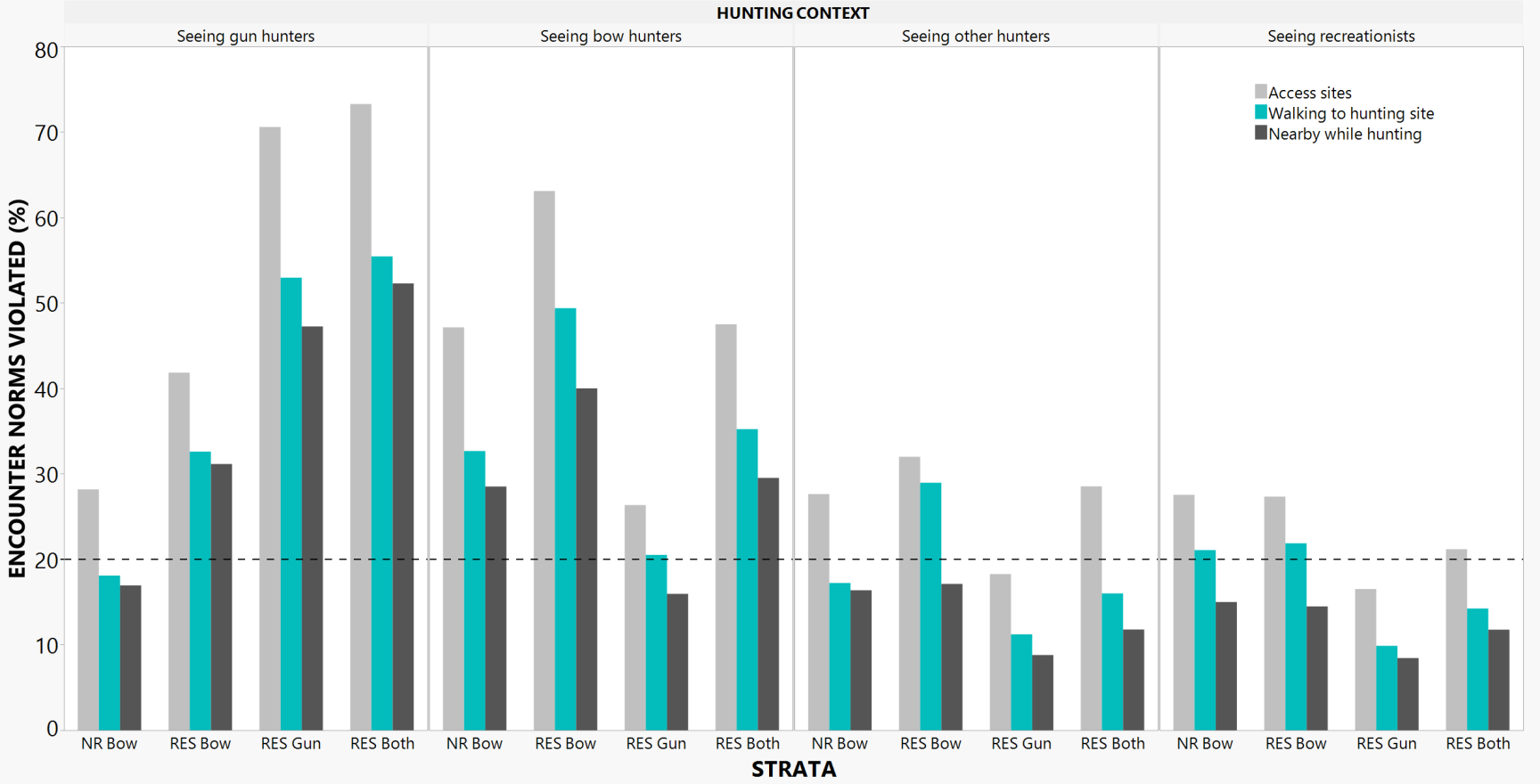


Figure 4. Percentage of hunter encounters that exceed desired hunter norms (i.e., encounter norm violation). The dashed line denotes the standard used to classify encounter norm violations. Values greater than 20% indicate encounter norm standard violations.

Perceived Conflict

Results for perceived conflict standards are presented as a percentage of hunters who reported having a problem seeing other hunters. Values close to 0% indicate hunters do not have a problem seeing other hunters and values close to 100% indicate hunters are extremely conflicted by seeing other hunters. Based on previous work (Vaske 2019), values >25% suggest a violation of the perceived conflict standard.

The results suggest the perceived conflict standard was violated across a variety of evaluation contexts (Figure 5). With respect to interactions with other gun hunters (left-most panel in Figure 5), all strata violated the conflict standard. With respect to interactions with other bow hunters (second panel from left in Figure 5), all strata reported conflict rates that violated the standard, with the exception being RES_Gun hunters. Violations of the perceived conflict standard were not common for interactions with non-deer hunters or recreationists (Figure 5). When violations occurred they were usually associated with RES_Bow, RES_Both hunters, or NR_Bow hunters.

