

Research Article

Wildlife Agency Trust and Perceived Risks From Chronic Wasting Disease

JERRY J. VASKE,¹ *Colorado State University, Human Dimensions of Natural Resources Department, Fort Collins, CO 80523, USA*

MARK D. NEEDHAM, *Oregon State University, Department of Forest Ecosystems and Society, Corvallis, OR 97331, USA*

CRAIG A. MILLER, *University of Illinois, Illinois Natural History Survey, Champaign, IL 61820, USA*

ABSTRACT We examined the extent that hunters' perceptions of risks related to chronic wasting disease (CWD) and trust in state wildlife agencies to address CWD were related to their demographic (sex, age, education, residence) and hunting (CWD presence, type of hunter, years hunting in state, harvest) characteristics. Demographic and hunting characteristics have been suggested by some managers and researchers to be strongly related to perceived risks and trust in wildlife agencies. We obtained data from a mail survey ($n = 9,567$) of hunters in 8 states (2004). Demographic and hunting characteristics were statistically related to both risk and trust, but the relationships were complex for several reasons. First, although the demographic variables were significantly related to both risk and trust in 11 of the 15 tests, almost all of the effect sizes (η) were minimal (<0.100 ; $\bar{X} = 0.051$). For the hunting characteristics, 11 of the 12 tests were significant ($P \leq 0.038$), but the average effect size was only 0.059. Second, hierarchical linear regression analyses indicated that although 65% of the beta coefficients (another effect size indicator) were significant ($P < 0.001$), the average standardized regression coefficient was only 0.066 (minimal). Third, not all demographic and hunting characteristics were related to risk and trust in the same manner. For example, in the regression models, sex was never statistically significant. Other variables (resident of the state, education, harvest) were always significant. Finally, all R^2 (explained variance) were $<5\%$. The weak relationships between demographic and hunting characteristics and both risk and trust suggest that managers should be cautious when targeting communication messages about CWD to specific subgroups of hunters based on these characteristics. © 2021 The Wildlife Society.

KEY WORDS chronic wasting disease, social trust, perceived risk, demographics, hunting.

Chronic wasting disease (CWD) is one of a class of transmissible spongiform encephalic neurological diseases caused by prion mutations (Edmunds et al. 2016). Chronic wasting disease is found in members of the cervid family, including free-ranging and captive white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), red deer (*Cervus elaphus*), moose (*Alces alces*), and reindeer (*Rangifer tarandus*; Saunders et al. 2012, Haley and Hoover 2015). Emaciation, abnormal behavior, and death occur in all animals infected with CWD (Williams et al. 2002). Chronic wasting disease is a transmissible spongiform encephalopathy (TSE) similar to bovine spongiform encephalopathy (BSE) in cattle (mad cow disease), scrapie in sheep, and a variant of Creutzfeldt-Jakob disease (vCJD) in humans (Williams et al. 2002, Needham and Vaske 2008). Current evidence suggests that CWD poses minimal risk to human health, but results from in-vitro

studies indicate that the species barrier is not absolute (Belay et al. 2004, Hannaoui et al. 2017, Barria et al. 2018).

Chronic wasting disease was first identified in captive animals during the late 1960s in Colorado and then in free-ranging herds during the 1980s in the same state (Williams et al. 2002). Chronic wasting disease is now found in free-ranging cervids in 24 states throughout the United States (U.S.) and in free-ranging or captive cervids in 3 Canadian provinces, Finland, Norway, Sweden, and South Korea (Centers for Disease Control and Prevention 2021). In the U.S., some states have experienced declines in hunting participation attributable to CWD (Vaske et al. 2004, Brown et al. 2006, Needham et al. 2006). Research has suggested that declines in hunting participation can be partially influenced by 2 concepts of interest to wildlife managers: 1) perceptions of risk, and 2) trust in managing agencies (Needham and Vaske 2008, Harper et al. 2015). Perceived risk is the extent that individuals believe they are or may be exposed to a hazard (Sobkow et al. 2016, Walpole and Wilson 2020) and in the context of CWD, can involve perceived threats to humans and wildlife (Needham and Vaske 2008, Needham et al. 2017, Vaske et al. 2018).

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¹E-mail: jerryv@colostate.edu

Social trust has been defined as the willingness to rely on those with formal responsibility for making management decisions in a variety of industries and services (Earle and Cvetkovich 1995).

