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Evaluating competing preferences of hunters and landowners for management of deer populations

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Abstract: Most state wildlife agencies consider public input in the management of white-tailed deer (*Odocoileus virginianus*) populations. In 2013, we surveyed deer hunters (n = 3,600) and landowners (n = 4,604) in southwest Minnesota to gauge their preferences for managing deer. We hypothesized a priori that, irrespective of their perceived impacts of deer, hunters would prefer deer populations to be increased and landowners would prefer deer populations to be decreased. Our findings suggest that defining stakeholder groups according to primary associations with deer (i.e., farming and hunting) accurately categorized differences in tolerance levels for deer populations in our study area. Deer damage was considered relatively minor by landowners, yet, 51% of landowners wanted deer densities reduced. Although 59% of hunters were satisfied with the number of deer, 62% of hunters still wanted deer densities increased in the future. Almost two-thirds of hunters were not satisfied with the number or quality of bucks where they hunted, and an antler-point restriction was the only potential regulation supported by hunters to reduce harvest mortality rates of bucks. To enable managers to monitor trends in public satisfaction relative to the fundamental objectives of deer management in an area, we recommend conducting frequent surveys of primary stakeholders.

Key words: agriculture, human–wildlife conflicts, hunters, landowners, Midwest, *Odocoileus virginianus*, preferences, survey, white-tailed deer

White-tailed deer (*Odocoileus virginianus*) provide more benefits, yet, cause more problems for people than any other species in North America (Conover 2011). The effects of deer populations on people may be positive or negative (Campa et al. 2011, Conover 2011) and may include satisfaction with deer-related recreation, including hunting, damage to agriculture or personal property, or deer–vehicle collisions. Decker and Purdy (1988) introduced the concept of wildlife acceptance capacity, which reflects the maximum wildlife population level in an area that is acceptable to people. Managers must balance the preferences of stakeholder groups to manage deer at optimum population levels and below acceptance capacity, given the complexities of managing deer for the whole of society and to benefit ecosystems.

A person's preferences for deer population levels may be influenced by multiple factors, including hunting (Stewart 2011), farming (Lischka et al. 2008), or social values (Stout 1993). Most individuals cannot be characterized into a single stakeholder group. Lischka et al. (2008) found that acceptance capacity for deer populations is most influenced by perceived impacts of deer. In many regions throughout the range of white-tailed deer, the fundamental objectives for managing deer populations are to maximize recreational opportunities associated with deer and to minimize damage caused by them. It follows that hunters and agricultural producers are the primary stakeholders in defining goals for deer populations. Lischka et al. (2008) found that participation in hunting and farming affected an individual's perception of impacts from deer, but these activities were poor predictors of acceptance capacity for deer. Rather, Lischka et al. (2008) recommended assigning individuals to stakeholder groups by the total effect of the impacts a person perceived.

However, the impacts of deer that are perceived by stakeholders may not reflect current deer population levels, further complicating use of these data to define stakeholder groups. For example, individuals involved in deer–vehicle collisions (DVCs) or those who fear being involved in DVCs, prefer lower deer population sizes (Stout et al. 1993, Lischka et al. 2008, Marcoux and Riley 2010).

A direct relationship exists between localized deer population levels and the number of DVCs (Hussain et al. 2007, DeNicola and Williams 2008, Grovenburg et al. 2008, D'Angelo et al. 2012). When the rate of DVCs is lowered due to reduced deer numbers, it follows that fewer people should perceive negative impacts of deer related to DVCs. However, West and Parkhurst (2002) suggested that an individual's opinion about deer incorporated not only their personal experiences, but also information from the media and perceptions they received from other people. Local media report annually about the risk of DVCs during peak seasons, irrespective of current, local deer population levels. Therefore, even after deer populations are lowered, there may be lasting effects of repeated dissemination of information, negative experiences in the past, or recent incidents impacting fewer individuals in the community. Put simply, the perceptions of stakeholders may not match the current reality.

Rarely do managers have current data about the perceived impacts of deer to assign stakeholder groups prior to drawing samples of individuals to survey (Carpenter et al. 2000). Because deer populations can affect people across society and may impact individuals in multiple facets of their lives (Decker and Purdy 1988), managers often conduct surveys with a comprehensive suite of questions targeting a broad sample of citizens (Curtis and Lynch 2001, Campa et al. 2011, Stewart 2011). Such efforts can be cost prohibitive and often may lead to ambiguous results, which frequently cause time lags for applying the survey findings to management.

