

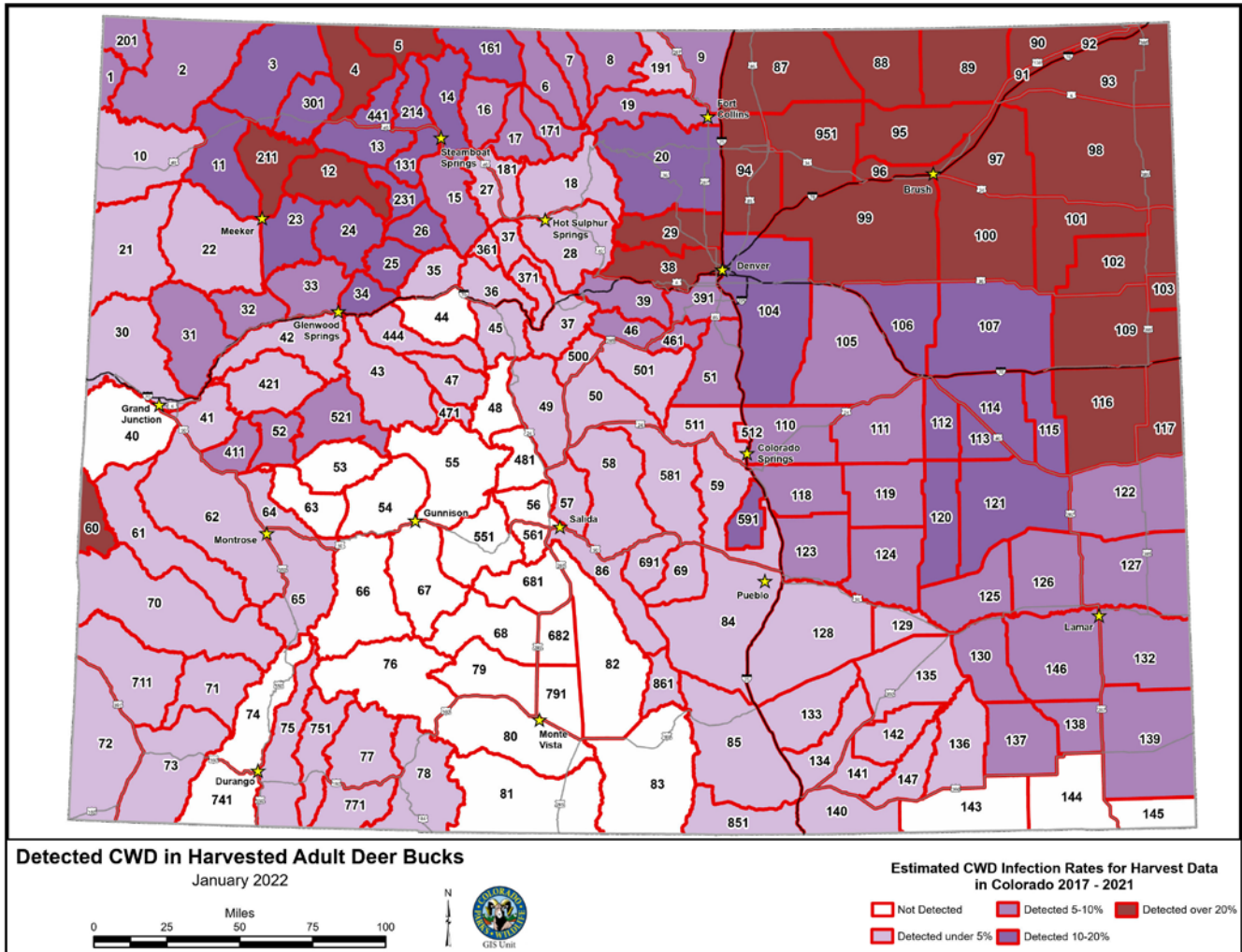
COLORADO PARKS & WILDLIFE

Linking Hunting Access and Chronic Wasting Disease: A Case Study from Northeastern Colorado

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Linking Hunting Access and Chronic Wasting Disease: A Case Study from Northeastern Colorado

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Executive Summary

Background

In 2018, the Colorado Parks and Wildlife Commission approved of the agency's chronic wasting disease (CWD) Response Plan, which detailed how the agency would monitor, and ultimately respond to, CWD infection rates across the state. In 2019, the agency focused its attention on deer herds in northeastern Colorado. The majority of land in this part of the state is privately owned; accordingly, land use decisions – including whether landowners allow (or do not allow) hunting on their property – has the potential to impact Colorado Parks and Wildlife's (CPW) ability to address CWD. As a result, the agency surveyed a subset of landowners (n = 948) who participate in the agency's Landowner Preference Program (LPP). The goal of this effort was to examine the relationship between CWD and hunting access specifically from the perspective of private landowners in northeastern Colorado. Three objectives guided this study:

1. To understand whether and to what extent landowners allow hunting access on their property and to identify messages that might encourage them to do so (or continue doing so).
2. To examine landowners' experiences with and attitudes toward CWD including their preferences for how the disease should be managed.
3. To identify landowners' trust in CPW to effectively manage and communicate about CWD issues.

Methods

We surveyed 948 landowners in northeastern Colorado over a two-month period in the summer of 2020 using a standard mail survey. We also included a unique link allowing landowners to participate online. Everyone in the sample was registered in CPW's LPP at the time of the survey. The survey instrument was designed by CPW staff and included 8 major themes (e.g., hunting access, CWD, trust) and 19 total questions.

Key findings

■ Survey participation rates

- ▶ We mailed the survey to 948 landowners in northeastern Colorado; 38 were undeliverable and 635 completed it resulting in a 70% response rate.
- ▶ 574 participated via standard mail; 61 participated online.

■ Landowner characteristics

- ▶ On average, respondents were 66 years old (mean) and 64% were male.
- ▶ The number of years respondents have lived in Colorado ranged from less than 1 year to greater than 76 years (mean = 57 years).
- ▶ Nearly three-quarters (71%) of respondents own more than 640 acres of land, and about 76% use their land primarily for agricultural production.

■ Hunting activity

- ▶ The majority (78%) of respondents or their family members hunt on their land.
- ▶ Big game are the most commonly hunted species (61%) followed by small game (46%).

■ Hunting access

- ▶ About half (54%) of respondents currently allow hunting on their land but only for people they personally know. Only 7% do not allow access for deer hunting on their land.

- ▶ Respondents who do allow deer hunting access on their land frequently described topics under the umbrella of herd management including (but not limited to): controlling the deer population (114 responses), preventing damage from deer (40), and supporting a healthy deer population and ecosystem (48).

■ Message testing and communication

- ▶ Survey respondents were asked to consider 6 different informational messages and to rank the persuasiveness of each message as to which would encourage them to allow hunting access on their land. Overall, the following messages garnered the most support:
 - Benefits to herd health (63%)
 - Hunting opportunities for future generations (56%)
 - Managing CWD (35%)
 - Safety (20%)
 - Science (20%)
 - Economic benefit (18%)
- ▶ The majority of respondents (n = 314) receive information about CWD and landowner access programs through the Colorado Landowner Preference Program, via word of mouth (267), and through CPW's website (224).

■ CWD experience and awareness

- ▶ The vast majority (85%) of respondents indicated that they have *not* seen an increase in deer that appear sick in northeastern Colorado and about 89% have not seen an increase in deer carcasses.
- ▶ Similarly, about three-quarters (71%) of respondents have never themselves harvested an animal infected with CWD nor do they know anyone else who has.
- ▶ Nearly half (46%) of respondents were “Not sure” what their chances of harvesting a buck infected with CWD in northeastern Colorado would be.
 - Of respondents who provided a specific response, about 29% estimated their chances of harvesting an infected buck to be 2% or less (i.e., 1 out of every 50 or 100 deer). Based on CPW monitoring efforts, their actual chance of harvesting a CWD positive buck is closer to 20%.
 - ◆ These findings indicate that the majority of landowners are unaware or are significantly underestimating the presence of CWD in northeastern Colorado.

■ Concerns about CWD

- ▶ Respondents' top three concerns about CWD were: (1) future generations' ability to enjoy deer hunting, (2) herd health, and (3) a reduction in their own deer hunting opportunity in Colorado.

■ Management preferences

- ▶ More than three-quarters (77%) of respondents supported the agency creating special “disease management” hunting opportunities and more than half (60%) supported the idea of increasing the number of hunting licenses (buck and doe).
 - Only 10% opposed disease management hunts and 21% opposed increasing hunting licenses.

■ Confidence in CPW

- ▶ Overall, the majority of respondents were confident that CPW will manage CWD and communicate about it appropriately.
 - About 64% agreed that the agency will provide truthful information about CWD and 62% agreed that the agency will balance hunting opportunities with the need to manage the disease.

Summary

Findings from this research provide insight into landowners' experiences with and attitudes about CWD, including what they are concerned about, what information they desire, and what messages might resonate with other landowners to encourage them to allow hunting access on their property. Specifically, we learned that most landowners hunt big game on their land and allow family members and close friends to do so as well. Many respondents cited population management, hunting opportunities, and a desire for hunting heritage to be passed on to future generations as reasons why they provide hunting access on their land. Landowners who do *not* allow hunting access on their property typically cited safety concerns, a lack of abundant deer, and the potential for property damage as reasons why they do not permit others to hunt on their land.

Overall, experience with and awareness about CWD is relatively low. The majority of landowners have not witnessed an increase in the number of sick deer or deer carcasses in this part of the state. Similarly, most respondents – including their family members – who have submitted their harvested deer for CWD testing have not received a positive result. We also learned that the majority of landowners drastically underestimated CWD infection rates in this part of the state where they are typically between 20%-30%.

Most landowners are concerned about future generations' ability to hunt deer in the state and the long-term health of deer herds because of CWD. Human health and issues associated with economic loss were much less of a concern. However, most landowners did not feel as if they had enough information about potential human and livestock health risks due to CWD nor did they believe they had enough information about what CPW was doing to manage CWD in the state. That being said, the majority of landowners have confidence in the agency's ability to manage and provide truthful information about the disease. Similarly, many learn about CWD through local wildlife managers though more seek information about it from the LPP or CPW website.

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Background

Continued geographic expansion of known CWD distribution and the growing severity of infection rates in some affected cervid populations has renewed calls for sustainable intervention strategies (Miller & Fischer, 2016; Uehlinger et al., 2016; EFSA, 2017; Mysterud & Edmunds, 2019). The vast majority of effective management actions currently rely on hunting participation and modifications to license setting to reduce infection rates in affected cervid populations (Uehlinger et al., 2016; Mysterud & Edmunds, 2019; Miller et al., 2020). As a result, state wildlife agencies (SWAs) need to maintain public support for CWD management objectives and prescriptions over long periods of time to obtain measurable effects and evaluate their effectiveness (WAFWA, 2017; Colorado Parks and Wildlife, 2018).

Given the important role that hunters play in helping SWAs manage the disease, it is unsurprising that the vast majority of human dimensions research on CWD has focused on hunter perceptions of this disease including, but not limited to, their attitudes about CWD management; perceptions of risk and how these influence future hunting behaviors; and hunters' trust in SWAs' ability to effectively manage and communicate about the disease (Needham & Vaske, 2006; Vaske, Miller, Ashbrook, & Needham, 2018; Harper, Miller, & Vaske, 2015; Vaske & Miller, 2019). These efforts have identified a generally supportive constituency in terms of wanting something to be done to reduce disease prevalence and spread (Needham et al., 2004), yet preferences for how this is done are often highly variable (Quartuch & Studebaker, under review).

One of the challenges associated with engaging the public about CWD is that the disease epidemiology unfolds slowly (Miller et al., 2000, 2020). Clinical disease and population effects can be subtle in wild cervids (Williams et al., 2002; Miller et al., 2008; DeVivo et al., 2017; WAFWA, 2017), thereby masking effects to casual or infrequent observers. Limited direct, personal experience with a hazard or disease such as CWD can result in decreased topical saliency and in more extreme cases, create apathy about agencies ability to contain the disease or result in a vocal minority who actively dismiss scientific concerns about it (Gigliotti, 2004; Holsman et al., 2010; Pfeiffer, 2006). In other words, individuals who do not perceive a problem because they are not seeing an increase in the number of sick or dying deer – and

by proxy do not perceive an overall decrease in wildlife populations – may be less concerned about the disease. These individuals may become complacent about or overtly antagonistic to efforts needed to combat the disease. Consequently, landowners may choose not to cooperate with management strategies and hunters may not have their harvested animal tested for CWD. The former also represent an understudied unit of analysis within the human dimensions of CWD (See Petchenick, 2006; Poudyal, 2022, for exceptions).