We examined hunters' perceptions of risks associated with CWD and their trust in state wildlife agencies to address the impacts of this disease, as well as relationships between these risk and trust concepts and both demographic characteristics of hunters (sex, age, education, residence) and hunting characteristics (presence of CWD in the state, deer or elk hunter, years hunting in the state, harvested an animal). Research has suggested that demographic and hunting characteristics may be related to risk and trust (Mankin et al. 1999, Dougherty et al. 2003, Loyd and Miller 2010, Slovic 2010, Stern 2018). Understanding the influence of demographic and hunting characteristics might help managers target communication and information messages to specific stakeholder groups such as subgroups of hunters.

Risk Perceptions

Risk perceptions can influence human behavior (Siegrist et al. 2005, Vaske and Lyon 2011, Needham et al. 2017) including risks to both humans (e.g., perception that humans may become ill from eating meat of deer infected with CWD) and wildlife (i.e., perception that deer populations will severely decline due to CWD). Factors related to perceived risk include newness (new-old risk), knowledge (unknown-known risk), and severity of the risk (fatal-not fatal; Fischhoff et al. 1978, Vaske et al. 2006, Holland et al. 2020). Chronic wasting disease is a relatively new risk in many locations, has somewhat unknown consequences for human health, and is fatal among cervids.

Early studies addressing perceptions of risks associated with CWD consistently showed that hunters were concerned about potential effects of CWD on human health (Gigliotti 2004, Miller 2004). For example, the majority of Wisconsin hunters who did not hunt the year following the discovery of CWD in that state were moderately or strongly influenced by perceived risks associated with CWD (Vaske et al. 2004). Over time, however, perceptions can change. Holsman and Smail (2006), for example, compared Wisconsin hunters' attitudes toward CWD over a 3-year period (i.e., 2003–2005) and found that hunters were less concerned about the disease in 2005 than they were in 2003. Cooney and Holsman (2010) and Holsman et al. (2010) also found that although people in Wisconsin were still slightly concerned about getting sick from eating deer infected with CWD, their perceived risks had slightly declined since the discovery of this disease in Wisconsin. A similar trend occurred in Illinois over a 9-year period (Vaske and Miller 2019). Time and experience with CWD may have tempered some of the initial concerns identified in earlier studies (Needham et al. 2004, Vaske et al. 2004, Needham and Vaske 2006, Stafford et al. 2007). License sales now show that hunter numbers have returned to approximately where they were before the discovery of CWD in some states (Kamal 2017).

Research in several states has shown that some hunters are also concerned about effects of CWD on the health and population sizes of deer and elk (Needham and Vaske 2006, Stafford et al. 2007, Harper et al. 2015, Schuler et al. 2016, Needham et al. 2017). Although most articles examining perceived risks from CWD have involved hunters or other members of the public, a few studies by experts and other stakeholders have assessed CWD risks (Vaske 2010, Amick et al. 2015, Oraby et al. 2016, Tyshenko et al. 2016).

Risk perceptions can be influenced by demographics and other characteristics (Sjöberg 2000). Men, for example, are often less concerned about risks than are women (Kellert and Berry 1987, Slovic 2000). Individuals with lower education levels often report higher risk perceptions, depending on the hazard being evaluated (Sjöberg 2000, Hanisch-Kirkbride et al. 2013). Specific to CWD, resident hunters and those who hunt deer have reported greater risk of CWD to humans, whereas nonresident hunters and those who hunt elk perceived greater risk of CWD to animals (Needham and Vaske 2006). More specialized individuals who participated in hunting for a large part of their lives were less likely to let CWD alter their hunting behavior (Needham et al. 2007). Individuals living further away from areas with CWD have reported greater concerns about the disease and were least likely to think that its threat has been exaggerated (Needham and Vaske 2006, Vaske et al. 2018). People living in closer proximity to CWD perceived less risk, potentially because they have adapted to the disease (Needham and Vaske 2006, Vaske et al. 2018). We examined these and other characteristics that may be related to hunters' perceptions that CWD poses risks to both people and wildlife.

Social Trust

We also examined relationships between demographic and hunting characteristics and social trust in state wildlife agencies to address CWD. The adjective social emphasizes that the people being trusted are those with formal responsibilities within organizations that may not be personally known to the person making the trust attribution (Siegrist et al. 2000). In natural resource contexts, social trust has been examined relative to numerous issues such as:

- 1) pesticides (Siegrist et al. 2000),
- 2) insect outbreaks (McFarlane et al. 2012),
- 3) wildfires (Shindler et al. 2004, Shindler and Mallon 2009, Olsen and Sharp 2013),
- 4) prescribed burning and mechanical thinning in forestry (Vaske et al. 2007),
- 5) natural resource planning and management (Smith et al. 2013, Ford et al. 2020),
- 6) terrestrial and marine protected area management (Perry et al. 2017, Simpson and Correa 2020),
- 7) water allocation decisions (Hamm et al. 2013),
- 8) river restoration (Metcalf et al. 2015), and
- 9) wildlife diseases (Needham and Vaske 2008, Vaske and Miller 2018, Schroeder et al. 2021).

