



Proximity to chronic wasting disease, perceived risk, and social trust in the managing agency

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ABSTRACT

This article examined relationships between proximity to chronic wasting disease (CWD) and perceived risk and trust. The sample included 1,606 hunters in one of 10 northern Illinois counties with CWD, 1,958 hunters in a non-CWD county adjacent to these counties with CWD, and 2,099 hunters from the remaining non-CWD counties in Illinois. Compared to hunters in non-CWD counties, those in CWD counties were hypothesized to: (a) perceive more risk of CWD to humans, (b) perceive more risk of CWD to deer, (c) report less trust in the Illinois Department of Natural Resources (IDNR) CWD information, and (d) have less trust in the IDNR management of CWD. The first two hypotheses were not supported, as hunters in CWD counties perceived less risk to humans and deer than did respondents in non-CWD counties. Hunters in CWD counties, however, were less trusting of the IDNR information and management compared to the other hunters.

KEYWORDS

Chronic wasting disease; perceived risk; social trust; proximity

Introduction

Chronic wasting disease (CWD) is a neurological wildlife disease caused by a mutation in a prion protein. This disease causes abnormal behavior and emaciation in all infected animals, and is always fatal (Edmunds et al., 2016). CWD is found in captive and free-ranging white-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus*), elk (*Cervus canadensis*, *C. elaphus*), moose (*Alces alces*), and reindeer (*Rangifer tarandus*; Haley & Hoover, 2015; Saunders, Bartelt-Hunt, & Bartz, 2012; Williams, Miller, Kreeger, Kahn, & Thorne, 2002). This disease is similar to bovine spongiform encephalopathy (BSE) in cattle (i.e., mad cow disease), scrapie in sheep, and variant Creutzfeldt–Jakob disease (vCJD) in humans (McKintosh, Tabrizi, & Collinge, 2003). CWD was first identified in captive animals during the 1960s in Colorado and in free-ranging herds during the 1980s in the same state (Williams et al., 2002). In Illinois, the focus of this article, CWD was discovered in 2002 and when the data were collected in 2012, there were 372 confirmed cases located in 10 northern Illinois counties (Miller, McCleary, Harper, & Campbell, 2013). This disease is now found in free-ranging herds in 23 states across the USA, two Canadian provinces, and Norway (Edmunds et al., 2016).

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CWD is not known to pose a risk to human health, but transmission to humans in the future cannot be entirely dismissed (Belay et al., 2004; Haley & Hoover, 2015; MaWhinney et al., 2006). Given this uncertainty, some hunters have stopped hunting (e.g., Heberlein, 2004; Lyon & Vaske, 2010; Miller, 2003, 2004; Needham, Vaske, & Manfredo, 2004, 2006). Research has repeatedly shown that these changes in hunting behaviors are at least partially related to risk perceptions associated with CWD and trust in the managing agency (Harper, Miller, & Vaske, 2015; Miller & Shelby, 2009; Needham & Vaske, 2008; Needham, Vaske, Donnelly, & Manfredo, 2007; Needham, Vaske, & Petit, 2017; Stafford, Needham, Vaske, & Petchenik, 2007; Vaske & Lyon, 2011; Vaske, Needham, Stafford, Green, & Petchenik, 2006; Vaske, Timmons, Beaman, & Petchenik, 2004). Proximity to a disease has also been shown to be related to attitudes and behaviors in response to diseases such as West Nile virus (WNV; Zielinski-Gutierrez & Hayden, 2006), bovine tuberculosis (TB; Brook & McLachlan, 2006), and CWD (Needham et al., 2006; Petchenik, 2003). This article examined relationships between proximity to CWD (i.e., hunters in CWD counties, hunters in non-CWD counties adjacent to these CWD counties, and hunters in the remaining non-CWD counties) and both perceived risk and trust associated with this disease.