Of Colorado's 66,678,400 acres of land, almost 60% are privately owned (R. Aberle, personal communication, September, 16, 2022). In Northeastern Colorado, about 1,110,012 acres are designated as part of the Landowner Preference Program (LPP), a program designed to encourage habitat restoration by allocating hunting licenses to landowners who participate in it. West of I-25, upwards of 10% of all licenses from the general pool are awarded through the LPP, and about 15% of licenses east of I-25 are allocated for the program. As a result, the land use decisions of thousands of individuals and families can impact the overall efficacy of CWD management efforts in this part of the state. Thus, initial and sustained cooperation of private landowners who own large parcels of land is critical in maximizing the ability to evaluate the efficacy of CWD management over time (Holsman et al., 2010). What remains unknown is whether program participants perceive there to be a problem with CWD in certain areas of the state and to what extent they understand, or care about, the connection between CWD management efforts and hunting access. If landowners in this part of the state – where recent disease prevalence estimates are as high as 50% in certain deer herds – believe that CWD management efforts will decimate buck deer populations, they may be less likely to provide hunting access operating under the assumption that the cure (i.e., harvest management) may actually be worse than the disease itself (Colorado Parks and Wildlife, 2020). Thus, it is important for CPW to engage landowners and identify their perceptions about CWD and specifically, the connection between disease management and hunting access. Doing so will serve as a necessary first step toward improving the agency's ability to implement and evaluate disease management prescriptions uniformly at landscape scales.

GOALS AND OBJECTIVES

The overarching goal of this project was two-fold. First, we wanted to develop a series of stories about CWD, highlighting landowners' experiences with and perceptions about the disease. The purpose of these stories – which were captured via professional videos – was to provide a mechanism by which local community members could share personal accounts of CWD with other Coloradans and in doing so, dispel potential myths associated with the disease. Additionally, the produced content would be freely available, distributed widely, and accessible to the public using multiple platforms aimed at reaching national and international audiences. Second, we wanted to better understand landowners' concerns about, preferences for, and interests in CWD and corresponding management alternatives. These baseline data will help CPW to craft communication messages that are more likely to resonate with landowners in Colorado, help the agency identify what concerns they had about the disease, and inform how the agency could help address them over time. The remainder of this report focusses on the second goal which was guided by three specific objectives:

1. To understand whether and to what extent landowners allow hunting access on their property and to identify messages that might encourage them to do so, or continue doing so.
2. To examine landowners' experiences with and attitudes toward CWD, including their preferences for how the disease should be managed.
3. To identify landowners' trust in CPW to effectively manage and communicate about CWD issues.

Methods

Given our interest in understanding the perceptions of landowners in northeastern Colorado, we collected data for this study using a standard mail survey with an option for respondents to participate online via Qualtrics.

SURVEY DESIGN AND MEASURES

The survey instrument was developed by a team of CPW staff, led by the lead author of this report. The questionnaire contained seven broad sections spanning the following topics: (1) land ownership, land use, and hunting

behaviors/preferences; (2) land access; (3) communicating about land access; (4) experiences, concerns, awareness, and management preferences related to CWD; (5) trust in CPW to manage and communicate about the disease; (6) communication preferences; and (7) respondent attributes (socio-demographics).

We measured perspectives about land access using two questions. Specifically, we asked if landowners currently allow access on their land and used four response options to capture the nuance in the type(s) of access they allow (e.g., “Yes, I allow deer hunting access but only for people I personally know”, “Yes, I allow deer hunting access to the general public on a case by case basis”, “Yes I allow deer hunting access through a hunting guide/outfitter”, and “No, I do not allow any deer hunting on my land”). Respondents who indicated that they do not allow hunting access were asked a follow up question to measure why this was the case. We provided a list of potential reasons why they might not allow access and asked these individuals to check all that apply (e.g., concerns about safety, noise, etc.), with the option for them to choose “other” and write in a response as well.

Next, we examined messages that might encourage landowners to allow hunting access or continue allowing access by asking respondents to rank six statements from 1 (most convincing) to 6 (least convincing). The messages were developed based on previous research (Quartuch, House, & Eckert, in-prep), and each was tailored for this particular context (i.e., northeastern Colorado).

We asked a series of six questions to understand landowner experiences with and attitudes about CWD which were developed from previous research (Quartuch & Studebaker, in review; Vaske, et al., 2018). To examine landowners' direct experience with CWD, we asked if they had seen an increase in the number of deer carcasses or deer that appear sick, and if they or anyone they know who hunts, has ever harvested an animal infected with CWD using a dichotomous (yes/no) response option for each. In order to assess landowners' perceptions about disease prevalence, we asked what they believe their chances would be of harvesting a buck infected with CWD in this part of the state. Responses ranged from 1 out of every 100 deer (1%) to 1 out of every 3 deer (33%) with an option for respondents who were unsure to say so.

The final three questions assessed landowners' attitudes (i.e., risk perceptions/concerns) about CWD, their knowledge about the disease, and management preferences. We used a 4-point scale to examine concerns (ranging from not at all concerned-to-very concerned); a 4-point agreement scale to examine information needs (ranging from strongly disagree-to-strongly agree), and a 5-point, support/opposition Likert scale to examine management preferences (ranging from strongly oppose-to-strongly support).

We examined landowners' trust in CPW using a 5-point, agreement scale (ranging from strongly disagree-to-strongly agree). The following statement "I am confident CPW will..." preceded each of the four items we measured which assessed the agency's ability to: (1) properly address CWD in Colorado to keep infection rates low, (2) find an appropriate balance between controlling the disease and preserving hunting opportunity, (3) make good deer herd management decisions about CWD issues, and (4) provide truthful information about human safety issues related to CWD.

SAMPLING DESIGN

The sampling frame for this inquiry consisted of all possible landowners – approximately 7,249 individuals – who are currently registered in Colorado Parks and Wildlife's Landowner Preference Program (LPP). After removing individuals who own land outside of north-eastern Colorado, we were left with 1,888 landowners. However, the LPP allows landowners to register multiple parcels of land which meant that some individuals were listed in the database more than once. We removed duplicate entries resulting in a sampling frame of 948 individuals. Rather than draw a random sample from this list, we included all 948 landowners in our final sample.

SURVEY IMPLEMENTATION

We implemented the survey using a modified Dillman tailored design method (Dillman, Smyth, & Christian, 2014). In early June, 2020 we mailed a cover letter explaining the purpose of the study to everyone in the sample. Due to delays with mailing from the Covid-19 pandemic we waited about four weeks to mail the reminder/thank you postcard to all nonrespondents. This allowed ample time for mail to be returned to

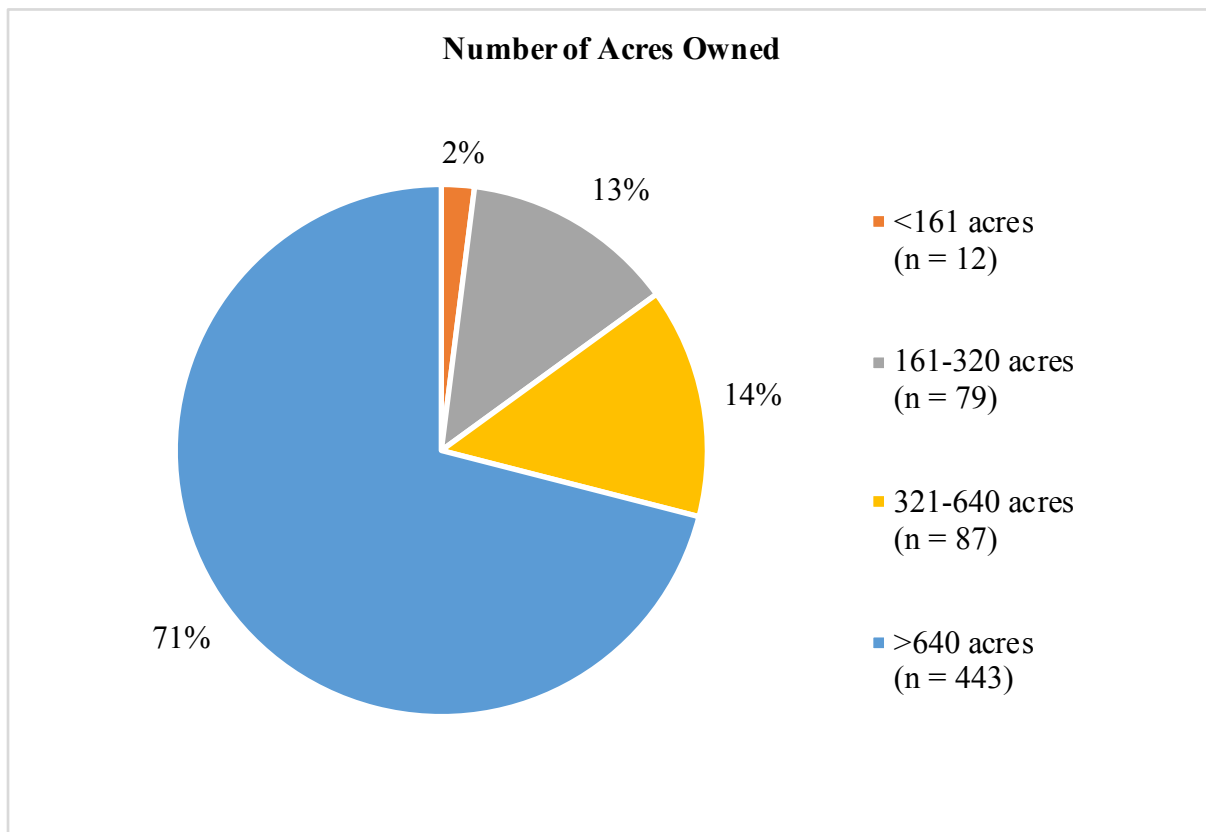


Figure 1. Percentage of total acres owned grouped according to parcel size.

our offices while also providing our team with enough time to enter completed surveys into our database and remove respondents from our mailing list. Similarly, we delayed mailing the second round of questionnaires to nonrespondents until end-July.

Analysis

Survey data were analyzed using the Statistical Package for Social Science (SPSS version 25). Descriptive statistics including percentages, means, medians, standard deviation are provided throughout. Qualitative, open-ended questions were analyzed using a three-step process described in detail elsewhere (Cite).

Results

SURVEY PARTICIPATION

In total, we mailed the survey instrument to 948 landowners in northeastern Colorado. Thirty-eight were returned as undeliverable and 635 landowners completed it resulting in a 70% response rate. Nearly everyone (90% or 574 people) participated via standard mail versus 10% (61 people) who participated online.

LANDOWNER CHARACTERISTICS

The majority of respondents own large plots of land and they have owned it for many years. For example, nearly three-quarters (71%) of respondents own more than 640 acres (Figure 1) and on average, respondents have owned their land for 33 years (Table 1). Over three-quarters (76%) primarily use their land for agricultural production with 33% indicating that it serves as a primary residence. About one-quarter (24%) use it for hunting (Figure 2).

Table 1. Number of years respondents have owned land.