Trust is especially important in situations where knowledge is low (Siegrist et al. 2005, PytlikZillig et al. 2017). Public knowledge about CWD is generally low in many states. Prior to the discovery of CWD in Wisconsin, for example, few people had even heard of this disease (Heberlein and Stedman 2009). In response to a series of true-false questions about CWD, fewer than 5% of hunters and nonhunters in Wisconsin and hunters in Colorado and Illinois answered all questions correctly and the largest proportions failed to answer more than half correctly (Vaske et al. 2006, Miller et al. 2013).

Wisconsin 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 those who participated in the hunting season (Vaske et al. 2004). In another study of Wisconsin deer hunters, Holsman et al. (2010) proposed that the WDNR had low credibility with Wisconsin hunters regarding deer management that was not directly related to CWD. The pre-existing perceptions transferred to CWD management programs and created low trust for those programs. Conversely, Illinois hunters expressed relatively high trust in the Illinois Department of Natural Resources' use of science and communication regarding CWD in the state, but held lower trust in agency management responses (Harper et al. 2015).

There is limited empirical research directly examining relationships between trust in state wildlife agencies and both demographic and hunting characteristics. For hunting characteristics, those living or hunting further away from areas where CWD has been found reported greater trust in agencies to manage this disease, whereas those in closer proximity to CWD reported less trust (Brown et al. 2006, Vaske et al. 2018). Hunters also had less trust in these agencies than did nonhunters (Stafford et al. 2007). For demographic characteristics, there is some indirect evidence of relationships with trust in these agencies. Manfredo et al. (2017, 2018), for example, conducted a nationwide survey ($n = 43,949$) of all 50 U.S. states to understand a mutualism–domination wildlife value orientation continuum. Domination-oriented individuals believe the environment should be managed for human benefit. Mutualism-oriented individuals are more egalitarian and supportive of social inclusion that extends to human–land relationships. A mutualism-oriented individual believes the environment is deserving of rights and care. Across the U.S., domination-oriented individuals made up 28% of the population and mutualists made up 35% (Manfredo et al. 2018). The remainder of the sample included 21% pluralists (i.e., people who gave high scores on both domination and mutualism items) and 15% distanced individuals (i.e., people who do not care about wildlife related issues). States with higher percentages of mutualists reported lower rates of trust in state wildlife agencies (Manfredo et al. 2017, 2018). Research has found that mutualism is more common in younger, female, and urban samples, whereas domination-oriented individuals are more likely to be older, male, and live

in rural areas (Martinez-Espineira 2006, Vaske 2008, Loyd and Miller 2010).

Research Questions

Based on the literature, we asked 2 research questions. First, to what extent are hunters' social trust in state wildlife agencies to manage CWD and perceived risks to humans and wildlife from CWD related to their sex, age, education, location of residence (i.e., farm, town, city), and state of residence (resident vs. nonresident)? Second, to what extent are hunters' trust and risk perceptions related to their hunting characteristics, including the presence or absence of CWD in the state, type of hunter (deer vs. elk), years hunting deer or elk in the state, and harvest success?

METHODS

Study Area

Data were from a mail survey of resident and nonresident deer hunters in 8 states (Arizona, Colorado, Nebraska, North Dakota, South Dakota, Utah, Wisconsin, Wyoming) and elk hunters in 3 states (Colorado, Utah, Wyoming), yielding a total of 22 strata. At the time of our study (in 2004), CWD had been found in free-ranging deer and/or elk in each state except Arizona and North Dakota. Each state's wildlife agency provided names and addresses of random samples of hunters ≥ 18 years of age who purchased a license to hunt deer or elk with a firearm.

Data Collection

Three mailings were used for administering questionnaires. Hunters were initially mailed a questionnaire, postage-paid return envelope, and letter explaining the study. Reminder postcards were sent to nonrespondents approximately 2 weeks after the initial mailing. A second complete mailing (questionnaire, return envelope, letter) was sent to nonrespondents approximately 3 weeks after the postcard reminder. Questionnaires were mailed to 22,320 hunters. Across all 22 strata, 773 questionnaires were undeliverable (e.g., incorrect address, moved) and 9,567 completed questionnaires were returned, yielding a 44% response rate ($9,567/[22,320 - 773]$). Among the strata, sample sizes ranged from 308 (33% response rate, Wyoming resident deer hunters) to 564 (56% response rate, Colorado nonresident elk hunters).