Perceived risk

Perceived risk is the degree that individuals believe they are or may be exposed to a hazard such as CWD (Harper et al., 2015; Siegrist & Cvetkovich, 2000; Sjöberg, 2000; Slovic, 2010). Perceptions of risk are subjective and can influence decision-making and behavior under uncertainty (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Siegrist, Gutscher, & Earle, 2005). Among Illinois hunters, 54% were uncertain about CWD and human health, 20% believed this disease posed a risk to deer but not humans, and 17% felt humans could potentially contract CWD if they ate meat from an infected animal (Miller, 2004). A minority (10%) of Illinois hunters believed the threat from CWD had been exaggerated. In an eight state study, 33% of hunters believed the threat from CWD had been exaggerated, 32% thought the risk was isolated to deer and elk but not humans, 64% believed there was a risk of CWD to humans, and 44% believed that CWD may cause disease in humans (Needham & Vaske, 2006). On average, these hunters slightly agreed that CWD posed health risks to humans (Needham & Vaske, 2008). A study of Colorado hunters showed similar perceptions of health risks to humans, and also showed moderate concerns associated with risks of CWD to wild deer and elk populations (Needham et al., 2017).

Miller and Shelby (2009) compared the perceived risks from CWD, BSE (i.e., mad cow), *Salmonella*, *Escherichia coli*, WNV, and Lyme disease, and identified three hunter segments (i.e., no risk, slight risk, moderate risk). The risk sensitive (moderate risk) group reported the lowest hunting participation and were the most likely to change their hunting behavior due to the presence of CWD (42%) and believe that CWD posed a risk to humans (81%). A recent paper by Vaske and Miller (2017) also examined disease risk sensitivity relative to CWD, BSE, *E. coli*, *Salmonella*, Lyme disease, and WNV. As hypothesized, disease risk perceptions varied over time (2004 vs. 2012) and between hunters and non-hunters.

Social trust

Perceived risk can be related to social trust, which is the willingness to rely on those with responsibility for making decisions and taking actions regarding the management of

technology, the environment, medicine, or other realms of health and safety (Siegrist & Cvetkovich, 2000). The adjective “social” emphasizes that people being trusted are those with formal responsibilities within organizations who may not be personally known to the individual making the trust attribution (Siegrist, Cvetkovich, & Roth, 2000). Trust can be influenced by shared goals, values, and opinions; people trust agencies that are perceived to share similar views (Needham & Vaske, 2008; Siegrist et al., 2000). Trust in a managing agency can be an important predictor of public acceptance of management actions (Perry, Needham, & Cramer, 2017; Stern & Coleman, 2015; Vaske, Absher, & Bright, 2007; Winter & Cvetkovich, 2004; Winter, Vogt, & McCaffrey, 2004).

Trust plays an important role in risk perceptions (Cvetkovich & Winter, 2003; Harper et al., 2015; Siegrist & Cvetkovich, 2000; Sjöberg, 2001). Needham and Vaske (2008), for example, examined the relationship between trust and CWD risk across eight states. Across all 22 strata included in their investigation, hunters who trusted state wildlife agencies to manage CWD perceived slightly less risk from this disease. Despite this negative relationship between trust and risk, hunters still perceived slight to moderate trust in these agencies and some personal health risks from CWD. These types of perceptions can be related to behavior. In Wisconsin, for example, hunters who did not hunt for reasons associated with CWD were less trusting of information provided by the Wisconsin Department of Natural Resources (WDNR) compared to hunters who either dropped out for other reasons or participated in the hunting season (Vaske et al., 2004). In another study of Wisconsin deer hunters, Holsman, Petchenik, and Cooney (2010) proposed that the WDNR had low levels of credibility among these hunters regarding deer management that was not directly related to CWD, and these pre-existing attitudes transferred to CWD management and created low trust for that program.

Proximity to diseases

Temporal (Doss, McPeak, & Barrett, 2008) and spatial proximity (Zielinski-Gutierrez & Hayden, 2006) to diseases have been shown to be related to these attitudinal and behavioral responses. For example, CWD was discovered in Wisconsin in early 2002, and nine months later, hunting license sales had declined by more than 90,000 licenses (Heberlein, 2004). Approximately half of this decline was attributed to perceived risks associated with this disease (Vaske et al., 2004). These perceptions can be related to the “newness” (i.e., temporal proximity aspect) of the threat. In 2003, for example, 12% of Wisconsin hunters reported a personal concern over venison safety, but by 2004, that percentage had dropped to 4% (Holsman, 2005). Humans often attribute higher risk to hazards that are new or unknown, and this risk can be related to behavioral responses (e.g., Fischhoff et al., 1978; Sjöberg, 2000).