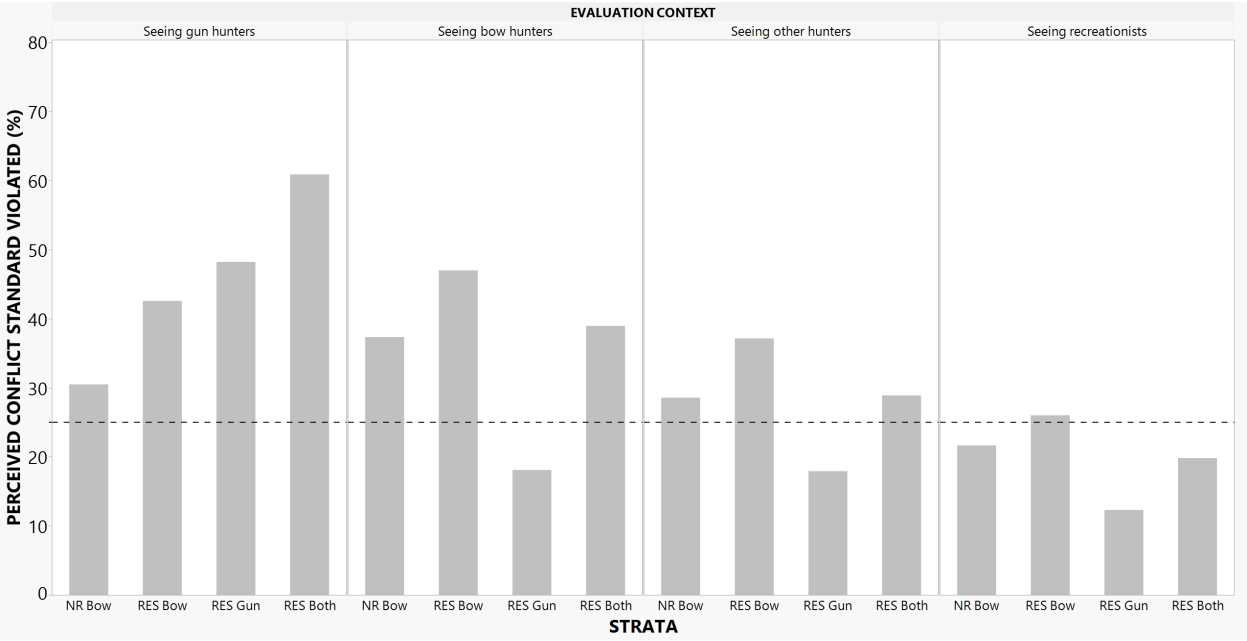


Figure 5. Percentage of hunter's that report conflict when seeing other hunters (i.e., perceived norm violation). The dashed line denotes the standard used to classify perceived conflict violations. Values greater than 25% indicate perceived conflict standard violations.

Perceived Crowding

Results for perceived crowding standards are presented as a percentage of hunters who reported crowding values ≥3 on the 9-point crowding scale. Values close to 0% indicate no crowding and values close to 100% indicate a hunting site is greatly over carrying capacity. Following previous research (Shelby et al. 1989, Vaske and Shelby 2008) the standard for the crowding indicator suggests that <35% of respondents should feel crowded. There were few evaluation contexts and hunting scales in which the perceived crowding standard was violated (Figure 6).