We surveyed hunters and owners of relatively large landholdings (>65 ha) in southwest Minnesota to evaluate their experiences and preferences related to management of deer populations. We hypothesized that irrespective of their perceived impacts of deer, hunters would prefer deer populations to be increased, and landowners would prefer deer populations to be decreased.

Background of public goal-setting process for deer populations in southwest Minnesota

During 2012, Minnesota Department of Natural Resources (MNDNR) conducted a deer goal-setting process to gather public input to aid in setting deer population goals for southwest Minnesota (Thorson 2012). The goal-setting process included development of recommendations for deer population goals by a stakeholder team and an internet-based questionnaire of voluntary participants. The team of stakeholders represented hunters, landowners, local government officials, and other people with an interest in deer. They were presented with information about deer biology and management in their region. After discussion among stakeholders, the team developed population goal recommendations to MNDNR regarding the desired direction for deer population management (i.e., increase, remain the same, or decrease) in individual deer management units (DMUs). Recommendations from the stakeholder team included increasing deer populations 33% in 3 DMUs and 25% in 8 DMUs, and for deer populations to remain the same in 1 DMU. Recommendations from the stakeholder teams were posted on the MNDNR public website with an accompanying questionnaire. The questionnaire was available on the website for 25 days and was announced through several news releases. Participants in the online questionnaire were voluntary, so, the sample represented responses from self-selected individuals (Duda and Nobile 2010). The participants were presented with a slide show of information specific to southwest Minnesota, including the recommendations for deer population goals from the stakeholder teams. Participants then completed the questionnaire about deer management in their area; then they were asked at what level the deer population should be managed in the future.

Ninety-one percent of respondents to the on-line questionnaire were hunters (n = 319). Respondents were divided regarding how deer populations should be managed, with 46% of respondents indicating that deer numbers were about right and 50% of respondents indicating that deer numbers were too low. With no plurality of opinion about deer population levels in southwest Minnesota, the results of the goal-setting process were difficult to apply to management. In addition, only 36% of online

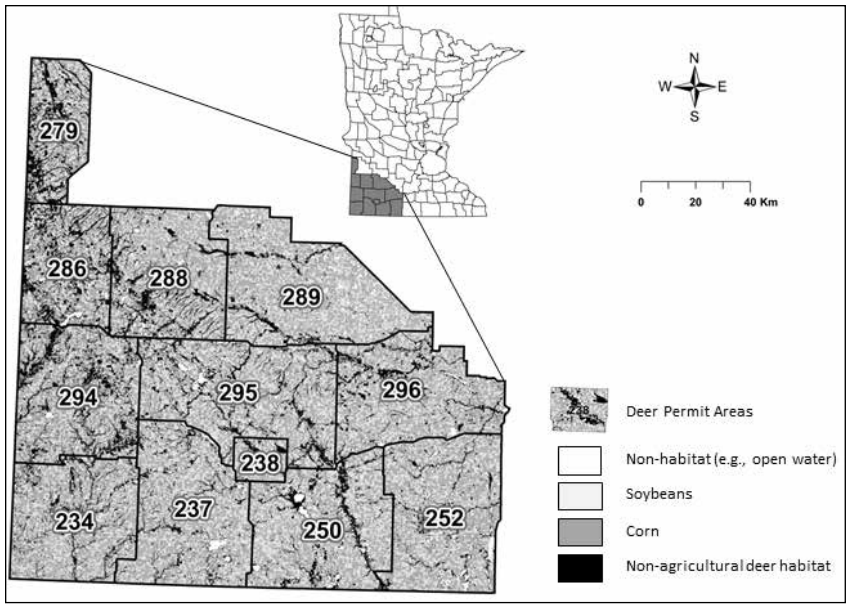

Figure 1. Map of deer permit areas in southwest Minnesota where hunters and landowners were surveyed about management of white-tailed deer, 2013. Eighty-seven percent of land was devoted to agriculture.

respondents were satisfied with the goal-setting process. Thus, the primary purpose of our study was to obtain detailed public input data to aid in setting deer population goals for southwest Minnesota. We believe that our approach and findings have broader applications for similar regions in the Midwest.