Spatial proximity to diseases can also be related to behaviors. In Wisconsin, for example, hunters from counties with CWD were slightly more likely to skip the 2002 gun deer hunting season than were hunters from non-CWD counties (Petchenik, 2003). Conversely, in the eight state study, Needham et al. (2004, 2006) observed that in states where CWD had not yet been found at the time of their study (Arizona, North Dakota), hunters were most likely to change their behavior if CWD was ever to be detected in these states. North Dakota hunters were most likely to give up deer hunting, whereas Arizona hunters were among the most likely to switch to other states. In Wisconsin, where deer

hunting has a culturally significant history (Heberlein, 2004; Vaske et al., 2004), hunters were least likely to change their behavior despite the existence of CWD in this state at the time (Needham et al., 2004, 2006).

Although there are no known instances of CWD affecting human health (Belay et al., 2004; Haley & Hoover, 2015; MaWhinney et al., 2006), other diseases, such as WNV, have caused mortality in humans related to the spatial proximity of diseases (Peterson & Hayes, 2005). Zielinski-Gutierrez and Hayden (2006) compared a city with high WNV transmission (Fort Collins, Colorado) against a city with low WNV transmission (Colorado Springs, Colorado). People living in Fort Collins reported a heightened sense of awareness to WNV and were more likely to take preventative actions compared to those in Colorado Springs.

Similarly, Baird, Leslie, and MaCabe (2009) examined the relationship between proximity to Tarangire National Park in Tanzania and resident perceptions of risk from wildlife (e.g., fear of wildlife attacking humans, eating humans). Their analyses compared four villages near the park and four villages further away, with results indicating that residents living near the park identified different kinds of risks compared to those from more distant villages. Villagers near the park held perceived risks with greater intensity and severity, and adopted more pre-emptive farming practices to mitigate the threats of wildlife and park expansion. In a related study, Brook and McLachlan (2006) examined farmer concerns regarding the presence of bovine TB in livestock and wildlife near Riding Mountain National Park (RMNP) in Canada. The spatial variables of greatest concern were distance of the farm from RMNP and the frequency of observing elk on the farmer's property.

Hypotheses

This article examined relationships between proximity to CWD in Illinois (i.e., lived and hunted in a CWD county, lived and hunted in a non-CWD county adjacent to a county with CWD, lived and hunted in one of the remaining non-CWD counties in this state [hereafter referred to as a downstate county]) and both perceived risk and social trust associated with this disease. Based on previous research, the following hypotheses were advanced.

Compared to hunters in non-CWD counties adjacent to counties with CWD and also hunters in the remaining non-CWD downstate counties, individuals in counties with CWD were hypothesized to:

H₁: perceive more risk of CWD to human health,

H₂: perceive more risk of CWD to the health of the deer herd,

H₃: report less trust in the Illinois Department of Natural Resources (IDNR) information about CWD, and

H₄: report less trust in the IDNR management of CWD.

It was also hypothesized that:

H₅: Hunters in adjacent non-CWD counties and non-CWD downstate counties have similar perceptions of risk and trust associated with this disease.

Methods

Data were obtained from a mail survey of resident deer hunters sampled randomly from Illinois permit holders. Three mailings were used for administering the questionnaires beginning in July 2012 and ending in November 2012. Resident hunters first received a questionnaire, postage-paid return envelope, and personalized letter explaining the study and requesting their participation. Two weeks after this initial mailing, a reminder postcard was sent to non-respondents. A second complete mailing (questionnaire, postage-paid return envelope, letter) was sent to non-respondents 10 days after this postcard reminder. To increase the response rate, a third complete mailing was sent one month following this second complete mailing. Funding limitations prohibited a nonresponse bias check.

Questionnaires were mailed to 3,000 hunters who lived and hunted in one of the 10 Illinois counties with CWD (at the time of this survey). An additional 3,000 surveys were mailed to hunters living and hunting in non-CWD counties that were adjacent to these CWD counties, and 4,000 questionnaires were mailed to hunters living and hunting in the remaining non-CWD downstate counties. After accounting for undeliverables, completed questionnaires were obtained from: (a) 1,606 hunters (response rate = 58%) in the 10 northern counties with CWD, (b) 1,958 hunters (response rate = 56%) from the adjacent non-CWD counties, and (c) 2,099 hunters (response rate = 52%) from the remaining 73 non-CWD downstate counties.