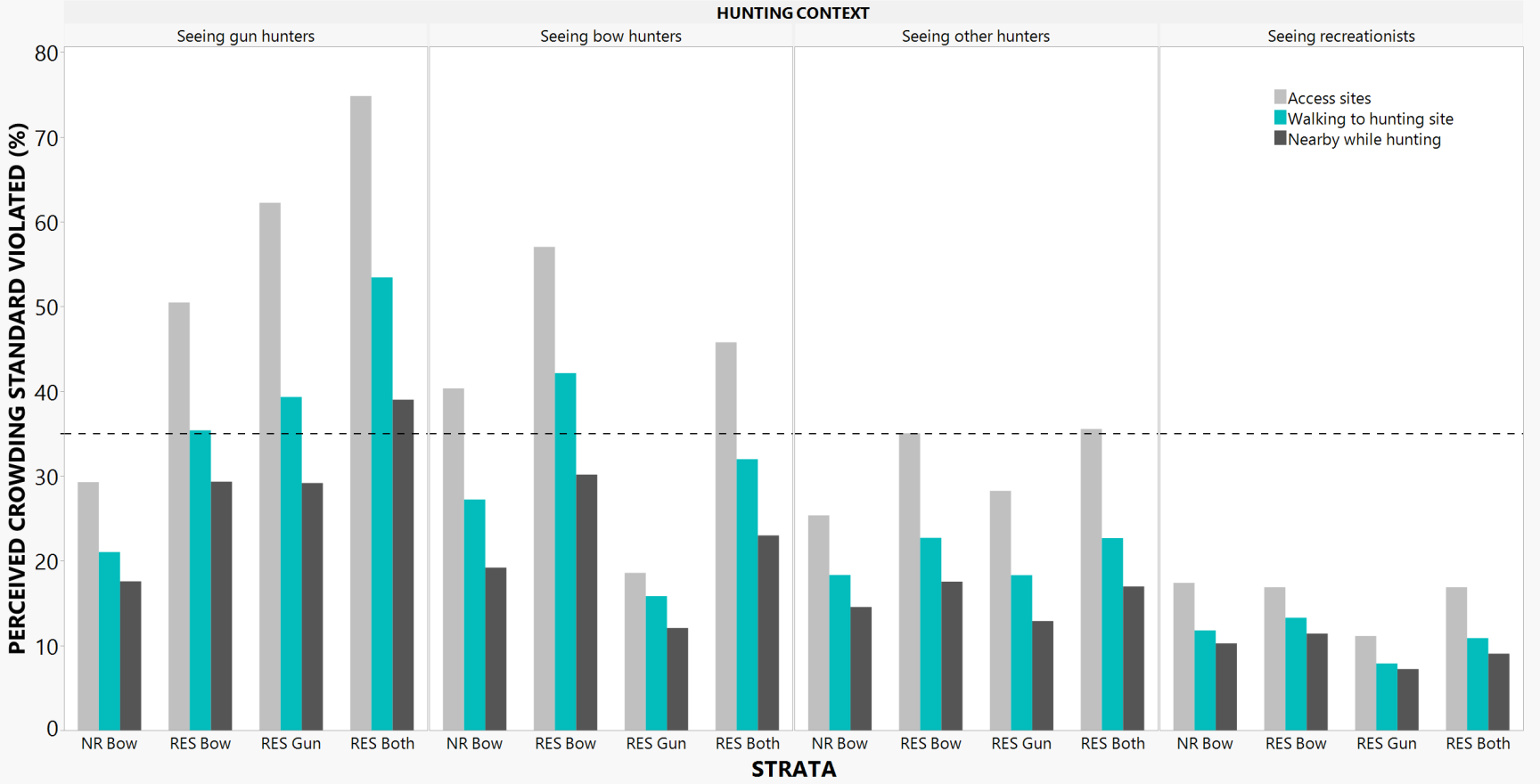


Figure 6. Percentage of hunter's that report crowding values ≥3 on the 9-point crowding scale (i.e., perceived crowding violation). The dashed line denotes the standard used to classify perceived crowding violations. Values greater than 35% indicate perceived crowding standard violations, and values greater than 50% denote a site is nearing carrying capacity.

Similar to the encounter norm standard, perceived crowding rates declined sharply once hunters distanced themselves from access sites and roadsides. Accordingly, there were only three interactions in which the perceived crowding standard was violated. RES_Gun and RES_Both hunters reported crowding rates that violated the standard with respect to seeing other deer gun hunters (left-most panel in Figure 6), and RES_Bow hunters reported rates that violated the standard with respect to seeing other bow hunters (second panel from left in Figure 6). Overall, this suggests hunters across all strata perceived crowding to be relatively low.

Beliefs about hunting pressure and management actions

After utilizing the indicators and standards framework to quantify hunter perceptions of hunting pressure in the Badlands, we sought direct input by posing a straightforward yes or no question: "Is there too much hunting pressure in the Badlands?" Across all respondents, 46.5% of hunters do not believe there is too much hunting pressure in the Badlands, and only 21.7% of hunters believe there is too much hunting pressure (Table 3). However, a substantial number of hunters chose not to respond to the question. When hunters who did not answer the question are excluded from the analysis, approximately two-thirds of hunters do not perceive excessive hunting pressure in the Badlands (Table 3). Hunters who participated during the regular deer gun hunting season (RES_Gun, RES_Both) were more likely to believe there was too much hunting pressure in the Badlands compared to bow hunters who only hunt during the bow season (RES_Bow, NR_Bow).

Table 3. Distribution of responses to the question, "Is there too much hunting pressure in the Badlands?" Columns with adjusted percentages (i.e., *Adj. %*) reflect the distribution of responses with NA's removed (i.e., hunters that did not provide an answer).

		Is there too much hunting pressure in the Badlands?							
		Yes			**No**			**Did not answer**	
Strata	**Returns**	**n**	**%**	**Adj. %**	**n**	**%**	**Adj. %**	**n**	**%**
NR_Bow	607	62	10.2	14.5	367	60.5	85.5	178	29.3
RES_Bow	358	68	19.0	28.5	171	47.8	71.5	119	33.2
RES_Gun	1,306	285	21.8	34.4	544	41.7	65.6	477	36.5
RES_Both	1,757	458	26.1	36.7	791	45.0	63.3	508	28.9
All Hunters	**4,028**	**873**	**21.7**	**31.8**	**1,873**	**46.5**	**68.2**	**1,282**	**31.8**

Hunters were asked a straightforward yes or no question: "Do you support regulation changes to the bow season to reduce hunter congestion?" Across all survey respondents, 36.3% of hunters do not support regulation changes to the bow season, while 31.1% of hunters support potential regulation changes (Table 4). Similar to the question pertaining to hunting pressure, many hunters opted not to respond. When these non-respondents are excluded from the analysis, support for new bow season regulations increases considerably, to nearly half of all hunters (46.1%), yet, a small majority of hunters are still not in support of additional regulations (53.9%).