YEARS OWNED (CATEGORIES)	%
1 - 15 years	23
16 - 30 years	36
31 - 50 years	27
51 - 75 years	10
76 or more years	5

HUNTING ACTIVITY

The majority of respondents (78%) hunt on their land or allow an immediate family member to hunt on their land. Of those respondents who hunt on their land, most

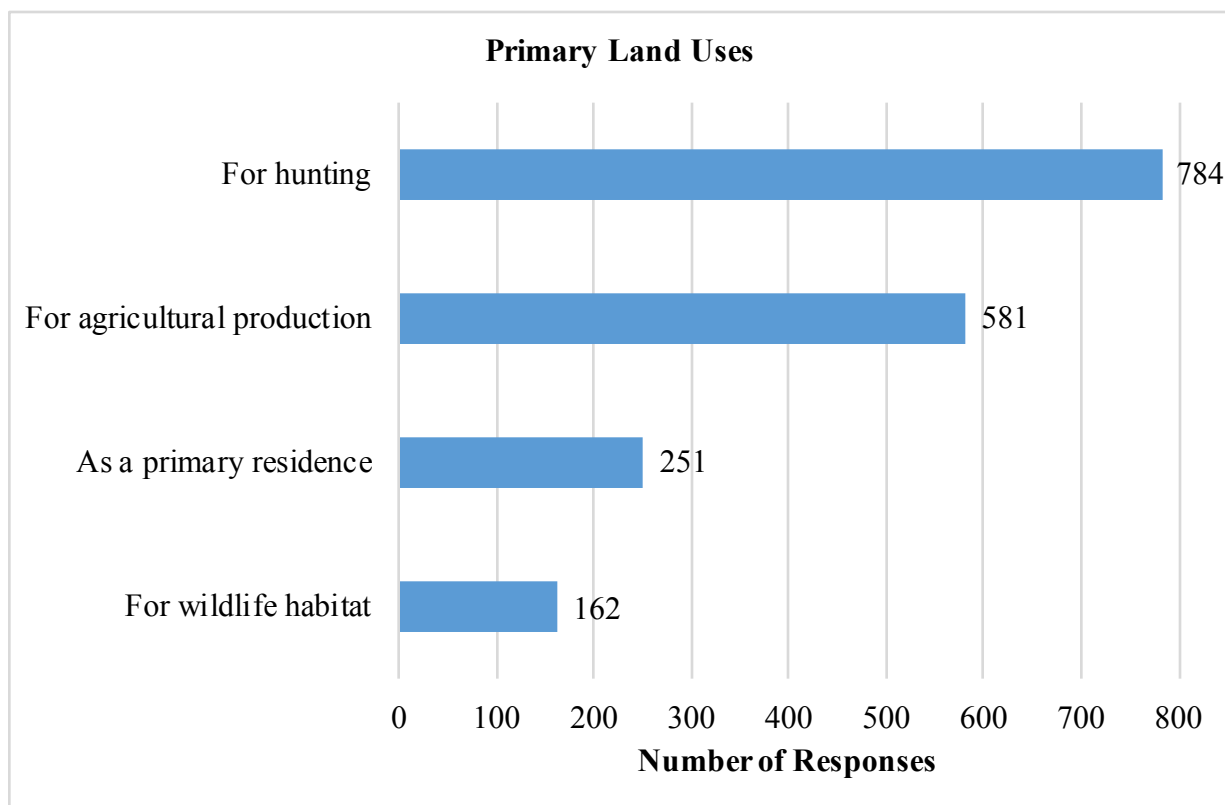


Figure 2. How respondents primarily use their land.

Table 2. Reasons why landowners allow hunting access on their land.

THEMES (BOLD) AND SUBTHEMES	NUMBER OF COMMENTS*	EXAMPLE COMMENTS
Income		
Unspecified	20	"For income"
Outfitters/fees	6	"For friend and family to have a place to hunt. To generate income through a guide/outfitter"
Clubs	6	"A hunting club leases the rights to hunting on my property"
Herd Management		
Population control	114	"Need to control population"
Healthy population/ecosystem	48	"To manage herd health"
Prevent damage	40	"The deer population moves into my corn fields and they do a lot of crop damage"
Disease control	10	"I allow limited access for population control and to help control CWD in the deer population"
Disapprove		
Property rights	15	"Due to theft in the area I only allow people I know"
Damage	14	"It's the right thing to do as long as people don't damage the property"
Liability	6	"We only allow access to individuals that we know as a courtesy. Due to the liability and lack of respect to the property landowner we try to prevent any other access"
Small herd size	5	"Sometimes there aren't good bucks out there, so we don't allow deer hunts"
Ethics		
Heritage/promote hunting	42	"I allow responsible hunters. I appreciate the fact that they need a place to hunt. It is a part of our heritage"
Next generation	39	"We try and allow kids in the community access so their first early big game hunts are successful"
Access	33	"I like to give people the opportunity to hunt without paying big money."
Ask permission	31	"We allow hunters if they stop and ask for access"
Nice/neighborly	26	"Hunting is a good sport, being neighborly"
Rights	7	"We have always been committed to public access. The land is in our name, but the wildlife belong to all people"
Reciprocity	4	"I hunt on some other peoples property so I allow then to hunt mine"
Miscellaneous		
Family and friends	51	"As a courtesy to friends and family, especially to encourage young hunters"
Personal enjoyment	38	"Me and my family like to hunt and observe wildlife"
Meat	36	"Hunt for meat"
LPP/tags/vouchers	34	"Through the LPP licenses issued to my property. Only allowing those licenses"

(61%) hunt big game or small game (46%). Less than one-third (32%) hunt furbearers and even fewer (14%) hunt waterfowl on their property (Figure 3).

HUNTING ACCESS ON PRIVATE LAND

About half (54%) of respondents currently allow deer hunting access on their land but only for people they know personally such as friends and family (Figure 4). About one-quarter (24%) also indicated that they allow deer hunting access for members of the general public but only on a case-by-case basis and 9% allow access through a hunting guide or outfitter. Five broad themes emerged from respondents' open-ended comments regarding reasons why they allow hunting on their land (Table 2). Themes ranged from economic reasons to herd management and hunting ethics. The most frequently cited themes included: population control (114 responses), hunting opportunities for family and friends (51 responses), to maintain healthy ecosystems and wildlife populations (48 responses), to promote and maintain hunting heritage (42 responses), and to prevent property damage (40 responses) (Table 2).

Only 40 people indicated that they do not allow any deer hunting on their land and responses were highly variable. For example, about 24 respondents indicated that it



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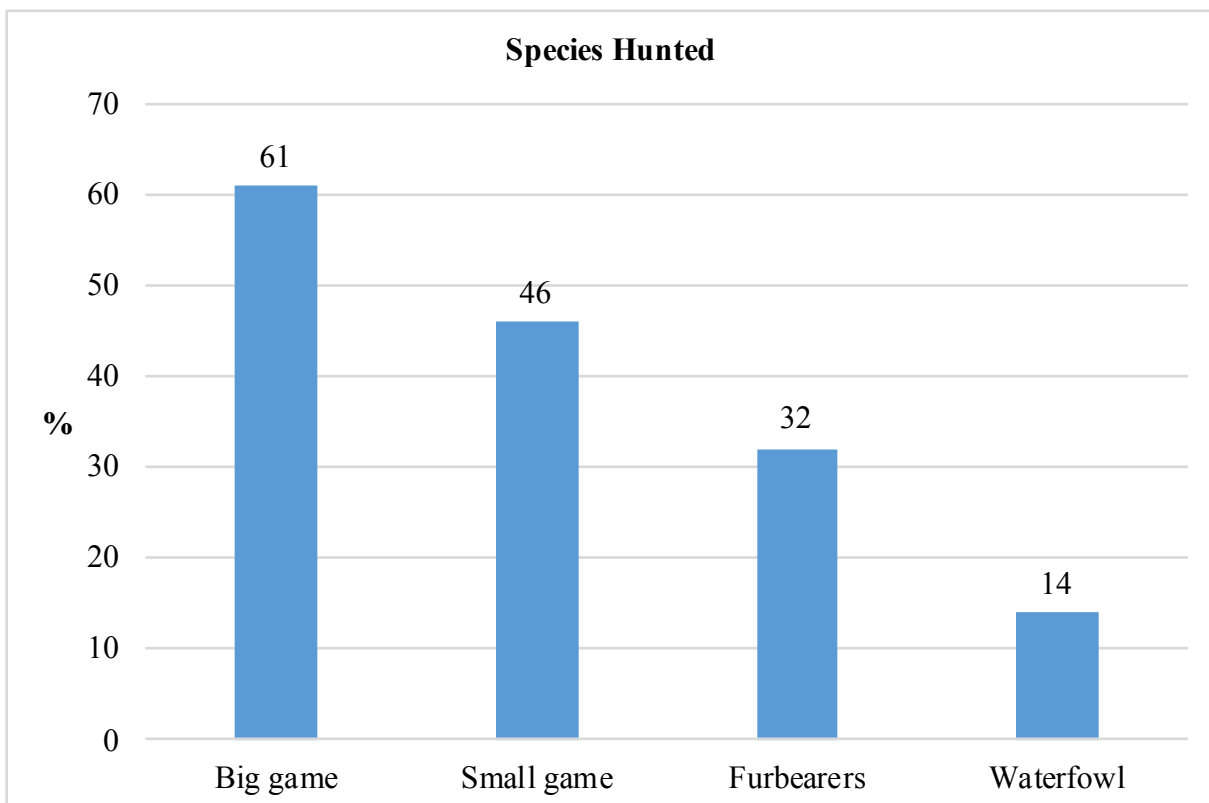


Figure 3. Percentage of respondents who have hunted different species on their property.

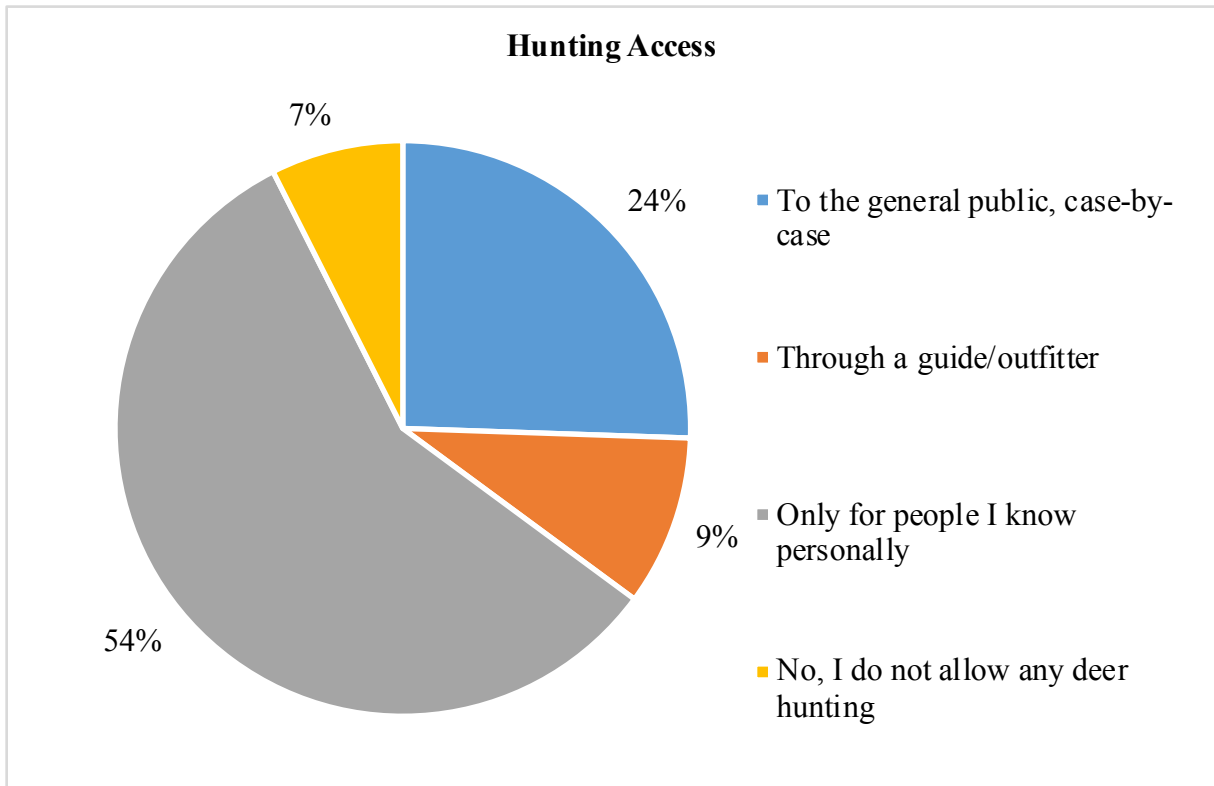


Figure 4. Individuals/groups permitted to hunt on landowners' property.