Variables

The independent variable was proximity to CWD (i.e., hunters in counties with CWD, hunters in non-CWD counties adjacent to these CWD counties, hunters in non-CWD downstate counties). One of the dependent latent concepts, perceived risk of CWD to human health, was measured with three questions: (a) CWD may cause disease in humans if they eat meat from animals infected with CWD; (b) because of CWD, my family has concerns about eating deer meat; and (c) because of CWD, I have concerns about eating deer meat. These items were identical to those used in previous research (Needham & Vaske, 2008; Needham et al., 2017). Each question was measured on a 7-point scale (originally coded from 1 to 7 and then recoded from -3 = “strongly disagree” to 3 = “strongly agree” for analysis purposes).

Perceived risk of CWD to deer health was measured with five items: Because of CWD, how concerned are you about... (a) the health of the deer population in Illinois, (b) not having enough healthy deer left to hunt in Illinois, (c) CWD spreading throughout the entire deer population in Illinois, (d) the potential for CWD to dramatically reduce the deer population in Illinois, and (e) the potential for CWD to kill the entire deer population in Illinois. These items were also similar to those in previous research (Needham & Vaske, 2008; Needham et al., 2017). Responses were on an 8-point scale (1 = “not at all concerned” to 8 = “extremely concerned”).

Trust in both the IDNR information and management related to CWD were examined. The information questions included seven items: I trust the IDNR to provide... (a) me

with enough information to decide what actions I should take regarding CWD, (b) the best available information on CWD in Illinois, and (c) timely information regarding CWD; and the additional items were: I trust the IDNR to provide truthful information. . . (d) about human safety issues related to CWD, (e) about deer population estimates, (f) about how CWD spreads, and (f) on the number of CWD-positive deer discovered in Illinois. The three management questions asked: I trust the IDNR to. . . (a) make good deer management decisions regarding CWD issues, (b) follow the best available science in managing CWD, and (c) properly address CWD in Illinois. These items were consistent with those used in other studies (Needham & Vaske, 2008; Needham et al., 2017) and each statement was measured on a 7-point scale (originally coded from 1 to 7 and then recoded from $-3 =$ “strongly disagree” to $3 =$ “strongly agree” for analysis).

Analysis strategy

Cronbach’s alpha was used for examining the reliability of each set of dependent variables measuring risks to human health and the deer herd, and trust in agency information and management. One-way analysis of variance was used for examining relationships between proximity to CWD and these four latent constructs. Eta (η) was used for indicating the strength of relationship with an eta of .10 considered a “minimal” relationship, .243 a “typical” relationship, and .371 a “substantial” relationship. These guidelines for effect sizes were proposed by Vaske (2008).

Results

Reliability analysis for the perceived human health risk construct yielded a Cronbach’s alpha of .78 (Table 1). These Illinois hunters, on average, slightly disagreed that they perceived risk from humans eating meat of infected animals ($M = -.24$), from their family eating deer meat ($M = -.75$), or from themselves eating deer meat ($M = -.74$). The Cronbach’s alpha for risk to the deer herd was high at .92. These hunters, on average, perceived a moderate risk to deer, as all of the means were near 5 on the response scale (i.e., moderately concerned): deer health ($M = 5.61$), having healthy deer left to hunt ($M = 5.51$), CWD spreading throughout the deer herd ($M = 5.54$), CWD dramatically reducing the herd ($M = 5.40$), and CWD killing the entire herd ($M = 4.78$).

The Cronbach’s alpha for trust in the IDNR information about CWD was also high at .95 (Table 2). These Illinois hunters, on average, slightly agreed that they trusted the IDNR to provide enough information to decide what actions should be taken ($M = 1.01$), the best available information on CWD in this state ($M = 1.13$), and timely information regarding CWD issues ($M = 1.00$). On average, respondents also trusted the IDNR to provide truthful information about human safety issues related to CWD ($M = 1.23$), deer population estimates ($M = 1.06$), how CWD spreads ($M = 1.29$), and the number of positive CWD cases in Illinois ($M = 1.37$). Similarly, reliability analysis for trust in the IDNR management of CWD had a Cronbach’s alpha of .93 (Table 2). These hunters, on average, slightly agreed that they trusted the IDNR to make good deer management decisions regarding CWD ($M = .89$), follow the best available science in managing this disease ($M = 1.14$), and properly address CWD in Illinois ($M = 1.08$).