Table 4. Distribution of response to the question, "Are you supportive of regulation changes to the bow season to reduce hunter congestion?" Columns with adjusted percentages (i.e., *Adj. %*) reflect the distribution of responses with NA's removed (i.e., hunters that did not provide an answer).

		Supportive of regulation changes to the bow season?							
		Yes			**No**			**Did not answer**	
Strata	**Returns**	**n**	**%**	**Adj. %**	**n**	**%**	**Adj. %**	**n**	**%**
NR_Bow	607	139	22.9	32.8	285	47.0	67.2	183	30.1
RES_Bow	358	79	22.1	33.5	157	43.9	66.5	122	34.1
RES_Gun	1,306	480	36.8	59.1	332	25.4	40.9	494	37.8
RES_Both	1,757	555	31.6	44.6	689	39.2	55.4	513	29.2
All Hunters	**4,028**	**1,253**	**31.1**	**46.1**	**1,463**	**36.3**	**53.9**	**1,312**	**32.6**

It's important to point out that non-response associated with questions about hunting pressure and regulation changes was nearly identical (31.8% and 32.6%). These questions were presented to hunters as a pair, in a single block of questions (that is, hunters did not see the first question independent of the second question). It's unclear why hunters would skip both questions at such a high rate relative to other survey questions. It's possible that hunters are unsure how they feel about each statement as the issues are complex, and simple yes or no answer options do not capture their beliefs. Nevertheless, when a pair of question elicits such a disproportionate nonresponse than would be expected by random chance, the concern for nonresponse bias emerges. Thus, conclusions drawn from these results should account for uncertainty because of nonresponse.

Hunters who responded "Yes" to the question pertaining to new bow hunting regulations were presented an additional question to measure their support for potential management actions to manage the number of bow hunters in the Badlands (Figure 7). Responses to the question reflected individual interests. For example, NR_Bow hunters opposed a delay in the season for nonresidents, and RES_Gun hunters favored a regulation change that closed the bow season during the 16½-day gun season. All hunters broadly supported biological-based regulation changes like using the biological status of mule deer populations to determine the number of bow hunting licenses issued or the distributing bow hunters across units. Notably, bow hunters, while generally supportive of biological-based changes, did so at a lower rate relative to gun hunters.

DISCUSSION

Hunting Pressure in the Badlands

Part of the motivation for this study was based on feedback from concerned hunters regarding the hunting pressure issues that resulted from excessive bow hunter densities in the Badlands. We used an indicators and standards framework to formally quantify the different measurable features that result when hunter density increases. We suggest a logical way to combine each of the standards to better understand a hunter's thought process might be done in the following manner. When encounter norm standards at a hunting site are violated (i.e., if an individual encounters more hunters than they're comfortable with), the hunter may experience conflict, and logically, the hunter might perceive the hunting site to be crowded.