Methods

Study area

The surveys focused on 12 DMUs in southwest Minnesota (Figure 1), which lies in the Prairie Parklands Province, with flat to rolling topography that was dominated historically by upland prairie communities (Minnesota Department of Natural Resources 2014). From 1992 to 2012, the amount of farming in southwest Minnesota was stable, with 87% of land devoted to agriculture, but the number of farms decreased 11%, from 13,241 to 11,813, and the average size of farms increased 11%, from 155 ha to 175 ha (U.S. Department of Commerce 1994,U.S. Department of Agriculture 2014). In 2012, about 92% of farms were in cropland, growing mainly corn (*Zea mays*) and soybeans (*Glycine max*). Farming was the primary occupation of 62% of principal operators with an average net cash income of $146,986 per farm (U.S. Department of Agriculture 2014).

The framework of the firearms deer season in southwest Minnesota consisted of a continuous, 9-day hunting season that began on the Saturday nearest to November 6. The MNDNR made an unlimited number of firearms licenses available to the public, and possession of a firearms license allowed the person to kill a buck (deer with >7.5 cm antlers) legally anywhere in Minnesota. The MNDNR offered a limited number of permits to kill antlerless deer those who purchased a firearms licenses; individuals who received an antlerless deer permit were able to harvest any deer in a designated DMU. The number of permits to kill antlerless deer offered in each DMU fluctuated from year to year based on where the spring deer population was relative to population goal. A permit was required to kill antlerless deer (deer without >7.5 cm antlers) during the firearms and muzzleloader hunting seasons, but archery hunters could kill any deer. In addition, youth hunters (<18 years old) could kill any deer during any deer-hunting season. The annual bag limit was 1 deer per person, but hunters afield together in a party were permitted to tag deer killed by other members of their party (i.e., cross-tagging). The archery season was a continuous season that began in mid-September and ended on December 31. The muzzleloader season was a continuous season that began the first Saturday after

Thanksgiving and ended the third Sunday after Thanksgiving.

Pre-fawn deer densities within our southwest Minnesota study area averaged an estimated 1 deer per km^2 in spring 2012 (Grund and Walberg 2012), representing the lowest deer densities found in the farmland zone of Minnesota. When purchasing their deer licenses for 2012, >16,000 individuals indicated that they intended to hunt in a DMU included in our study area, and 2,000 permits for antlerless deer hunting were available in southwest Minnesota. Hunters reported harvesting 4,919 deer during 2012 in our study area; this equals approximately 0.3 deer harvested per km^2 or 1 deer per 3.3 hunters (McInenly 2013). During 2012, legal bucks comprised 73% of the harvest in our study area.

Data collection

We selected a random sample of 3,600 hunters from the MNDNR electronic licensing system. All Minnesota hunters were asked to indicate which DMU they intended to hunt when they purchased a license for hunting deer in 2012. Our survey population included adult, resident firearms deer hunters who indicated they intended to hunt in 1 of the DMUs within our study area. We created a database of landowners from tax records of the counties in our study area and selected landowners who owned at least 1 property >65 ha. We then randomly selected 4,604 landowners for the landowner survey. We cross-referenced mailing lists for hunters and landowners and removed individuals from the list of hunters who were already included in the list of landowners.

We mailed individuals a self-administered survey with a postage-paid return envelope. Accompanying the survey was a cover letter that requested participation in the survey, outlined the goals of the survey, and assured individuals that their participation, contact information, and answers would remain confidential. We conducted 3 mailings each for the surveys of hunters and landowners, beginning in February 2013, with 4 weeks between the first and second mailing, and 6 weeks between the second and third mailings.

Survey instruments

The survey for hunters was 8 pages and included questions about their hunting participation and behaviors, satisfaction with their hunting experiences, opinions about deer population levels, and preferences for potential regulations.

The survey for landowners was 12 pages and included questions about land ownership, perceptions of wildlife damage, strategies used to reduce wildlife damage, opinions about deer population levels, and preferences for potential regulations. Landowners who indicated they hunted were directed to the same questions asked in the survey of hunters, including their hunting participation, behaviors, and satisfaction with their hunting experiences. Questions regarding potential hunting regulations were presented to all landowners and the questions were identical to those presented to hunters.