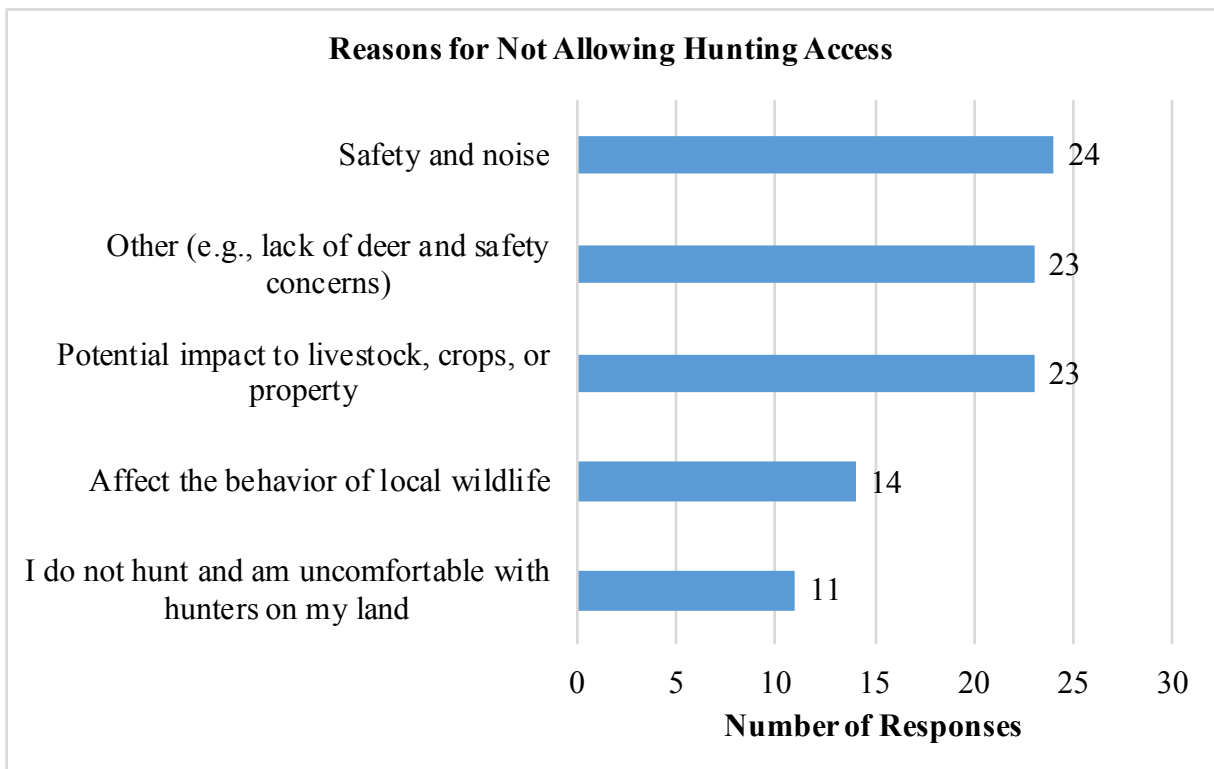


Figure 5. Reasons why landowners do not allow hunting access on their land.

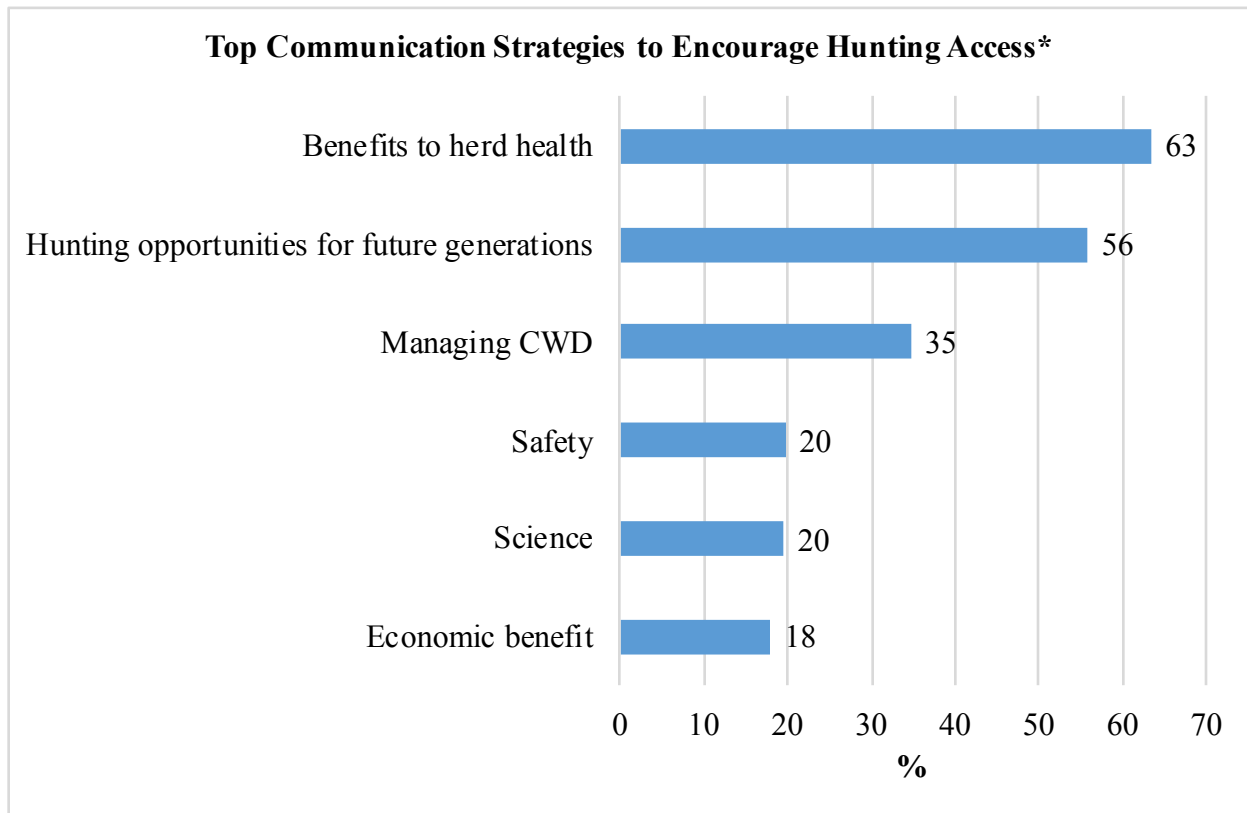


Figure 6. Most convincing informational messages (1st and 2nd overall ranked messages displayed).

was because of safety concerns and 25 described concerns about it negatively affecting local wildlife. Another 23 landowners said it was because of concerns about potential damage from hunting on livestock, crops, or their property (Figure 5). Finally, 23 respondents indicated that it was for “other” reasons than those listed in the question. Some examples included: safety concerns, a lack of deer, and for their own, personal hunting opportunities.

MESSAGE TESTING AND COMMUNICATION

In order to help CPW develop targeted communication strategies highlighting the relationship between hunting, hunting access and controlling the spread of CWD, we asked respondents to rank six informational messages that would encourage them to allow, or continue allowing, hunting access on their land (Table 2; see Appendix B for full description of messages). Overall, respondents ranked messages about benefits to herd health (63%) and hunting opportunities for future generations (56%) as the most convincing. Messages describing scientific and economic benefits were the least convincing (Figure 6).

The top three ways respondents stay informed about CWD or landowner access opportunities are through the Colorado Landowner Preference Program (314), via word of mouth (267), and from CPWs’ website (224) (Figure 7). The three modes of communication with the fewest responses included the TV/radio (54), Colorado Parks and Wildlife E-newsletter (51), and the Colorado Department of Public Health and Environment website (14) (Figure 7). Another 18 respondents selected “Other,” and their responses included mail-outs, outfitters, and being related to a CPW employee.

EXPERIENCE WITH AND AWARENESS OF CWD

The vast majority of respondents had not seen an increase in deer carcasses or deer that appear sick in northeastern Colorado (89% and 85%, respectively) (Figure 8). Additionally, nearly three-quarters (71%) have not harvested an animal (nor did anyone that they know) that was infected with CWD. We also examined landowners’ perceptions about current CWD infection rates in northeastern Colorado. About half (46%) were unsure what their chances might be of harvesting a buck infected with CWD in this part of the state. More than one-third (35%) believed their chance of harvesting a

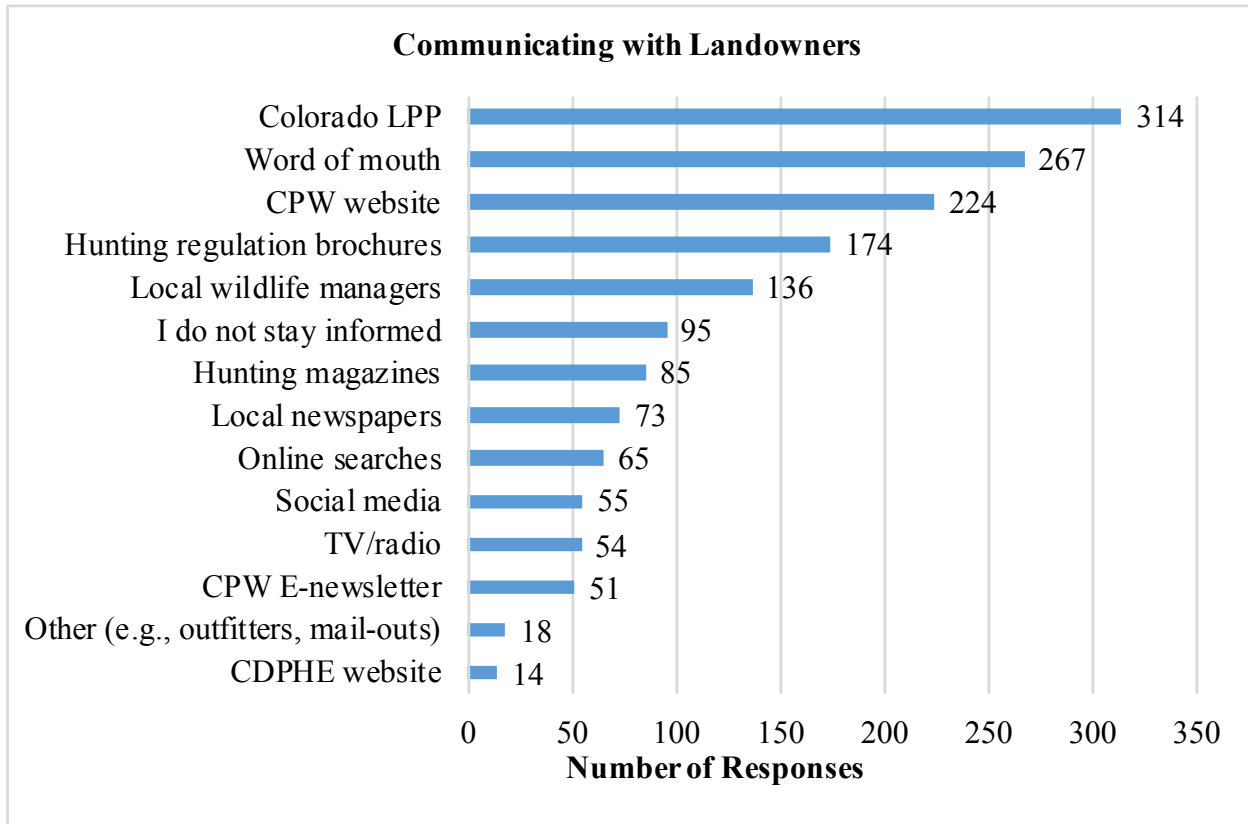


Figure 7. How respondents stay informed about CWD and access programs.