Table 1. Perceived risk of CWD to human and deer herd health among Illinois deer hunters.

| Perceived risk variables | Mean | Corrected item-total correlation | Cronbach's alpha if item deleted | Cronbach's alpha |
|---|------|----------------------------------|----------------------------------|------------------|
| Risk to humans ¹ | | | | .78 |
| CWD may cause disease in humans if they eat meat from animals infected with CWD | -.24 | .53 | .78 | |
| Because of CWD, my family has concerns about eating deer meat | -.75 | .60 | .73 | |
| Because of CWD, I have concerns about eating deer meat | -.74 | .75 | .56 | |
| Risk to the deer herd | | | | .92 |
| Because of CWD, how concerned are you about: ² | | | | |
| the health of the deer population in Illinois | 5.61 | .70 | .92 | |
| not having enough healthy deer left to hunt in Illinois | 5.51 | .77 | .90 | |
| CWD spreading throughout the entire deer population in Illinois | 5.54 | .86 | .89 | |
| the potential for CWD to dramatically reduce the deer population in Illinois | 5.40 | .88 | .88 | |
| the potential for CWD to kill the entire deer population in Illinois | 4.78 | .78 | .91 | |

¹Measured on a 7-point recoded scale (-3 = strongly disagree, 0 = neither, 3 = strongly agree).

²Measured on an 8-point scale (1&2 = not at all concerned, 3&4 = slightly concerned, 5&6 = moderately concerned, 7&8 = extremely concerned).

Table 2. Perceived trust in agency CWD information and management of CWD among Illinois deer hunters.

| Perceived trust variables | Mean | Corrected item-total correlation | Cronbach's alpha if item deleted | Cronbach's alpha |
|---|------|----------------------------------|----------------------------------|------------------|
| Trust in the IDNR information ¹ | | | | .95 |
| I trust the IDNR to provide: | | | | |
| me with enough information to decide what actions I should take regarding CWD | 1.01 | .79 | .94 | |
| the best available information on CWD in Illinois | 1.13 | .85 | .94 | |
| timely information regarding CWD issues | 1.00 | .85 | .94 | |
| I trust the IDNR to provide truthful information: | | | | |
| about human safety issues related to CWD | 1.23 | .88 | .94 | |
| about deer population estimates | 1.06 | .84 | .94 | |
| about how CWD spreads | 1.29 | .87 | .94 | |
| on the number of CWD-positive deer discovered in Illinois | 1.37 | .83 | .94 | |
| Trust in the IDNR management ¹ | | | | .93 |
| I trust the IDNR to: | | | | |
| make good deer management decisions regarding CWD issues | .89 | .82 | .93 | |
| follow the best available science in managing CWD | 1.14 | .87 | .89 | |
| properly address CWD in Illinois | 1.08 | .89 | .87 | |

¹Measured on a 7-point recoded scale (-3 = strongly disagree, 0 = neither, 3 = strongly agree).

Based on these reliabilities, composite indices were computed for each of the two risk constructs and each of the two trust concepts. **Table 3** compares where a hunter lived and hunted (i.e., CWD county, non-CWD county adjacent to a county with CWD, or non-CWD downstate county) on each of these four computed indices. Those who lived and hunted in a CWD county perceived slightly less human health risk from CWD ($M = -.85$) compared to those living in a non-CWD adjacent county ($M = -.51$) or a non-CWD downstate county ($M = -.49$), $F = 49.72$, $p < .001$, $\eta = .133$ (i.e., minimal). Individuals in the CWD counties also perceived slightly less risk to the health of the deer herd from CWD ($M = 4.85$) compared to the other two samples (non-CWD adjacent county

Table 3. Relationships between proximity to CWD and both perceived risk and agency trust.

| Dependent variables ² | CWD county | Non-CWD adjacent county | Non-CWD downstate county | F-value ¹ | η |
|--|-------------------|-------------------------|--------------------------|----------------------|--------|
| Risk to humans ³ | -.85 ^a | -.51 ^b | -.49 ^b | 49.72 | .133 |
| Risk to the deer herd ⁴ | 4.85 ^a | 5.50 ^b | 5.64 ^b | 81.53 | .170 |
| Trust in the IDNR information ³ | .97 ^a | 1.23 ^b | 1.20 ^b | 19.63 | .084 |
| Trust in the IDNR management ³ | .68 ^a | 1.14 ^b | 1.22 ^b | 69.62 | .158 |

¹ All F-values were statistically significant at $p < .001$.