Potential regulations for deer hunting presented in the survey included: (1) an early youth-only season; (2) buck-only hunting when deer densities were considered below goal in a DMU; (3) buck permit lottery with youth exemption; (4) antler-point restriction with youth exemption; (5) prohibition of cross-tagging of bucks; (6) prohibition of cross-tagging of antlerless deer; (7) earlier start of the firearms season; and (8) delayed start of the firearms season.

Nonresponse checks

We sorted randomly the lists of hunters and landowners that did not respond to the 3 mailings of the self-administered survey, and attempted to conduct follow-up phone surveys with a sample of those individuals. We asked hunters key questions from the mail survey about deer population management and potential regulatory changes. We asked landowners key questions of interest from the mail survey about deer damage and management of local deer populations.

Data analysis

Using the Statistical Program for the Social Sciences (version 22.0, SPSS, Inc., Chicago, IL), we produced descriptive statistics, cross-tabulations; we compared means using independent samples *t*-tests and determined differences among groups using Pearson chi-square test statistics.

Results

Survey response rates

We mailed 3,600 full-length surveys to hunters; 125 surveys were undeliverable. We received 2,063 surveys completed by hunters, for a response rate of 59%. We mailed 4,604 full-length surveys to landowners; 201 of them were undeliverable. We received 2,105 surveys by landowners, for a response rate of 48%.

Nonresponse check of hunters

We obtained responses from 25 hunters via nonresponse phone surveys. Fewer respondents to the nonresponse phone survey hunted deer in southwest Minnesota during 2012 than respondents to the mail survey (84% versus 98%, t = -5.451, df = 2080, P = 0.00). There was no statistical difference ($P > 0.05$) in answers between the nonresponse phone surveys and mail-based surveys for 13 questions related to management of deer populations or potential regulatory changes. Therefore, we had no reason to suspect nonresponse biases. We did not add data from nonresponse surveys to the primary analyses.

Nonresponse check of landowners

We obtained responses from 100 landowners via nonresponse phone surveys. All but 1 person still owned land in southwest Minnesota at the time of the survey. There was no difference in the ability to answer questions about wildlife damage on their property between respondents to the phone survey or the mail survey (t = 0.12, df = 2138, P = 0.90). However, more phone survey respondents (34% versus 2%; χ^2 = 233, df = 4, P = 0.000) stated they did not know how to rate the amount of deer damage experienced on their property in 2012. There was no difference in responses between phone survey respondents and mail survey respondents regarding the trend in the deer population the last 5 years (χ^2= 4.35, df = 3, P = 0.22) or the current level of the deer population (χ^2 = 5.08, df = 3, P = 0.16). More respondents to the phone survey were likely to want no change in the deer population or to have the deer population decreased (χ^2 = 13.53, df = 6, P = 0.03). Although opinions about deer population management differed among respondents to the phone and mail surveys, we believe our conclusions about data from the mail survey were justified. It is possible that nonrespondents had limited knowledge of deer population levels, damage caused by deer, and hunting on their property, and that they chose not to complete the mail survey. Therefore, we recognize that nonresponse biases may have existed, but the respondents that elected to complete the mail survey likely represent landowners with first-hand knowledge and interest in the management of the local deer population. We did not add data from nonresponse surveys to the primary analyses.

Participation in hunting

Most respondents (98%) of the hunter survey participated in the 2012 deer hunting season. A majority (52%) of respondents to the landowner survey hunted deer at some point in their lives; however, only 26% hunted deer in Minnesota during 2012. For analysis of questions about hunting activities, deer population levels, and preferences for deer hunting regulations, we combined responses for hunters and landowners who hunted in DMUs within our study area during 2012 (hereafter, hunters).

Nearly 90% of hunters indicated hunting mostly in DMUs in southwest Minnesota versus other areas of the state. Most (78%) landowners who hunt also indicated hunting most in DMUs within our study area. Thirteen percent of hunters archery hunted, 97% firearms hunted, and 18% muzzleloader hunted. Respondents of the hunter survey had an average of 23 years of experience hunting in Minnesota, whereas landowners who hunt spent an average of 33 years hunting in Minnesota. Forty percent of hunters did most or all of their hunting on private land they owned. Leasing land to hunt is uncommon in southwest Minnesota, with 90% of hunters having done no hunting on land they leased themselves. Eighty percent of hunters did at least some hunting on private land that they did not own, and 52% of hunters utilized public land for deer hunting.