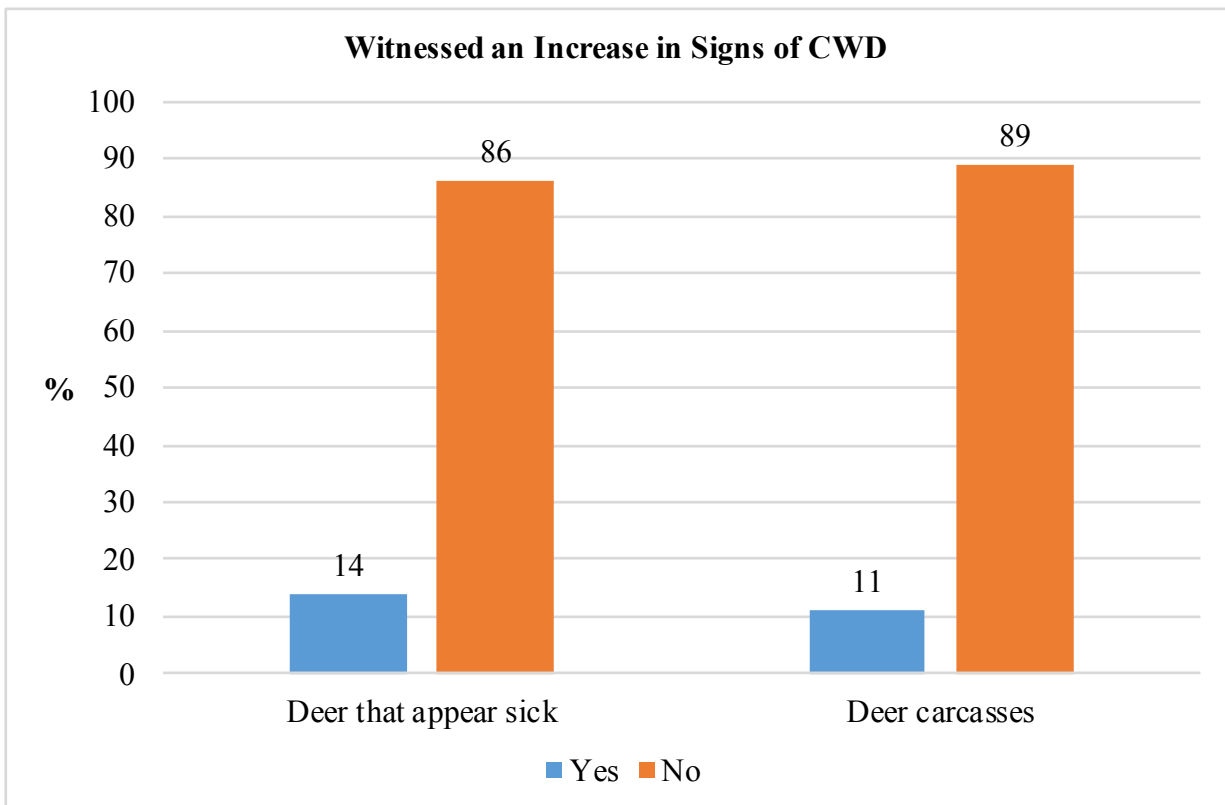


Figure 8. Respondents' perceptions about increasing CWD cases.

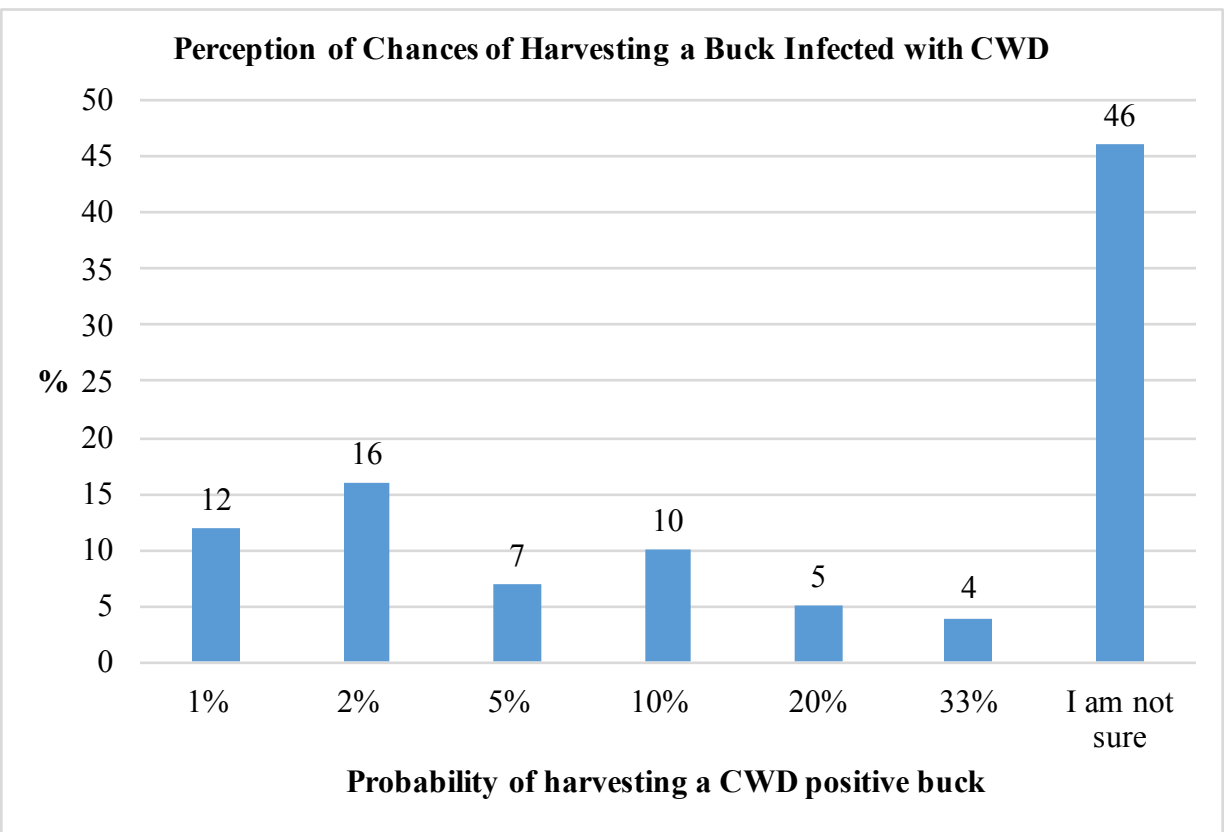


Figure 9. Respondents' perceptions about the probability of harvesting a CWD-positive buck (number of bucks out of every 100).

CWD-positive buck would be less than or equal to 5% (or 1 out of every 20, 50 or 100 deer) (Figure 9). About 10% of respondents believed the infection rate to be at 10% (or 1 out of every 10 deer). The actual percentage is closer to 20-50% (Figure 9).

We also wanted to know whether landowners believed they had enough information about CWD. Overall, more than half of respondents disagreed that they had enough information about different aspects of CWD. Specifically, about 55% and 52% of respondents disagreed with having enough information about possible livestock or human health risks because of CWD, respectively (Figure 10). Almost half (45%) also disagreed with having enough information about what Colorado Parks and Wildlife is doing about CWD.

CONCERNS ABOUT CWD

The top three concerns respondents had about CWD were: (1) future generations' ability to enjoy deer hunting (61%), (2) the health of affected deer herds where they live (61%), and (3) the potential for CWD to reduce deer hunting opportunities in Colorado (52%) (Figure 11). Fewer respondents were concerned about their or

their family's health (21%) or economic losses to themselves, their family or others in their community (21%), due to reduced deer herds.

MANAGEMENT PREFERENCES

Respondents were asked about their support or opposition toward various management practices to reduce CWD. Overall, respondents were relatively supportive of different approaches. Nearly three-quarters (77%) supported creating specialized "disease management" hunts in areas of high CWD prevalence (10% opposed) and about 60% supported the agency increasing the number of buck and doe hunting licenses (21% opposed) (Figure 12). Half (50%) were also supportive of creating a landowner incentive program to increase public access in areas of high disease prevalence but nearly one-third (32%) were opposed. About the same percentage (46%) supported the idea of creating additional deer hunting seasons, though 30% were opposed (Figure 12).

CONFIDENCE (TRUST) IN CPW

A majority of respondents are confident CPW will appropriately manage and communicate about CWD. Specifically, almost two-thirds (64%) agreed that the

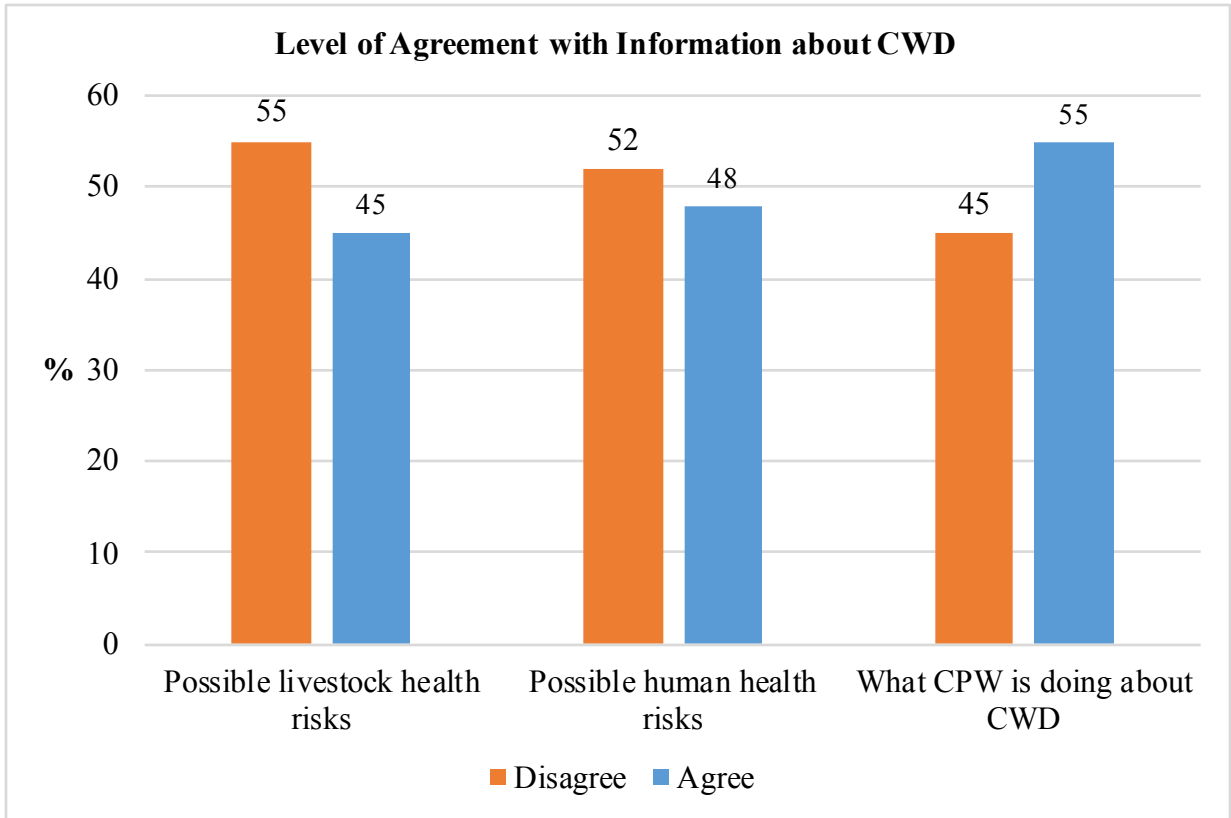


Figure 10. Respondents' disagreement with having enough information about CWD.