² Means with different letter superscripts across each row were statistically significant at $p < .05$ based on Tamhane's T2 post-hoc tests for unequal variances.

³ Measured on a 7-point recoded scale (-3 = strongly disagree, 0 = neither, 3 = strongly agree).

⁴ Measured on an 8-point scale (1 & 2 = not at all concerned, 3 & 4 = slightly concerned, 5 & 6 = moderately concerned, 7 & 8 = extremely concerned).

$M = 5.50$, non-CWD downstate county $M = 5.64$), and the effect size was between minimal and typical, $F = 81.53$, $p < .001$, $\eta = .170$. These findings do not support hypotheses 1 and 2, which predicted more risk, not less risk, as proximity to CWD increased. Consistent with hypothesis 5, Tamhane's T2 post-hoc tests showed that hunters in the non-CWD adjacent counties and the non-CWD downstate counties did not differ from each other on these two risk indices.

Respondents living and hunting in the CWD counties were less trusting of the IDNR information about CWD ($M = .97$) and the IDNR management of this disease ($M = .68$) compared to those in the non-CWD adjacent counties ($M = 1.23$ and $M = 1.14$, respectively) and the non-CWD downstate counties ($M = 1.20$ and $M = 1.22$, respectively). The F-values for these two trust indices were statistically significant at $p < .001$ and the effect sizes were minimal ($\eta = .086$) and between minimal and typical ($\eta = .158$), respectively. These findings support hypotheses 3 and 4; hunters in the CWD counties were less trusting of the IDNR information and management compared to those in the non-CWD counties. Results for the trust indices also supported hypothesis 5, as the Tamhane's T2 post-hoc tests showed that hunters in the non-CWD adjacent counties did not differ in trust from those in the non-CWD downstate counties.

Discussion

This article examined relationships between proximity to CWD and both perceived risk and social trust. Perceived risk was operationalized as risks of CWD to humans and deer. Trust was conceptualized as trust in the IDNR information about CWD and trust in this agency's management of this disease. Contrary to hypotheses 1 and 2, hunters in Illinois counties with CWD perceived less risk (not more risk) to both humans and deer compared to those in non-CWD adjacent and downstate counties. Consistent with hypotheses 3 and 4, hunters in CWD counties were less trusting of the IDNR information and management compared to the other hunters. Risk and trust did not differ between hunters in the non-CWD adjacent and downstate counties (hypothesis 5). Although some of the effect sizes were relatively minimal, these results do support the idea that proximity to a disease is related to risk and trust perceptions.

These findings have implications for management and research. These Illinois hunters, for example, perceived moderate risks of CWD to the health of deer populations. This finding is consistent with a study in Colorado showing that hunters in this state were also

moderately concerned about impacts of CWD on deer and elk (Needham et al., 2017). Results here also showed that respondents slightly agreed that they trusted the IDNR information and management regarding CWD. In a study of eight different state wildlife agencies, Needham and Vaske (2008) also found that hunters slightly to moderately trusted these agencies to address CWD. Findings presented here build on this previous research by showing that trust in agency information and management associated with CWD decreased as proximity to this disease increased, suggesting that managing agencies should target areas where CWD is prevalent and build trust with hunters.