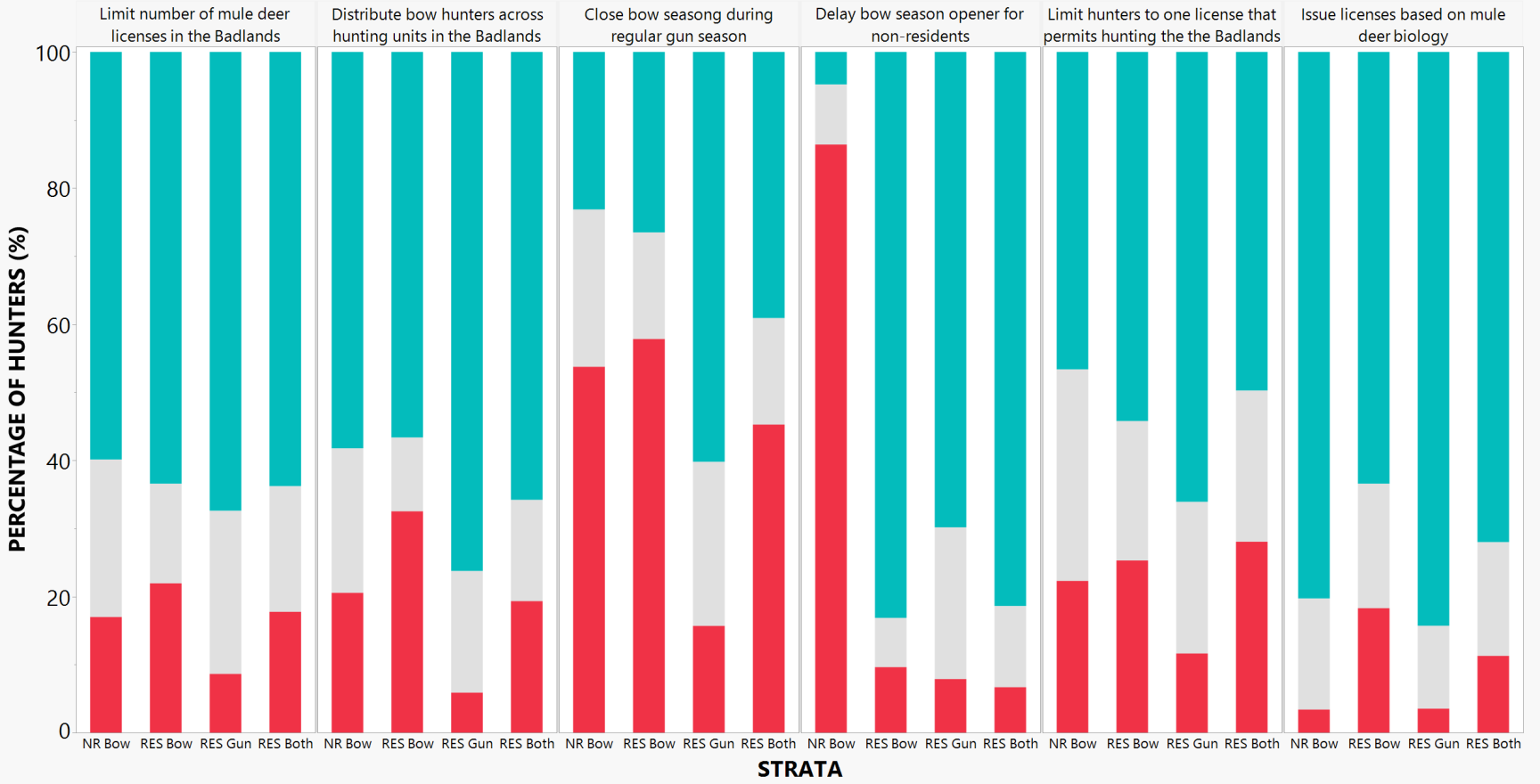


Figure 7. Distribution of responses about potential bow hunting regulation changes. Hunters indicated if they agreed (green bars) with a series of a proposed regulation changes, were neutral (gray bars), or disagreed (red bars).

Patterns in encounter norm tolerance violations (Figure 4) closely mimic the patterns observed for perceived conflict (Figure 5). Generally, bow hunters and gun hunters believe they encounter too many other regular deer gun season hunters and the results suggest they have significant conflict. Similarly, bow hunters believe they encounter too many other bow hunters during the archery season. Based on these results, it would be logical to assume hunters also experience excessive rates of crowding. However, we observed fewer evaluation contexts where the perceived crowding standard was violated relative to encounter norm violations and perceived conflict violations.

Although perceived crowding did not appear to be problematic for a majority of hunting contexts, the NDGF should be concerned with crowding rates reported by RES_Both hunters during the regular deer gun season (left-most panel in Figure 6). Gun hunters and bow hunters within the RES_Both stratum reported crowding rates that violated the standard across all hunting scales. More importantly, the rate of perceived crowding at access sites and roadsides (74.8%) was the second highest perceived crowding rate reported in the literature (Vaske and Shelby 2008). Even at a hunters most personal scale, nearby while hunting, RES_Both hunters reported perceived crowding rates that violated the standard–which was the only hunting context in the Badlands where this occurred.

Overall, these findings suggest that hunters encounter more fellow hunters than they ideally prefer, and there are localized hunting contexts where crowding rates are excessive. Despite this, a majority of hunters did not agree that there was too much bow hunting pressure when questioned directly. This implies a willingness among hunters to endure higher levels of hunting pressure. Given the value placed on hunting in the Badlands, particularly considering the challenges of drawing a license during the regular gun season, this tolerance of other hunters may be understandable.

Support for New Bow Hunting Regulations

Evaluating support for additional regulation changes to the bow hunting season is complicated because of significant levels of non-response. Approximately one-third of hunters were supportive of changes, one-third of hunters were not supportive, and one-third of hunters did not respond to the question. When non-respondents are removed from the analysis, hunters are generally not supportive of changing bow season regulations.

Among hunters that did support regulation changes, our findings suggest overwhelming support for biological-based regulation changes, particularly among RES_Gun hunters. For example, when asked if bow hunting license availability should be tied to the biology of the mule deer population, nearly all hunters agreed (right-most panel in Figure 7). However, amongst bow hunters, support for biological-based regulations diminishes when the proposed regulation change limits their opportunities to hunt. Essentially, bow hunters support potential regulations designed to impact the biological status of the deer population but are reluctant to support regulation changes that impose limitations on their own hunting activities. This implies that hunters would be amenable to a variety of different hunting regulations if they don't

meaningfully change how they prefer to hunt in the Badlands, and particularly if the regulations are based on deer biology.

CONCLUSIONS

In North Dakota, the cultural significance of the Badlands is difficult to quantify. The Badlands attracts considerable numbers of bow hunters, who evidently, are aware of the increasing hunter densities. In normal circumstances, hunters likely wouldn't tolerate the same levels of hunting pressure observed in the Badlands at another hunting site. However, the desire for a Badlands hunting experience evidently overrides hunter's personal encounter norm preferences and they are willing to tolerate much higher levels of crowding. Given the passionate commitment of Badlands deer hunters (bow hunters, in particular) and the reluctance among the majority of hunters towards regulation changes (albeit a slim majority), any potential changes to hunting regulations should focus on sound biological support and avoid changes that limit hunter's opportunities to participate. The underlying issue, however, is that identifying potential regulation changes that are grounded in deer biology, benefit hunters in the regular gun season, and do not result in meaningful changes to the bow season are incredibly difficult to achieve.