When asked about what type of deer they prefer to kill if given the choice, 58% of hunters would prefer to kill a mature buck, 31% have no preference, 6% prefer to kill any legal buck, and 5% prefer to kill any antlerless deer. Seventy-two percent of hunters indicated that there were no restrictions on the type of deer that could be killed on the properties they hunted, while 14% indicated that antlerless harvest was restricted,

but hunters could take any legal buck. Thirty-four percent of respondents harvested a buck in 2012, and 19% chose to pass up an opportunity to kill a legal buck because it was not big enough for them to want to harvest it. Fifteen percent of hunters harvested an antlerless deer, and 7% chose to kill an antlerless deer instead of a buck during the 2012 season.

We asked hunters to rate their satisfaction with the number and type of deer they observed while hunting during 2012. Seventy-four percent of hunters heard about or saw legal bucks while hunting, but only 39% were satisfied with the number of legal bucks. Likewise, only 35% were satisfied with the quality of bucks. Hunters who harvested a buck during 2012 were more likely to be satisfied with the number of bucks ($\chi^2 = 79.41$, df = 5, $P < 0.0001$) and the quality of bucks ($\chi^2 = 40.62$, df = 5, $P < 0.0001$). Most hunters were satisfied with the total number of deer (59%) and the number of antlerless deer (61%). Hunters who killed any deer during 2012 were more likely to be satisfied with the total number of deer ($\chi^2 = 38.44$, df = 5, $P < 0.0001$).

Only 56% of hunters applied for a permit to kill an antlerless deer during the 2012 season. Seventy-seven percent of hunters felt that the allocation of antlerless deer permits in the area they hunted was about right (26%) or too low (51%), and 6% of hunters thought it was too high. When hunters were asked why they did not apply for a permit to kill an antlerless deer, 40% of respondents missed the application deadline, 25% do not shoot antlerless deer, and 10% felt there were not enough deer to justify killing an antlerless deer.

Experiences of landowners

Respondents of the landowner survey controlled an average of 243 ha in southwest Minnesota, with an average of 189 ha under their ownership and an average of 168 ha leased. The primary land use was row crop agriculture (average = 194 ha per respondent), and an average of only 10 ha was enrolled in conservation programs. Sixty-eight percent of respondents felt that they could answer questions about wildlife damage that occurred on their property. Sixty-seven percent of respondents felt that deer damage was negligible or minor, 24% believed damage was moderate, and 8% believed that damage was severe during 2012. When asked to compare the level of damage caused by deer to the previous 5 years, 56% of landowners believed damage was about the same, 31% thought damage was greater, and 13% thought there was less damage. Overall, landowners attributed 35% of damage to deer. Losses caused by deer were reported for all crops included in the survey, including row crops, hay, stored forage, fruits, vegetables and nursery stock. Greatest average monetary losses due to deer were reported for corn ($2,824), stored forage ($1,793), and soybeans ($1,299). Average crop damage due to deer reported by individual respondents was $4,485. Landowners also believed that crop damage was caused by other species, including raccoons (*Procyon lotor*; 72%), geese (48%), and gophers (*Rodentia* sp.; 47%).

Eleven percent of respondents used nonlethal techniques to reduce crop damage caused by deer. An average of 72 person-hours and $509 was spent annually employing nonlethal damage management techniques. Of the nonlethal techniques used, electric fencing, wire or plastic fencing, and harassment were most commonly used. Harassment was rated as the most ineffective technique (60%). All other techniques were rated as somewhat effective or extremely effective, including alternative feeding sites (94%), wire or plastic fencing (81%), electric fencing (80%), and propane cannons (50%).

For deer seasons 2008 through 2012, ≥90% of landowners reported that hunting occurred on their property each year. Ninety percent of landowners allowed family members to hunt on their property, and 19% allowed hunting by nonfamily. Of the 19% of landowners who granted permission to nonfamily, 80% allowed friends or neighbors to hunt, 18% allowed strangers who asked permission, and only 5% allowed specific hunting groups. Landowners cited several reasons why they denied people permission to hunt their land, including hunters caused them too many problems (44%), they were concerned about liability (45%), and a variety of other reasons (72%). Less than 1% of landowners stated that they did not allow people to hunt because they did not believe in hunting.