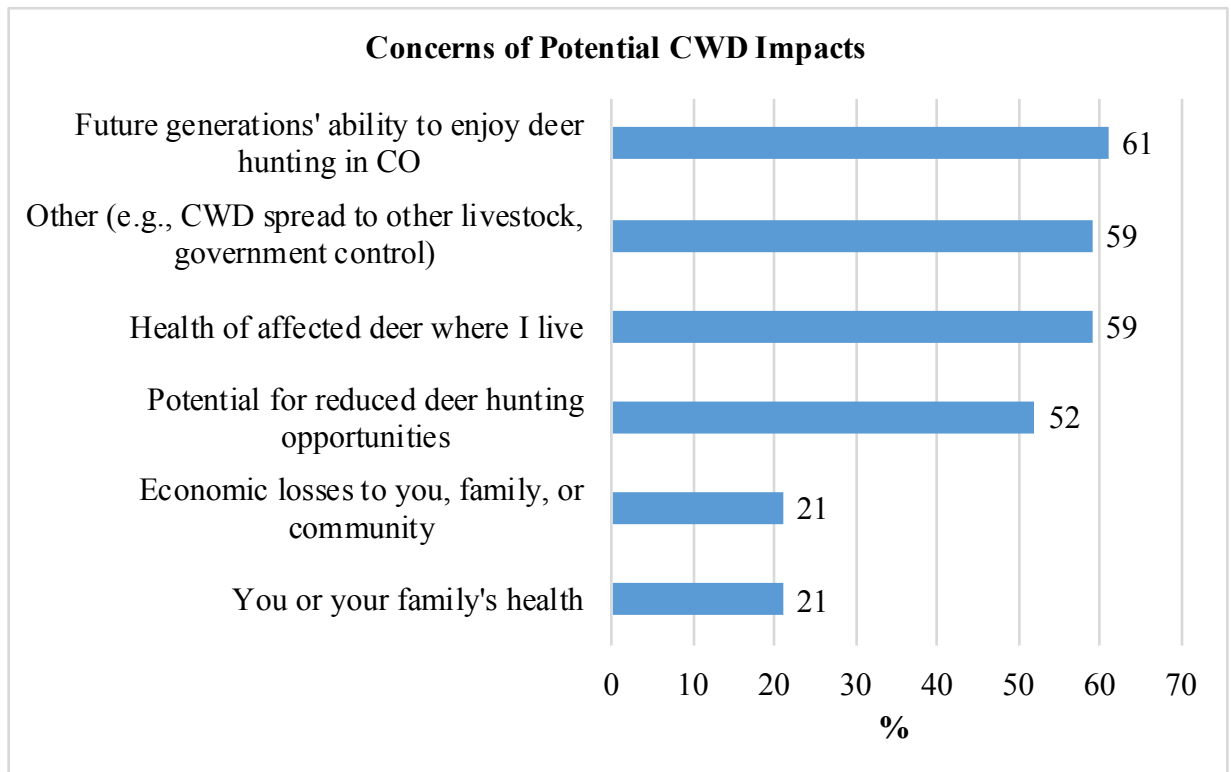


Figure 11. Concerns about CWD (moderately and very concerned combined).

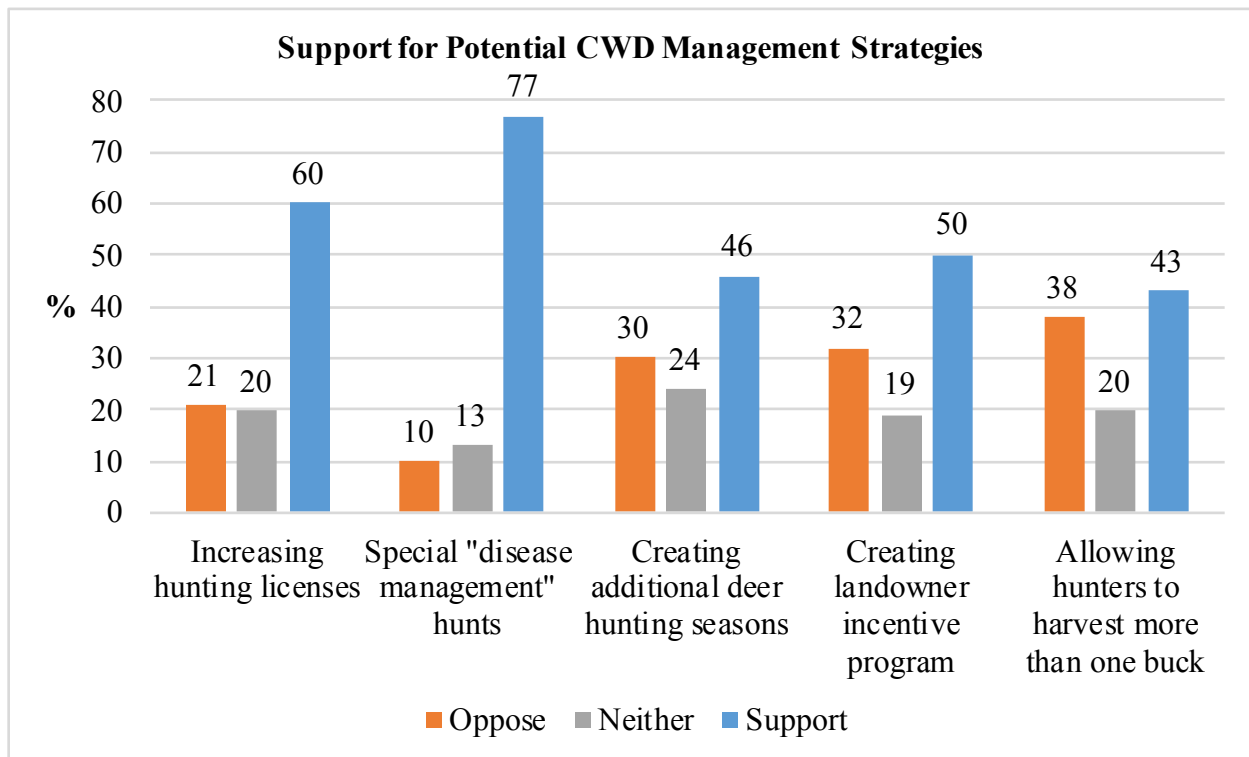


Figure 12. Support and opposition for management approaches to minimize CWD (somewhat and strongly scales combined).

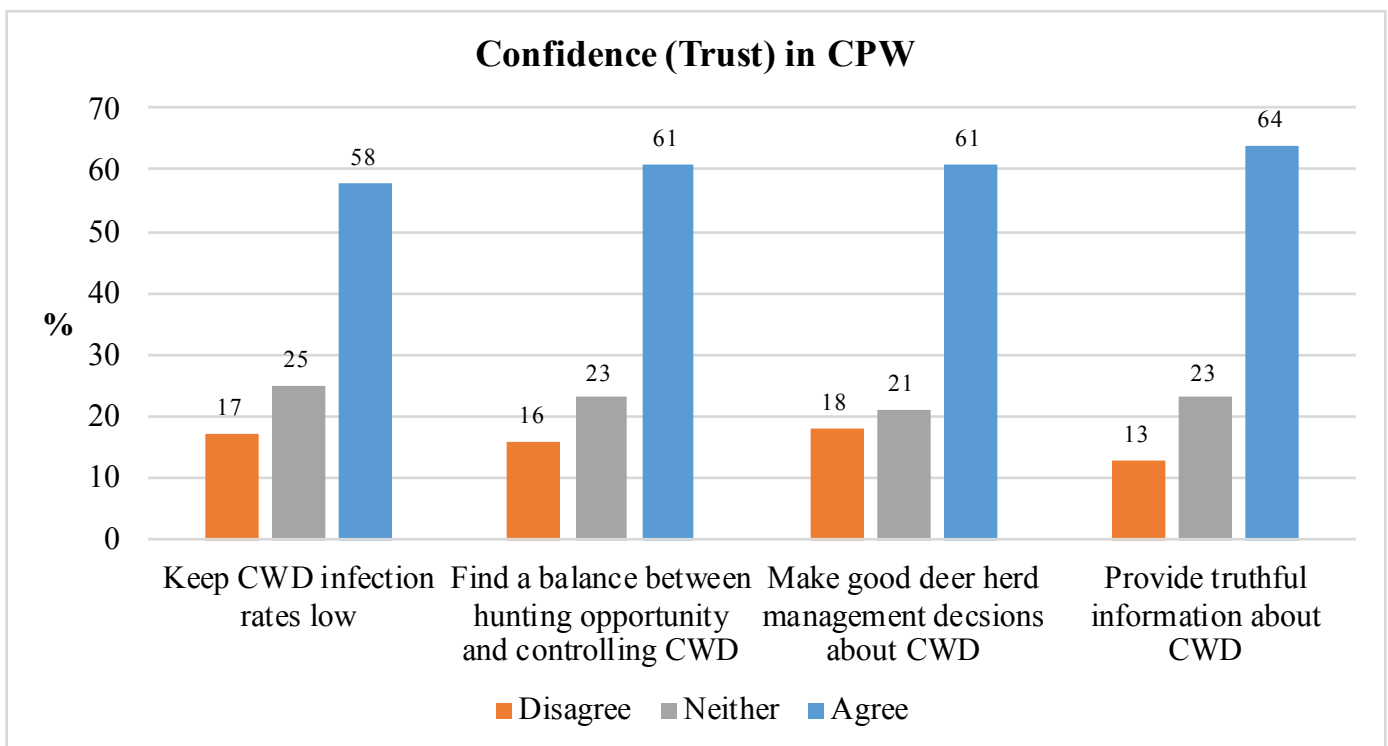


Figure 13. Respondents' confidence or trust in CPW to manage and communicate about CWD (somewhat and strongly disagree combined).

agency will provide truthful information about human safety issues related to CWD. The same percentage (61%) agreed that CPW will find an appropriate balance between controlling CWD and providing hunting opportunities and make good deer herd management decisions about CWD. About 58% of respondents were confident that CPW will properly address CWD in order to keep infection rates low (Figure 13). It is also important to highlight that nearly one-quarter of respondents neither agreed nor disagreed with each of these statements.

Discussion

The majority of land in northeastern Colorado is privately owned and in agricultural production. This means that landowners' decisions to use, enjoy or benefit from the natural resources found on their property have the potential to impact wildlife and thousands of acres of land in this part of the state (Quartuch & Beckley, 2012). Wildlife management in Colorado falls under the purview of Colorado Parks and Wildlife who rely on hunting to help manage big game herds and also minimize the spread of CWD. Thus, it is critical to understand landowners' awareness of and concerns about CWD as well as their decisions to permit or not permit hunting access on their property. Both have the potential to impact CPW's ability to effectively manage big game herds in this part of the state.

HUNTING ACCESS AND PERCEPTIONS ABOUT CWD

We learned from this study that the majority of landowners or their family members hunt big game on their land and nearly all respondents allow some form of hunting access on their property for close friends/family members and to a lesser degree, members of the public. We also learned that the majority of landowners use their property for agricultural production or as a primary residence. Taken together, these results suggest that landowners spend significant amounts of time on and are very familiar with their property and by proxy, the wildlife that inhabit it. Despite considerable opportunity to observe local wildlife, the vast majority of landowners have not seen an increase in the number of sick deer or deer carcasses in northeastern Colorado even though results from CPW's CWD monitoring in this part of the state suggest that infection rates for adult males in nearly all deer herds are greater than

20%. In some deer herds, infection rates of adult males within "CWD hot spots" are as high as 33% with others suspected to be as high as 50% (see estimated CWD prevalence). Results from this survey also show that landowners' perceptions of CWD infection rates vastly underestimate the actual prevalence of CWD. This gap in perception and reality highlights the complex nature of the disease, the effects of which unfold slowly over time making it nearly impossible to identify an infected animal based on visual signs alone (Miller et al., 2000, 2020).

Respondents' limited experience with and awareness about CWD may lead to complacency about the disease and its impact on deer herds over time. In turn, this may influence landowners' behavior, which can reduce the agency's ability to manage CWD if, for example, fewer individuals submit harvested animals for CWD testing or no longer allow hunting access on their land. However, it is also important to note that landowners' awareness (or lack thereof) about CWD is not universal. Results from focus groups with landowners in northeastern Colorado highlighted a different outcome than what we found from our survey. The majority of focus group participants were much more aware of CWD infection rates and most indicated seeing more dead or sick deer on their property (CDR Associates, 2021). Future research should attempt to identify the reasons why awareness about CWD varies among landowners and how, over time, this may impact landowner behavior. Doing so may help increase landowners' understanding about the disease including how the agency is managing it and how they can continue to be part of the solution. It is also increasingly important for the agency to identify ways to more clearly communicate with landowners in this part of the state about CWD and specifically, about the importance of CWD testing as a tool to monitor infection rates. Fortunately, survey results also highlight ways to effectively communicate with landowners about CWD using their concerns to frame the discussion.