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Appendix A

2023 North Dakota Badlands

Mule Deer Hunter

Survey and Responses

Appendix A

1. **Did you hunt mule deer in the Badlands (units 4A, 4B, 4C, 4D, 4E) between 2018 and 2022?**
   90% Yes
   10% No

2. **During which seasons did you hunt mule deer in the Badlands (units 4A, 4B, 4C, 4D, 4E)? (Percentages are yes responses)**

with a **Bow**	with a **Rifle**
45% 2018	26% 2018
46% 2019	30% 2019
59% 2020	30% 2020
50% 2021	33% 2021
49% 2022	30% 2022

3. **About how many days did you hunt for mule deer in the Badlands during your most recent hunting season indicated above?**

	Days bow hunting	Days rifle hunting
Mean	5.66	3.78
Median	4	3
Mode	0	0
SD	7.99	3.54
Minimum	0	0
Maximum	85	17

	Days bow hunting %		Days rifle hunting %
0	37	0	26
1 to 3	11	1 to 2	14
4 to 5	17	3 to 5	35
6 to 10	22	6 to 10	21
11 to 20	10	11+	4
21+	4		

4. **In the time you have hunted in the Badlands, how do you think the population of <u>mule deer</u> has changed in the area(s) you hunted? (Check only one answer.)**
   9% Increased
   33% Stayed the same
   42% Decreased
   16% Unsure

5. **During your most recent hunting season in the Badlands, about how many opportunities did you have to shoot at mule deer? (Include mule deer that you could you have taken a shot at but chose not to, deer you took shots at and missed, and deer you harvested.)**

Opportunities for shooting	Mean	Median	Mode	*SD*	Minimum	Maximum
bucks (bow hunting)	2.63	1	0	4.39	0	50
does (bow hunting)	6.46	3	0	10.26	0	50
bucks (rifle hunting)	4.41	2	0	6.79	0	50
does (rifle hunting)	8.32	2	0	12.85	0	75

6. Please estimate how many total mule deer you harvested in the Badlands during seasons between 2018 and 2022? Enter zero (0) if you were unsuccessful.

Harvested	Mean	Median	Mode	SD	Minimum	Maximum
bucks (bow hunting)	0.42	0	0	0.84	0	5
does (bow hunting)	0.11	0	0	0.45	0	5
bucks (rifle hunting)	0.62	1	1	0.62	0	5
does (rifle hunting)	0.45	0	0	0.94	0	5

7. Which of the following best describes when you typically hunt mule deer hunting in the Badlands?

16% Traveling roads and trails to spot deer
84% Parking and walking away from the road to spot deer

8. Which of the following best describes when you typically hunt <u>mule deer</u> in the Badlands?

30% I only hunt the weekend(s) when the season opens
31% I hunt consistently throughout the season… opening weekend(s), gun season, late season
39% I avoid the opening weekend(s), but then hunt consistently throughout the season

9. On which type of land do you hunt most during a typical trip in the Badlands

to rifle hunt?
67% Public property (State & Federal lands)
1% Private property
22% I don't hunt with a rifle

to bow hunt?
55% Public property (State & Federal lands)
8% Private property
37% I don't hunt with a bow

10. During a typical trip to hunt mule deer in the Badlands, how often has *each* of the following happened to you, personally?

	Never %	1 or 2 times %	3 to 5 times %	Many times %	Almost always %
Seeing rifle hunters	12	13	18	30	26
Seeing bow hunters	23	30	17	17	13
Seeing other hunters (e.g., elk, bird, etc.)	18	35	19	18	10
Seeing other recreationists (e.g., hikers)	44	34	11	8	34

11. During a typical trip to hunt <u>mule deer</u> in the Badlands, to what extent do you think *each* of the following is a problem?

	Not at all a problem %	Slight problem %	Moderate problem %	Extreme problem %
Seeing rifle hunters	48	29	18	6
Seeing bow hunters	66	18	10	6
Seeing other hunters (e.g., elk bird, etc.)	73	20	6	1
Seeing other recreationists (e.g., hikers)	79	14	5	2

12. **Please estimate the number of people you saw in each activity (e.g., rifle, bow) and in each context (e.g., access point) during a typical trip to hunt mule deer in the Badlands?**

	Number of people in each activity seen at:		
	Access points or along roads	Walking to/from hunting sites	Close to me while hunting
	M	*M*	*M*
Rifle hunters	10.66	4.24	2.33
Bow hunters	5.57	2.53	1.25
Other hunters (elk, bird, etc.)	2.50	1.09	0.43
Other recreationists (e.g., hikers)	1.78	0.82	0.41

1. Cell entries are means.

13. During a typical trip to hunt <u>mule deer</u> in the Badlands, how crowded did you feel by the number of people participating in each of activities below?