Trends in deer populations

We asked respondents of both the hunter and landowner surveys about their perception of the trend in the local deer population over the last 5 years, current population levels, and their preferences for managing deer populations in the future. For analysis of these questions, responses of landowners who did not hunt in southwest Minnesota and landowners who hunted in southwest Minnesota were treated separately. Landowners, regardless of whether they hunted, were more likely than hunters to perceive that there was an increase in the number of deer in the last 5 years (Figure 2; $\chi^2 = 394$, df = 3, $P < 0.0001$). More landowners (43%) and landowners who hunt (34%) believed that the current deer population level was too high as compared to the opinions of hunters (15%, Figure 3; $\chi^2 = 796$, df = 6, $P < 0.0001$). Regarding future management of deer population levels, most hunters and landowners who hunt supported maintaining current numbers of deer (Figure 4, $\chi^2 = 665$, df = 4, $P < 0.0001$). Non-hunting landowners preferred to see the deer population in their area decreased by 25 to 50%.

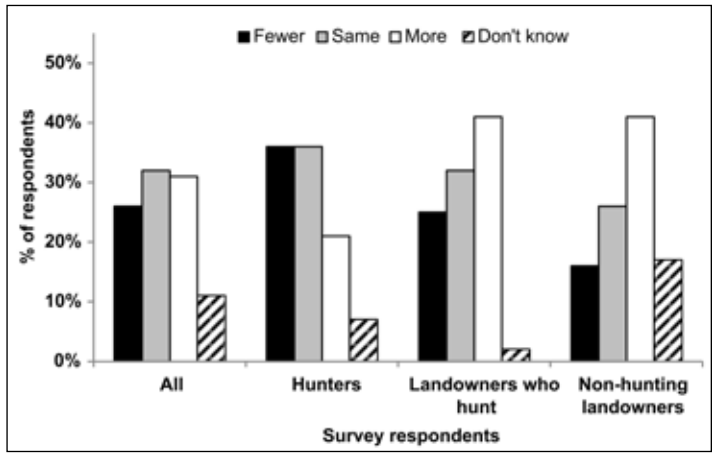

Figure 2. Perceptions of hunter, landowners who hunt, and landowners who do not hunt about the 5-year trend in the white-tailed deer population in their area in southwest Minnesota, 2013.

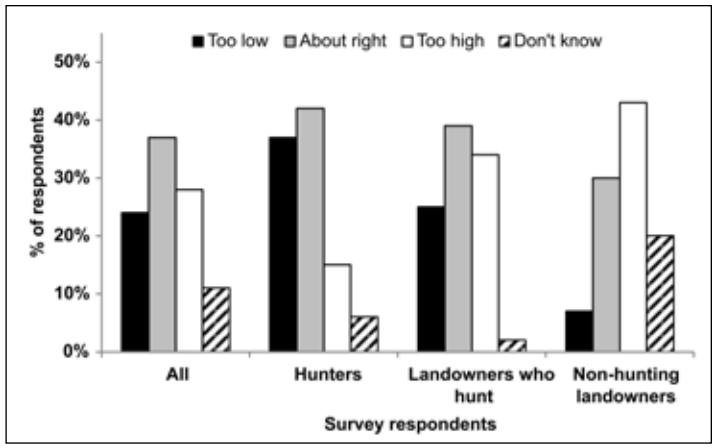

Figure 3. Perceptions of hunters, landowners who hunt, and landowners who do not hunt about the current level of the white-tailed deer population in their area in southwest Minnesota, 2013.

Preferences for regulations

For questions regarding alternative regulatory strategies for managing deer, nonhunting landowners (21%) responded "don't care" more frequently than landowners who hunt (1%) and respondents of the hunter survey (3%). Forty-eight percent of all respondents supported a regulation to increase the proportion of antlered bucks in the population, with the highest support among landowners who hunt (61%) and hunters (59%). Of strategies intended to increase the proportion of bucks in the population, an antler-point restriction was the only regulation supported by landowners who hunt (50%) and hunters (50%). Although an average of only 2% of hunters reported killing >1 buck in a single year from 2009 to 2012, 56% of landowners who hunt and 61% of hunters opposed a prohibition on cross-tagging bucks.