CONCERNS ABOUT CWD HIGHLIGHT COMMUNICATION OPPORTUNITIES

Landowners in northeastern Colorado are concerned about CWD and these concerns mirror those from other studies conducted in Colorado (Quartuch and Studebaker, in review; Quartuch, House, & Eckert, in-prep). Specifically, we learned that landowners are concerned about future generations' ability to hunt deer

and about the long-term health of deer herds in the state. These two concerns have been repeatedly identified in surveys of hunters, though herd health typically ranks first among hunters followed closely by hunting opportunities for future generations (Quartuch, House, & Eckert, in-prep). Concerns about one's personal health due to CWD or economic losses due to reduced deer herds are far less concerning to landowners and hunters alike. The former may be the result of landowners' awareness. For example, it is possible that landowners are aware that CWD has not yet crossed the species barrier from cervids into humans. The latter may stem from the fact that most respondents primarily use their land for agricultural production and are less reliant upon wildlife for their livelihood/income (Quartuch & Studebaker, under review). Future research could examine these claims by conducting an informational or message testing campaign (i.e., what messages are being used to communicate) about CWD transmission and how knowledgeable they are about the topic.

Our results also illustrate a desire for more and perhaps, more specific, communication with landowners in northeastern Colorado about CWD. We identified several messages that would encourage landowners to allow, or continue allowing, hunting access on their property. The two most convincing messages mirrored respondents' primary concerns about CWD including benefits to herd health and hunting opportunities for future generations. In the future, CPW can use these data to craft messages about CWD and hunting access that will be more likely to resonate with landowners. Additionally, we learned that more than half of all respondents did not believe they had enough information about possible livestock health or human health risks associated with CWD. Similarly, about half did not feel they knew what CPW is doing to manage the disease. These results can serve as an opportunity for CPW. Through additional outreach and engagement efforts with landowners, CPW may be able to provide information that landowners desire and in ways in which they currently obtain information about it (e.g., LPP, CPW website). It is important to consider the audience one is trying to reach when communicating about CWD or these programs. While this survey found the LPP to be the primary mode of gaining information about CWD, our sample may not reflect the general population of landowners in northeastern Colorado given our entire sample included LPP participants. Thus, CPW could

use this approach to reach landowners registered in the LPP, but other methods might prove more useful for reaching non-LPP landowners. For example, CPW could also draw upon local wildlife managers – another way landowners receive information (136 owners cited this method) – to share content with LPP members who may, in turn, share information with individuals who do not participate in the LPP. Peer-to-peer information sharing by individuals who are actively engaged in their communities (e.g., focus group participants; CDR Associates, 2021), may also prove useful at reaching landowners who are *not* registered in the LPP. Understanding other popular methods of obtaining information will be critical to engaging landowners who are not currently a part of the LPP.

While we did not explicitly ask landowners about their trust in wildlife managers, most respondents do have confidence in CPW to provide truthful information about CWD.

Additionally, landowners believed the agency will make good deer herd management decisions and find an appropriate balance between controlling the disease and providing hunting opportunities. Moving forward, CPW should continue to communicate with landowners about how the agency is managing CWD and ideally, doing so in ways that promote two-way communication as this would likely increase transparency regarding agency decision making and by proxy, trust in the agency (Richards et al., 2004). That being said, most landowners would support the agency's decision to manage CWD by developing special disease management hunts - an approach that most resident and nonresident hunters also supported (Quartuch & Studebaker, in review). It is important to note that nearly one-quarter of all respondents neither agreed nor disagreed with having confidence in CPW to effectively manage and communicate about CWD. These respondents represent individuals who are "on the fence" in terms of their trust in the agency. CPW should keep this in mind when communicating with them by developing messages that will resonate with landowners' interests and concerns.

Conclusion

Based on the results of this study, we learned that landowners' perceptions about CWD prevalence typically do not match the realities of the situation. Because CPW is entrusted with managing wildlife as a public trust resource (Forstchen & Smith, 2014), the agency needs

to understand how to most effectively communicate with landowners about the disease so that all members of the public can make the most informed decisions for themselves, their families, local communities and for the resource itself. Providing information in ways that resonate with landowners will likely increase awareness about the disease over time. However, it remains unclear in which direction landowners' perceptions might shift because there are other attributes – including social norms – which influence attitudes. On one hand, providing information about CWD infection rates for deer herds may increase landowner concerns about the disease. As a result, this may decrease hunting participation due to fear of harvesting a CWD-positive animal. On the other hand, this information may encourage more landowners to submit their harvested animal for CWD testing which the agency needs to monitor and track population trends (and disease spread). Doing so may even broadly encourage landowners to provide hunting access (or continue providing access) on their property.

Because the vast majority of land in northeastern Colorado is privately owned, CPW is inextricably linked to and reliant upon landowners who provide hunting access on their property to monitor infection rates and prescribe management actions over time. One way to encourage landowner participation is to do so using special disease management hunts. This was the most supported management approach overall.

Based on results from this study, CPW may find success emphasizing hunting opportunities for future generations and long-term herd health in their communication efforts. They can do so as part of the LPP, via word of mouth, and on CPW's website which will reach a large segment of landowners who use these mediums to learn about CWD and access programs in the state. While promising that a majority of landowners trust CPW to make the best decisions for CWD management for the deer and the people, CPW will need to continue building trust with landowners so that management decisions and agency policies continue to benefit Colorado's wildlife and its constituents.

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Appendix A

STATISTICAL SUMMARY

Percentages indicated throughout unless otherwise noted

[n = number of respondents; SD = standard deviation; = mean]

Questions About You

1. Do you or does anyone in your immediate family currently hunt on your land? (n = 616)
 - 22.1 No
 - 77.9 Yes (If “Yes” please CONTINUE to question 1.a)
 - 1a. What species do you or your family hunt?
 - 61.1 Big game (e.g., deer, pronghorn, elk) (n = 465)
 - 45.6 Small game (e.g., pheasant, dove, rabbit) (n = 347)
 - 32.1 Furbearers (e.g., coyote, fox) (n = 244)
 - 13.8 Waterfowl (e.g., goose, duck) (n = 105)
2. Approximately how many acres of land do you currently own? (n = 622)
 - 2.0 Less than 161 acres (n = 13)
 - 12.7 Between 161 - 320 acres (n = 79)
 - 14.0 Between 321 - 640 acres (n = 87)
 - 71.2 More than 640 acres (n = 443)
3. Approximately how many years have you owned your land? (n = 607, = 33.43)
4. How is your land primarily used (Check all that apply.)
 - 33.0 As a primary residence (n = 251)
 - 76.3 For agricultural production (crops or livestock) (n = 581)
 - 24.2 For hunting (n = 184)
 - 21.3 For wildlife habitat (n = 162)
 - 2.6 Other (please specify) (n = 23): E.g., personal enjoyment/recreation (5), for cattle/grazing/pasture (6), oil and gas, conservation.

Access

5. Do you currently allow access to your land for deer hunting? (Check all that apply.)
 - 24.3 Yes, I allow deer hunting access to the general public on a case by case basis (n = 185)
 - 8.7 Yes, I allow deer hunting access through a hunting guide/outfitter (n = 66)
 - 54.3 Yes, I allow deer hunting access but only for people I personally know (e.g., friends, family) (n = 413)
 - 7.4 No, I **do not** allow any deer hunting on my land (If “No” CONTINUE to question 5.a) (n = 56)
 - 5a. Of the possible concerns listed below, which, if any, are reasons why you **do not** allow hunting access on your land? (Please check all that apply.)
 - 3.2 Concerns about safety, noise, etc. (e.g., shots taken too close to our residence)
 - 3.0 Concerns about potential impact of hunting activities on our livestock, crops, or property
 - 1.8 Concerns about affecting the number or behavior of local wildlife
 - 1.4 I do not hunt myself and am uncomfortable with hunters on my land
 - 3.0 Other (please specify):

6. If you answered “Yes” to question 5 (above), please briefly describe *why* you **allow** access on your land for deer hunting. (Write-in your response below.) (n = 478)

Talking About Hunting Access

The next question will help Colorado Parks and Wildlife learn how to talk to other landowners about the important role deer hunting access plays in helping control the spread of chronic wasting disease (CWD).

7. Which of the following informational messages would encourage you to allow (or continue providing or increase) hunting access on your land?

(Please **rank** them with **1** being the **most convincing** message and **6** being the **least convincing** message.)

Benefits to herd health (n = 404, SD = 1.429, \bar{X} = 2.35)

Hunting is a useful management tool that can help reduce the spread of CWD within deer herds. Controlling this disease is critical for the long-term health of our herds.

Rank:	1	2	3	4	5	6
Percent:	36.4	27.0	16.8	7.9	8.4	3.5

Economic benefit (n = 402, SD = 1.673, \bar{X} = 4.47)

Colorado’s economic prosperity depends on healthy and sustainable big game herds. Hunting can help lower CWD infection rates in deer populations, which contributes to their long-term sustainability.

Rank:	1	2	3	4	5	6
Percent:	7.5	10.4	9.5	14.7	16.4	41.5

Managing CWD (n = 398, SD = 1.475, \bar{X} = 3.26)

Hunting is the easiest and most cost-effective tool wildlife managers have to control CWD infection in deer herds.

Rank:	1	2	3	4	5	6
Percent:	12.1	22.6	23.4	19.6	13.6	8.8

Hunting opportunities for future generations (n = 355, SD = 1.681, \bar{X} = 2.65)

Our quality of life and outdoor heritage are dependent on the health and sustainability of our wildlife populations. CWD management ensures these resources and hunting opportunities will be here for future generations.

Rank:	1	2	3	4	5	6
Percent:	37.2	18.6	13.2	11.3	12.4	7.3

Safety (n = 397, SD = 1.484, \bar{X} = 3.82)

Hunting is a safe and effective way to control the spread of CWD in deer herds.

Rank:	1	2	3	4	5	6
Percent:	8.1	11.6	21.9	21.9	21.4	15.1

Science (n = 395, SD = 1.646, \bar{X} = 4.14)

CPW has worked for well over a century to ensure the health and future of Colorado’s wildlife for our citizens. Through cutting edge science and innovative conservation practices, we continue to learn more about how CWD affects deer and what practices we can use to address this disease.

Rank:	1	2	3	4	5	6
Percent:	9.6	9.9	13.9	18.0	20.8	27.8

Table 1. Top two most preferred choices

CATEGORY	%
Benefits to herd health	63.4
Hunting opportunities for future generations	55.8
Managing CWD	34.7
Safety	19.7
Science	19.5
Economic benefit	17.9

Your Experience with CWD

8. Have you seen an increase in either of the following in northeastern, Colorado...
(Please check either “Yes” or “No” for each option.)

...deer that appear sick 14.5 Yes 85.5 No (n = 605)
 ...deer carcasses 11.2 Yes 88.8 No (n = 587)

9. Have you, or has anyone you know who hunts, harvested an animal infected with CWD?
(Please check one.) (n = 607)

29.3 Yes
 70.7 No

10. What do you believe are the chances of harvesting a buck infected with CWD in northeastern Colorado?
(Please choose the answer closest to what you believe is correct. *It’s OK to guess, but it’s also OK to not be sure!*)
(n = 605)

12.1 1 out of every 100 deer (1%)
 15.7 1 out of every 50 deer (2%)
 7.3 1 out of every 20 deer (5%)
 9.6 1 out of every 10 deer (10%)
 4.6 1 out of every 5 deer (20%)
 4.3 1 out of every 3 deer (33%)
 46.4 I’m not sure

Concerns About Chronic Wasting Disease

11. Because of CWD in deer, how concerned are you about each of the following? (Please check **one** response for **each** statement.)