	Not at all Crowded		Slightly Crowded		Moderately Crowded			Extremely Crowded	
Did you feel crowded by:	%		%		%			%	
Rifle hunters									
At access points or along roads	25	12	12	10	10	10	8	5	9
Walking to/from hunting sites	36	20	14	10	9	5	2	1	3
Close to me while hunting	49	19	11	7	6	3	2	1	1
Bow hunters									
At access points or along roads	49	13	10	6	7	3	4	3	5
Walking to/from hunting sites	58	14	9	5	5	3	2	1	3
Close to me while hunting	67	13	7	3	4	2	1	1	2
Other hunters									
At access points or along roads	53	16	10	7	5	3	2	1	3
Walking to/from hunting sites	61	18	8	4	4	1	1	1	1
Close to me while hunting	70	15	6	4	3	1	1	0	1
Other recreationists									
At access points or along roads	74	11	6	3	3	1	1	1	1
Walking to/from hunting sites	79	11	4	2	2	1	0	0	1
Close to me while hunting	82	9	4	2	2	1	0	0	1

13. Please indicate whether you agree or disagree with *each* of these statements.

Seeing other individuals at…	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree %
Access points or along roads changes the hunting experience	6	15	35	33	11
Walking to/from hunting sites changes the hunting experience	5	14	31	37	13
Close to me while hunting changes the hunting experience	4	6	17	35	39

14. Please indicate an acceptable number of other individuals to see for each activity (e.g., rifle hunter, bow hunter) in each cont4ext (e.g., access point).

	What is an acceptable number of ... [1]			
Seeing others at …	Rifle Hunters *M*	Bow Hunters *M*	Other Hunters (e.g., elk, bird) *M*	Other Recreationists *M*
Access points or along roads	5.24	3.56	3.05	2.78
Walking to/from hunting sites	2.62	2.03	1.82	2.56
Close to me while hunting	0.86	0.73	0.70	0.62

1. Cell entries are means.

15. Please indicate whether you agree or disagree with *each* of these statements by circling the number that best matches your response.

	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree %
It's ok that **rifle hunters** use my hunting area as long as they don't interfere with my hunt	5	10	23	51	12
It's ok that **bow hunters** use my hunting area as long as they don't interfere with my hunt	5	8	22	53	13
It's ok that **other hunters** use my hunting area as long as they don't interfere with my hunt	4	8	24	53	12
It's ok that **other recreationists** use my hunting area as long as they don't interfere with my hunt	8	11	23	45	13
Just knowing other people are in the area bothers me, even if I never see or hear them	10	31	35	20	5
The number of people in the area negatively affects the solitude I seek	5	16	31	37	12
The behavior of other hunters bothers me	4	12	39	33	12
The behavior of other recreationists bothers me	6	18	48	20	7

16. Do you believe there is too much bow hunting pressure in the Badlands?

68% No
32% Yes

17. Are you supportive of regulation changes to the bow season to reduce hunter congestion?

55% No
45% Yes

18. Only asked of those respondents that answered YES to question #17. The NDGF does not currently manage the number of bow hunters who hunt mule deer in the Badlands. Below are general approaches the NDGF could explore to reduce hunter congestion. Please circle the number that best matches your response for each of the following alternatives.

	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree %
Limit the number hunting licenses issued for mule deer in the Badlands	6	9	21	38	27
Use unit level mule deer bow licenses to distribute hunters more equally in the Badlands	5	10	17	44	24
Close the bow season during the 16 ½ day rifle season	0	36	20	45	0
Delay the opening of the bow season for non-resident hunters	8	8	15	27	41
Limit hunters to one license that permits hunting in the Badlands	8	13	23	27	29
Set the number of mule deer bow hunting licenses issued in the Badlands based on the biological status of the mule deer population	4	4	15	39	39

19. How many years have you hunted mule deer in the Badlands?

	Years Hunted
Mean	14.16
Median	10.00
Mode	1
SD	13.43
Minimum	1
Maximum	60

20. Which of the following describes how often you apply for a rifle license to hunt mule deer in the Badlands?

58% every year
15% most years
12% some but not most years
16% never, I only hunt with a bow

21. If you are not successful in drawing a rifle license to hunt mule deer, do you bow hunt in the Badlands?

42% Yes
43% No
15% I only hunt with a bow

22. If you do not apply for a mule deer rifle license for the Badlands every year, please choose the statements below that describes your reason for not applying. (Percentages are yes responses).

9% I'm a bow hunter
4% Low number of deer in the badlands
1% Too expensive
3% Difficult to access places to hunt
14% Drawing odds too difficult
4% I like to hunt in other parts of the state
4% Too many other hunters
1% Too many recreationists
1% Poor health
5% Not enough time
3% Lack of quality bucks

23. Do you plan to hunt mule deer in the Badlands in future seasons?

7% No
93% Yes

Appendix B

2023 North Dakota

Landowner Gratis Permit

Survey and Responses

Appendix B

The landowner survey included individuals who owned more than 160 acres and who were given gratis deer permits within the units in the Badlands region. Results are based on a Qualtrics survey (n = 267, response rate = 30%)

1. During which seasons did you hunt <u>mule deer</u> in the Badlands (units 4A, 4B, 4C, 4D, 4E)? (Check all that apply – Percent yes)

with a <u>Bow</u>	*with a <u>Rifle</u>*
21% 2018	42% 2018
22% 2019	42% 2019
21% 2020	47% 2020
21% 2021	49% 2021
20% 2022	46% 2022
41% none of these years	7% none of these years

2. About how many days did you hunt for <u>mule deer</u> in the Badlands during your most recent hunting season indicated above?