Contrary to many previous studies, however, this study showed that Illinois hunters, on average, disagreed that CWD posed risks to humans. Studies in a number of states have shown large proportions of hunters concerned about potential effects of CWD on human health (e.g., Brown et al., 2006; Gigliotti, 2004; Needham & Vaske, 2006, 2008; Needham et al., 2017; Vaske et al., 2004). Some research, however, has suggested that these risks may be dissipating over time since the initial discovery of CWD in a state. Holsman et al. (2010), for example, found that although Wisconsin hunters were still slightly concerned about getting sick from eating deer infected with CWD, their perceived risks had diminished since the onset of the disease in this state and they were less concerned about CWD now. In fact, Holsman (2005) reported that Wisconsin hunters' concerns over venison safety dropped from 12% in 2003 to 4% in 2004. Similar to Wisconsin, Illinois hunters also initially expressed moderate levels of risk to human health from CWD (Miller, 2004) and findings here showed that although some Illinois hunters were still concerned a decade after this disease was discovered in this state, these risks appear to be dissipating, especially in counties closer to where this disease persists.

Studies have shown relationships between perceptions of risk and spatial proximity of diseases (Brook & McLachlan, 2006; Zielinski-Gutierrez & Hayden, 2006). In Wisconsin, for example, people who lived and hunted closer to CWD counties perceived higher risk from this disease compared to hunters in other parts of the state (Petchenik, 2003). Conversely, in an eight state study, Needham et al. (2004, 2006) found the opposite; hunters in states without CWD at the time of their study (e.g., Arizona, North Dakota) reported higher CWD risk and likelihood of changing behaviors in response to this disease compared to hunters in many states with CWD. Findings reported here appear to be consistent with results from Needham et al. (2004, 2006), as respondents who lived and hunted in Illinois counties with CWD perceived less risk compared to those in non-CWD counties adjacent to these CWD counties and the remaining non-CWD downstate counties. These findings may have occurred for a variety of reasons. First, CWD was discovered in Illinois in November 2002; data for this article were collected in 2012. Hunters living in closer proximity to CWD have been exposed to this disease for a longer time (i.e., temporal proximity), so they likely have more knowledge about the hazard and a better understanding that CWD is not known to be harmful to humans (Haley & Hoover, 2015). Hunters in other parts of Illinois without CWD, especially the downstate hunters, perceive more risks possibly because they have less exposure to CWD and may lack detailed knowledge about this disease. Therefore, because CWD is not in these other parts of the state, it may represent a more unknown or newer risk for these hunters (Fischhoff et al., 1978; Needham et al., 2006).

Second, most agency information and education campaigns specify that there is no evidence that CWD poses a human health risk (Eschenfelder, 2006; Needham et al., 2017).

These same messages, however, also advise hunters to take precautions such as testing animals for CWD and wearing gloves when processing animals, suggesting a risk could be present. Although agencies are likely to continue communicating precautionary messages primarily out of concern for public safety, this ambiguity in the messages may influence perceptions of risk, especially in counties where CWD has yet to be detected and hunters are less familiar with this disease. Hunters may believe that mixed messages suggest that wildlife agencies are uncertain about CWD, which may influence risk evaluations (Needham & Vaske, 2008; Vaske et al., 2004). Concerns about CWD could also stem from its similarity to related diseases that can cause human death (e.g., vCJD; Miller, Hobbs, & Tavener, 2006). Research has found, for example, that some hunters perceived the risk of becoming ill from CWD and mad cow disease as similar (Miller & Shelby, 2009; Needham et al., 2017; Vaske & Miller, 2017). Agencies should consider these issues when planning their long-term responses to CWD and developing communication campaigns about CWD, especially in areas with low disease prevalence (Vaske, 2010).

Third, the lower risk perceptions among hunters in the CWD counties compared to those in the other counties may be due to success of the management program in Illinois. Although the total number of positive cases of CWD in Illinois has increased, the overall prevalence and distribution of this disease remains quite low with only 1.17% of all adult deer having the disease (1.60% of adult males, 0.69% of adult females; Shelton & McDonald, 2017). Illinois hunters harvested 14,760 deer from the 16 CWD counties during the 2016–2017 hunting seasons, which was a decrease from the average harvest of 16,309 deer during each of the previous five seasons. CWD prevalence was only 1.7% among deer harvested by hunters, whereas prevalence among deer harvested by agency sharpshooters was 3.2% (Shelton & McDonald, 2017). This difference suggests that hunters were less likely to encounter a CWD-positive deer. Given that more than 98% of deer harvested by Illinois hunters and tested for CWD were negative, hunters in the CWD counties may be using this evidence coupled with anecdotal information gathered through their social networks to conclude that CWD is a low risk. Findings here are similar to those from Norway that suggested personal experience was an important component of risk perception beyond simply living in an area where the risk is present (Lujala, Haakon, & Rød, 2015).