	NOT AT ALL CONCERNED	SOMEWHAT CONCERNED	MODERATELY CONCERNED	VERY CONCERNED
...your or your family’s health? (n = 602, SD = 0.973, \bar{X} = 1.77)	52.8	26.4	12.0	8.8
...the health of affected deer herds where I live? (n = 596, SD = 1.007, \bar{X} = 2.72)	13.6	27.3	32.4	26.7
...the potential for CWD to reduce your deer hunting opportunity in Colorado? (n = 600, SD = 1.063, \bar{X} = 2.57)	19.2	29.3	26.7	24.8

	NOT AT ALL CONCERNED	SOMEWHAT CONCERNED	MODERATELY CONCERNED	VERY CONCERNED
...future generations ability to enjoy deer hunting in Colorado? (n = 600, SD = 1.034, \bar{X} = 2.78)	13.8	25.5	30.3	30.3
...economic losses to myself, my family, or others in my community, due to reduced deer herds? (n = 598, SD = 0.949, \bar{X} = 1.77)	51.3	27.8	13.5	7.4
...other (please specify AND check the level of concern): (n = 46, SD = 1.241, \bar{X} = 2.72) E.g, Too much gov't control (2), can CWD spread to other livestock (8), Not at all concerned about CWD, concern for suffering animals (2)	26.1	15.2	19.6	39.1

12. To what extent do you disagree or agree with each of the following statements related to CWD? (Please check one response for each statement.)

I FEEL THAT I HAVE ENOUGH INFORMATION ABOUT...	STRONGLY DISAGREE	SOMEWHAT DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE
...possible livestock health risks associated with CWD (n = 592, SD = 0.933, \bar{X} = 2.31)	23.5	31.3	36.0	9.3
...possible human health risks associated with CWD (n = 594, SD = 0.960, \bar{X} = 2.39)	21.9	29.8	35.9	12.5
...what Colorado Parks and Wildlife is doing about CWD (n = 589, SD = 0.925, \bar{X} = 2.53)	16.0	29.2	40.7	14.1

Managing CWD

The best available science suggests that aggressively harvesting deer can help control CWD. Please consider this information when answering the next two questions.

13. Because of high CWD prevalence in northeastern Colorado deer herds, would you support or oppose each of the following management alternatives? (Please check one response for each alternative.)

	STRONGLY OPPOSE	SOMEWHAT OPPOSE	NEITHER OPPOSE NOR SUPPORT	SOMEWHAT SUPPORT	STRONGLY SUPPORT
Increasing deer (buck and doe) hunting license numbers (n = 591, SD = 1.243, \bar{X} = 3.57)	8.6	12.1	19.4	32.9	27.0

	STRONGLY OPPOSE	SOMEWHAT OPPOSE	NEITHER OPPOSE NOR SUPPORT	SOMEWHAT SUPPORT	STRONGLY SUPPORT
Creating special “disease management” hunts to target areas of high prevalence (n = 596, SD = 1.104, \bar{X} = 3.97)	6.0	4.4	12.9	39.6	37.1
Creating additional deer hunting seasons (n = 594, SD = 1.341, \bar{X} = 3.20)	15.8	14.5	23.7	26.1	19.9
Creating a landowner incentive program that increases public access in areas of high disease prevalence (n = 595, SD = 1.391, \bar{X} = 3.21)	17.8	13.8	18.8	28.6	21.0
Allowing deer hunters to harvest more than one buck each year (n = 594, SD = 1.413, \bar{X} = 3.03)	20.9	16.5	19.9	23.9	18.9

Confidence in Managing Agency

14. To what extent do you disagree or agree with each of the following statements regarding your confidence in Colorado Parks and Wildlife (CPW)? (Please check one response for each statement.)

I AM CONFIDENT CPW WILL...	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER DISAGREE NOR AGREE	SOMEWHAT AGREE	STRONGLY AGREE
...properly address CWD in Colorado to keep infection rates low (n = 594, SD = 1.125, \bar{X} = 3.55)	5.9	11.1	25.3	36.5	21.2
...find an appropriate balance between controlling the disease and preserving hunting opportunity (n = 596, SD = 1.060, \bar{X} = 3.60)	4.7	11.2	22.7	42.6	18.8
...make good deer herd management decisions about CWD issues (n = 596, SD = 1.123, \bar{X} = 3.58)	5.9	12.1	21.0	39.9	21.1
...provide truthful information about human safety issues related to CWD (n = 590, SD = 1.109, \bar{X} = 3.74)	5.3	7.8	22.9	35.9	28.1

Communication

15. How do you currently receive information or stay informed about CWD or landowner access programs in Colorado? (Please check all that apply.)

- 41.3 Colorado Landowner Preference Program (LPP) (n = 314)
(<https://cpw.state.co.us/thingstodo/Pages/LandownerPreference.aspx>)
- 35.1 Word of mouth (e.g., from a friend, neighbor, family member) (n = 267)

- 29.7 Colorado Parks and Wildlife website (<https://cpw.state.co.us/>) (n = 226)
- 22.9 Hunting regulations brochures (n = 174)
- 17.9 From local District or Area Wildlife Managers (n = 136)
- 12.5 I do not stay informed about CWD or landowner access programs (n = 95)
- 11. Hunting magazines (e.g., Field & Stream, Outdoor Life, Colorado Outdoors)(n = 85)
- 9.6 Local newspapers (n = 73)
- 8.5 Online searches (e.g., Google, Explorer, Safari, etc.) (n = 65)
- 7.1 TV/Radio (n = 54)
- 6.7 Colorado Parks and Wildlife E-newsletter (n = 51)
- 6.7 Social media (e.g., Facebook, Twitter, Instagram) (n = 51)
- 2.4 Other (Please specify): E.g., Landowner only mail outs, Colorado Outdoor, Outfitters, HPP program
- 1.6 Colorado Department of Public Health and Environment website (<https://www.colorado.gov/cdphe>) (n = 12)

About you

16. How old are you? (Please **write-in** your response.) YEARS
(n = 617; \bar{X} = 64.86; Median = 66.0; SD = 13.609; range = 29 - 100)

AGE GROUPS	FREQUENCY	%
18-35 years old	15	2.4
36-53 years old	103	16.7
54-71 years old	295	47.8
72-100 years old	204	33.1

17. With what gender do you identify? (Please **write-in** your response.)
64.8 Male (n = 493)
12.7 Female (n = 97)
0.1 Other (n = 1)
18. What is your current (residence) zip code? (Please **write-in** the five-digit number.)
(Not included here)
19. Approximately how many years have you lived in Colorado?
(Please **write-in** your response) (n = 574, SD = 19.153, \bar{X} = 57.20)

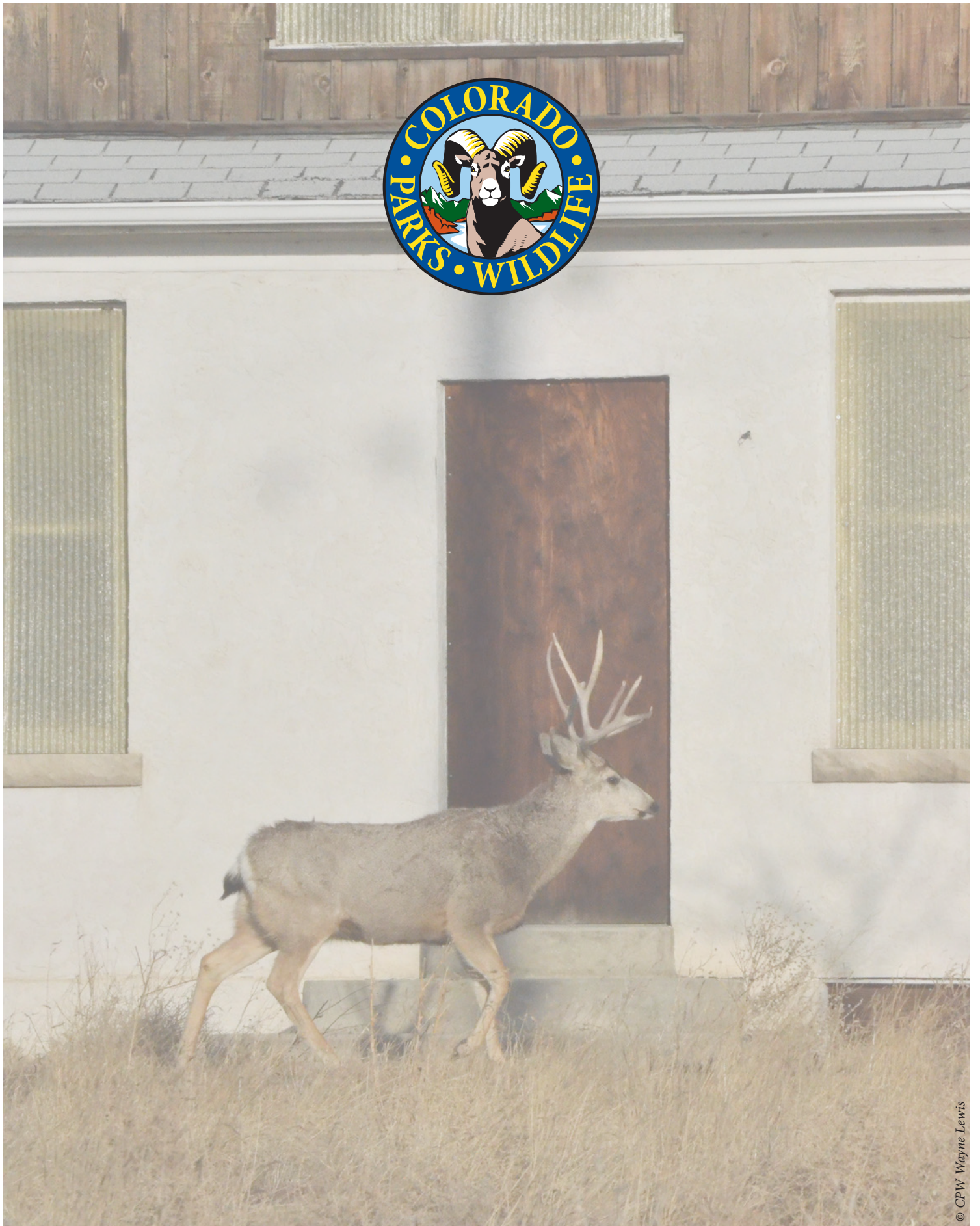
YEARS RESIDED	FREQUENCY	%
Less than 1 year	7	1.2
1-15 years	13	2.3
16-30 years	42	7.3
31-45 years	82	14.3
46-60 years	142	24.7
61-75 years	206	35.9
76 or more years	82	14.3

20. Please use the space provided to share any other additional thoughts you have about CWD or about hunting access (n = 218; See examples in Appendix B).

Appendix B

OPEN-ENDED COMMENTS

THEMES (BOLD) AND SUBTHEMES	NUMBER OF COMMENTS*	EXAMPLE COMMENTS
Disapprove of management		
Against increase of hunting	19	"I'm sick of hunters tearing up my land, and harassing my cattle. I will never be in favor of more hunting due to the lack of respect hunters have for landowners."
Mother nature/bigger issue	8	"I don't have very much faith in our government run programs. Nature takes care of itself. Humans are the only ones that won't let nature be"
No faith in government	8	"I have no confidence in the state, regarding game management issues"
Past control failed	4	"The Colorado Division of Wildlife had a all out massive effort to control CWD several years ago, other States did the same to no avail! At the cost of hundreds maybe thousands of deer in the control effort"
Management Suggestions		
Increase landowner tags	22	"Would like to see landowners get permits/ vouchers on a more regular basis"
Work with locals	10	"There seems to be little or no communication between our game wardens and the farmers and ranchers in NE Colorado."
Testing	7	"We need better access to testing ie kits available to hunters and more clearly detail where and how to test"
Harvest sick deer	6	"I know of 2 occasions when deer was found acting weird and sick and was told by CPW to just watch them. Instead of putting out of misery the landowner said I don't have time to watch. I guess my thought are if we see sick and report it lets get rid of the sick"
Additional incentives	3	"Nearly all land in NE Colorado is privately owned, so I think there needs to be some incentive for landowners to allow deer hunting to ensure that deer aren't all gathering in one area and spreading CWD more easily."
Pleased with management	3	"Thank you for keeping on top of CWD in Colorado"
Miscellaneous		
Unsatisfied with LPP	20	"Colorado landowner preference program is too complicated with too many rules"
Uninformed/want more info about CWD	15	"We need better info to identify the CWD" "I didn't know CWD was a problem again."



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