	Days bow hunting	*Days rifle hunting*
Mean	6.29	6.02
Median	0	5
Mode	0	10
SD	11.42	4.15
Minimum	0	0
Maximum	75	17

3. In the time you have hunted in the Badlands, how do you think the population of <u>mule deer</u> has changed in the area(s) you hunted? (Check only one answer)

14% Increased
24% Stayed the same
54% Decreased
7% Unsure

4. During your most recent hunting season in the Badlands, about how many opportunities did you have to shoot at <u>mule deer</u>? (Include mule deer that you could you have taken a shot at but chose not to, deer you took shots at and missed, and deer you harvested.)

Opportunities for shooting	Mean	Median	Mode	*SD*	Minimum	Maximum
bucks (bow hunting)	2.51	1	0	3.95	0	20
does (bow hunting)	5.72	2	0	8.41	0	40
bucks (rifle hunting)	5.65	4	2	6.75	0	50
does (rifle hunting)	11.85	8	0	13.36	0	50

5. Did you harvest a <u>mule deer</u> in the Badlands during any season from between 2018 and 2022? Enter zero (0) if you were unsuccessful.

Harvested	Mean	Median	Mode	SD	Minimum	Maximum
bucks (bow hunting)	0.47	0	0	1.03	0	7
does (bow hunting)	0.19	0	0	0.84	0	7
bucks (rifle hunting)	1.57	1	0	1.46	0	7
does (rifle hunting)	0.45	0	0	1.15	0	7

6. Which of the following best describes when you typically hunt <u>mule deer</u> in the Badlands?

27% I only hunt the weekend(s) when the season opens
44% I hunt consistently throughout the season… opening weekend(s), gun season, late season
29% I avoid the opening weekend(s), but then hunt consistently throughout the season

7. During a typical mule deer season in the Badlands, how often has *each* of the following happened to you, personally? Please circle the number that matches your response.

	Never %	1 or 2 times %	3 to 5 times %	Many times %	Almost always %
Having trespass issues with hunters	16	37	15	16	16
Concerns about my livestock from hunters	46	26	5	16	8
Hearing shots while working on my land	11	20	15	34	20
Having roads blocked by hunters	47	19	8	15	10

8. Please indicate whether you agree or disagree with *each* of these statements by circling the number that best matches your response.

	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree %
It's ok that **rifle hunters** hunt in the area as long as they don't interfere with my work on my land.	12	12	27	42	8
It's ok that **bow hunters** hunt in the area as long as they don't interfere with my work on my land.	10	9	24	44	14
Just knowing other people are in the area bothers me, even if I never see or hear them	12	23	38	21	6
The number of people in the area negatively affects my ability to work my land	10	24	38	23	5
The behavior of hunters gives me safety concerns	4	14	27	38	17

9. Do you believe there is too much bow hunting pressure in the badlands?

55% No
45% Yes

10. Are you supportive of regulation changes to the archery season to reduce hunter congestion?

37% No
63% Yes

11. The NDGF does not currently manage the number of bow hunters who hunt mule deer in the Badlands. Below are general approaches the NDGF could explore to reduce hunter congestion. Please circle the number that best matches your response for each of the following alternatives.

	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree %
Limit the number hunting licenses issued for mule deer in the Badlands	2	2	27	39	30
Use unit level mule deer bow licenses to distribute hunters more equally in the Badlands	3	7	17	45	29
Close the bow season during the 16 ½ day rifle season	5	18	29	20	28
Delay the opening of the bow season for non-resident hunters	2	5	32	24	37
Use a lottery to distribute antlered mule deer bow hunting license	5	8	26	33	28
Limit hunters to one license that permits hunting in the Badlands	7	7	28	30	28
Set the number of mule deer bow hunting licenses issued in the Badlands based on the biological status of the mule deer population	1	2	18	45	34

12. Do you plan to hunt mule deer in the Badlands in future seasons?

11% No
88% Yes

13. Do you allow hunters on your property?

to rifle hunt?

24% No
22% Yes
54% Yes, but only family or friends

to bow hunt?

24% No
26% Yes
50% Yes, but only family or friends

14. How many years have you owned property in the Badlands?

	Years Property Owned
Mean	23.90
Median	20
Mode	20
SD	21.55
Minimum	0
Maximum	125

15. How many acres do you own in the Badlands?

	Acres owned
Mean	1382.03
Median	800
Mode	160
SD	1908.03
Minimum	0
Maximum	12000

16. Where is your property located relative to other State & Federal public hunting land in the Badlands?

64% I share a border public with hunting lands
28% There are public hunting lands within 10 miles of my property
2% There are no public hunting lands near my property, but I live on a secondary road used to access public hunting lands
6% There are no public hunting lands near my property

17. What activities occur on your property? (Check all that apply)

% yes

59% Raising livestock
45% Agriculture
28% Manage habitat for wildlife
2% Charge other hunters to access land for hunting (i.e., fee hunting)
25% Rent out the land to other nearby producers
4% I just live here