Fourth, diminished perceptions of risk in areas closer to a disease are consistent with some studies in the risk communication literature. Aldoory and Van Dyke (2006), for example, found that information was an important factor in determining how risks were perceived, yet excessive coverage in an area could result in information overload and lead individuals to avoid, rather than adopt, safer behaviors. Similarly, Jackson and Farzaneh (2012) advanced the concept that tipping points exist beyond which individuals become overloaded by information. Personal factors and perceived quality and quantity of information combine to determine when people may retreat from the messages provided. A segment of hunters in CWD counties in Illinois may be experiencing information overload, thereby reducing their concerns about this disease and leading them to dismiss potentially safer behaviors. Research involving risk communication and messaging is needed to determine if such a tipping point has been reached among some hunters.

Although risk perceptions and trust in a managing agency can be related to proximity, relationships between risk and trust are less clear. Needham and Vaske (2008), for example, showed relatively weak but consistently negative relationships between trust in

wildlife agencies and perceived risk associated with CWD (i.e., risk decreased as trust increased, and vice versa). Similarly, Winter et al. (2004) found weak to moderate negative relationships between agency trust and risk related to wildfire management. This study here, however, showed that hunters in Illinois counties where CWD exists not only perceived the lowest risk, but also the lowest trust, possibly implying either a positive relationship or no clear relationship between these two concepts. This suggests that most of the variance in risk may remain unexplained by trust, and other attributes, such as knowledge, ability to control, and newness associated with the hazard, may contribute to relationships between perceptions of CWD risk and trust in management responses (Fischhoff et al., 1978; Needham & Vaske, 2008; Sjöberg, 2000). In addition, risk perceptions may also be influenced by trust in other sources beyond a managing agency, such as interest groups, media, friends, and family (Viklund, 2003; Walls, Pidgeon, Weyman, & Horlick-Jones, 2004). Effects of other attributes of CWD (e.g., control, newness) and diverse information sources on judgments of risk and trust related to this disease warrant further research attention.

Despite these findings, studies on other topics, such as nuclear power, have shown stronger negative relationships between trust and risk (e.g., Flynn, Burns, Mertz, & Slovic, 1992; Siegrist et al., 2000; Slovic, 2010). Nuclear power, however, is created and controlled by humans, whereas CWD occurs naturally and continues spreading to new locations (Miller et al., 2006; Needham et al., 2017). Natural risks are often considered to be more uncontrollable and random than anthropogenic risks (Sjöberg, 2000). Therefore, irrespective of whether hunters may trust or distrust wildlife agencies to inform people about CWD and manage this disease, these hunters may still believe the agencies have limited ability to control the spread and prevalence of this disease (Needham & Vaske, 2008). To mitigate any perceptions of risk associated with CWD, especially in areas currently without this disease, agencies may need to do more to inform hunters about strategies for managing CWD, such as preventing this disease from spreading to non-CWD counties. In addition, sharpshooting can be effective for reducing the prevalence of CWD (Harper et al., 2015), but it is controversial. Explaining why using agency sharpshooters is sometimes necessary may reduce risk perceptions and increase trust in the managing agency.

This study examined relationships between proximity to CWD and both perceived risk and social trust. Characteristics other than proximity (e.g., attitudes, norms), however, have received attention in the literature and have been shown to be related to trust and risk (e.g., Perry et al., 2017; Vaske et al., 2007; Zinn & Pierce, 2002). For example, most Wisconsin residents did not have a clear attitude toward CWD prior to discovery of this disease in the state (Heberlein & Stedman, 2009). The media barrage that ensued after the discovery, however, created an attitude that likely influenced initial reactions toward CWD. Research is required to examine other potential determinants of trust and risk in the context of CWD and other natural resource issues.

Finally, the concepts of trust and risk have generated considerable interest in the broader social science literature (Slovic, 2010; Stern & Coleman, 2015). Given the contentious nature of natural resource management issues such as CWD, continuing to draw on the literature associated with both risk and trust may improve understanding of challenges faced by natural resource managers. Researchers are encouraged to address

the research needs identified here to improve understanding of the human dimensions of CWD and other wildlife diseases.

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