Discussion

To successfully manage deer, agencies must balance public interests with sound biological information to make management decisions (Hansen 2011). Including the input of citizens into deer management can have advantages such as open communication between wildlife management agencies and the public; disadvantages may include biased participation

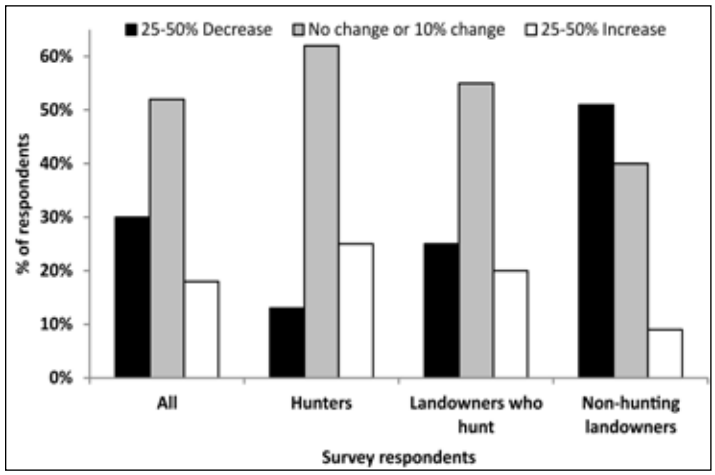

Figure 4. Opinions of hunters, landowners who hunt, and landowners who do not hunt about the future management of the white-tailed deer population in their area in southwest Minnesota, 2013.

by hunters (Fleegle et al. 2013). Managers must anticipate such biases and should recognize the limitations of asking citizens to assist in setting deer population goals or regulations. Most citizens lack biological training and have limited time to devote to the process. Utilizing citizens to provide perspectives about the impacts of deer, both positive and negative, may be the most effective approach to including public input in deer management.

Our surveys targeted both landowners with agricultural production occurring on their property and firearms deer hunters. These groups are likely the primary stakeholders for managing deer in most rural, agricultural regions of the Midwest. Our hypotheses held true that hunters would prefer deer populations to increase, and landowners would prefer deer populations to decrease. Hunters tend to prefer higher deer populations to maximize recreational opportunities (Diefenbach et al. 1997, Lischka et al. 2008, Stewart 2011), and agricultural producers prefer lower deer populations to prevent damage to crops (Curtis and Lynch 2001, West and Parkhurst 2002). The responses of landowners who hunt were moderate between hunters and landowners who do not hunt. In our study, most landowners themselves either farmed or their land was used for farming by others. Arguably, landowners who hunt represent a stakeholder group most in touch with the effects of deer populations on local conditions and those most likely to personally experience both positive and negative impacts of deer.

The marked differences in our survey findings compared to the results from the online survey provides another case example about why state wildlife agencies should interpret the results from online surveys with caution. For example, approximately 50% of the self-selected respondents associated with the online survey from the public goal-setting process indicated that deer populations were too low in the study area. However, only about 25% of our scientifically selected respondents indicated that deer populations were too low, and about two-thirds of the respondents perceived deer populations to be about right or too high in southwest Minnesota. We believe that most wildlife managers would manage for stable deer populations given our survey findings, but might erroneously manage for increasing deer populations given the results of the online survey. These issues previously have been identified (Duda and Nobile 2010, Cornicelli and Grund 2011), but we provide another noteworthy example.

Our findings suggest that defining stakeholder groups according to primary associations with deer (i.e., farming and/or hunting) accurately categorized differences in tolerance levels for deer populations in our study area. In a predominantly rural agricultural area in southern Michigan, Lischka et al. (2008) found that participation in hunting and farming were poor predictors of acceptance capacity for deer. However, their study was conducted in a region where 53% of questionnaire respondents were relocated urbanites who grew up in a city (Lischka 2006) and where deer densities had increased locally and relative to the rest of the state during the previous 40 years. Deer abundance in our southwest Minnesota study area was managed consistently at a low level historically, and the impacts of deer perceived by stakeholders were likely different from those found in Lischka et al. (2008).

The demographics of respondents to our surveys were seemingly appropriate for making informed judgments about deer population levels (e.g., years hunting, perceived knowledge of wildlife, land ownership). Compared to hunters, landowners seemed to be less knowledgeable about deer and their impacts and less willing to be engaged regarding strategies for managing deer. The survey response rate of landowners was 12% less than the response rate of hunters. Moreover, ≥ 17% of landowners responded "don't know" when asked questions about the deer population in their area, and the nonresponse check of landowners indicated that non-respondents did not know how to rate deer damage on their property. In a study of the perceptions of deer densities by suburban residents, Urbanek et al. (2013) found that citizens who did not return surveys experienced less damage to landscape plants and were more likely to perceive deer numbers in their area as perfect. Fleegle et al. (2013) reported a general lack of interest by nonhunting stakeholders for involvement in citizen advisory committees to direct deer management in Pennsylvania. As public involvement in deer management increases, managers will be challenged to educate stakeholders about the importance of their participation and the potential consequences of failing to engage in the process.

Hunters responded to surveys and to individual questions at a higher rate than landowners, which suggested that hunters were more confident in their knowledge of deer. Yet, responses by hunters to some questions suggested that they did not understand the immediate consequences of strategies for managing deer. For example, 87% of hunters wanted deer populations either to stay the same or increase; yet, 51% felt that the allocation of hunting permits for antlerless deer was too low. Although issuance of additional permits to kill antlerless would decrease deer populations, many hunters either did not make this connection or preferred additional recreational opportunities, irrespective of the impacts on deer population levels. Fulton and Manfredo (2004) found that regulations that hunters perceive as constraints to participation in hunting can lead to decreased satisfaction with the hunting experience.

Reports of damage due to deer were relatively minor in southwest Minnesota; yet, 51% of landowners wanted deer densities reduced. Although 59% of hunters were satisfied with the number of deer they saw while hunting, 62% wanted deer densities increased in the future. Given the propensity of agricultural producers to prefer fewer deer and hunters to prefer more deer, from a social perspective, we consider current deer densities to be near optimum levels to be acceptable to all citizens. Generally, the fundamental objectives for managing deer in our study area were met: (1) damage to agriculture was minimized; and (2) satisfaction with recreational hunting opportunities was maximized (i.e., total number of deer observed).

Almost two-thirds of hunters were not satisfied with the number or quality of bucks where they hunted. Several survey questions sought input regarding regulations aimed at decreasing harvest pressure on antlered deer, including an antler-point restriction, a buck permit lottery, or a ban on cross-tagging of bucks. Fifty-nine percent of hunters supported a regulation to increase the proportion of antlered bucks in the population, but the only specific regulation supported by most hunters was an antler-point restriction. Earlier studies demonstrated the importance of seeing and harvesting game to bolstering satisfaction of hunters (Gigliotti 2000, Schroeder et al. 2014), and our results support this relationship. Antler point restrictions instituted in other areas of Minnesota reduced harvest of antlered bucks (M. D. Grund, MNDNR, unpublished data), likely increased the number of bucks on the landscape, and, although the regulation was controversial, the use of antler-point restrictions was publicized regularly by the media. Hunters in southwest Minnesota were likely influenced by the perceived positive impacts associated with antler-point restrictions (i.e., more bucks and larger antlered bucks) in other parts of the state. Similar to a previous study in other regions of Minnesota (Cornicelli et al. 2011), hunters in our study did not support a ban on cross-tagging of bucks or a buck permit lottery, probably rationalizing that these regulations would reduce opportunities for participation. Recent legislation in Minnesota required that an antler-point restriction could be imposed only in the future if approved by the legislature

(Minnesota Chapter 121-S.F. No. 796, Section 53, 2013). To improve hunter satisfaction, managers should pursue legislative approval for implementing an antler-point restriction in southwest Minnesota if local hunters gain the necessary political support.

Management implications

In areas with relatively stable land use and human demographics across time, managers should expect the values of stakeholder groups about deer to be reasonably consistent. Thus, managers may more efficiently define sample populations for surveys of citizens. Using well-designed surveys, managers can gain valuable input from local stakeholders regarding impacts of deer and satisfaction with current deer populations. However, we caution managers to consider the inherent biases of stakeholder groups when asking citizens to provide input about their preferences for future deer population levels. Similar to Urbanek et al. (2013), we recommend conducting frequent surveys concentrating on stakeholder attitudes regarding only the fundamental objectives of managing deer populations (e.g., minimize deer damage, maximize recreation) to: (1) facilitate monitoring of long term trends in stakeholder attitudes to improve management; (2) minimize biases associated with asking stakeholders' preferences for future deer population levels; (3) engage more citizens in the deer management process to lessen the impact of persuasive messaging by stakeholders with minority preferences; and (4) reduce financial costs and logistical hurdles associated with conducting longer surveys on a regular basis.

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