To check for nonresponse bias, hunters who completed a questionnaire were compared to those who did not. A sample of 785 nonrespondents were telephoned and asked 9 questions from the questionnaire. Responses were examined for differences between respondents and nonrespondents for each of the 22 strata. Only 31 of 198 (16%) tests for differences ($22 \text{ strata} \times 9 \text{ questions} = 198 \text{ tests}$) were significant at $P < 0.05$. Effect size statistics were from 0.01 to 0.24 and averaged only 0.09. Using guidelines from Cohen (1988) and Vaske (2019), these effect sizes suggest that the strength of any differences between respondents and nonrespondents was weak or minimal. Thus, our findings suggest that nonresponse bias was not a problem, so the data were not weighted.

Table 1. Reliabilities for perceived trust in the U.S. state agency to address CWD and perceived risks from CWD in 2004

Perceived trust and risk variables	\bar{X}	SD	Corrected item-total correlation	Cronbach's alpha if item deleted	Cronbach's alpha
I trust the state agency to: ^a					0.96
Provide the best available information on CWD issues	1.48	1.43	0.87	0.95	
Provide me with enough information to decide what actions I should take regarding CWD	1.42	1.47	0.88	0.95	
Provide truthful information about human safety issues related to CWD	1.56	1.46	0.88	0.95	
Provide timely information regarding CWD issues	1.37	1.51	0.89	0.95	
Make good deer or elk management decisions regarding CWD issues	1.28	1.57	0.85	0.95	
Properly address CWD in the state	1.36	1.53	0.88	0.95	
Risk to Humans					0.95
Inadvertently eating meat from an animal infected with CWD ^b	3.54	1.77	0.78	0.95	
Contracting a disease caused by CWD ^b	3.23	1.74	0.92	0.91	
Becoming ill as a result of contracting a disease caused by CWD ^b	3.28	1.79	0.93	0.91	
Because of CWD, how concerned are you about your own personal health ^c	2.96	1.84	0.85	0.93	
Risk to Wildlife ^c					0.94
Because of CWD, how concerned are you about:					
The health of the deer or elk population in the state	6.36	2.17	0.75	0.93	
Not having enough healthy deer or elk left to hunt in the state	5.87	2.42	0.85	0.92	
CWD spreading throughout the entire deer or elk population in the state	6.21	2.39	0.89	0.91	
The potential for CWD to dramatically reduce the deer or elk population in the state	6.20	2.34	0.90	0.91	
The potential for CWD to kill the entire deer or elk population in the state	5.07	2.78	0.77	0.93	

^a Variables recoded on 7-point scales: (−3) Strongly Disagree, (−2) Disagree, (−1) Slightly Disagree, (0) Unsure, (1) Slightly Agree, (2) Agree, (3) Strongly Agree.

^b Variables coded on 9-point scales: 1 and 2 (No risk), 3 and 4 (Slight risk), 5, 6, and 7 (Moderate risk), 8 and 9 (Extreme risk).

^c Variables coded on 9-point scales: 1 and 2 (Not at all concerned), 3 and 4 (Slightly concerned), 5, 6, and 7 (Moderately concerned), 8 and 9 (Extremely concerned).

Variables

Dependent variables.—Variables and response scales used in the questionnaires for measuring social trust, perceived risk to humans, and perceived risk to wildlife associated with CWD are in Table 1. The respective agency name (e.g., Colorado Parks and Wildlife, Nebraska Game and Parks Commission) was included in variables measuring trust. These trust and risk variables were similar to those used in other studies (Winter et al. 2004, Needham et al. 2017, Perry et al. 2017).

Independent variables.—There were 2 sets of independent variables. First, demographic variables measured in the questionnaires were sex, age, education, location of residence, and state of residence (Table 2). Second, hunting characteristics were presence or absence of CWD in the state, type of hunter (deer, elk), years hunting in the state, and harvest success (Table 3).

Analyses

Measurement reliability for trust and both risk concepts were examined using Cronbach's alpha (Vaske 2019). All the dependent variables were continuous. For the dichotomous independent variables (sex, state of residence, type of hunter, CWD presence, harvest success), bivariate independent-samples *t*-tests were used for comparing the means of the dependent variables. For the categorical independent variables (age, education, location of residence, years hunting in the state), bivariate one-way ANOVAs were used for comparing the means for each of the dependent variables. Differences between categories were

measured using Bonferroni post-hoc tests if variances were equal and Tamhane's T2 post-hoc tests if variances were not equal. Eta (η) was the effect size indicator; an η of ≤ 0.100 is considered a minimal relationship, 0.243 represented a typical relationship, and ≥ 0.371 reflected a substantial relationship (Vaske 2019). Multivariate hierarchical linear regression analyses were then conducted using trust and the 2 risk concepts as the dependent variables, and the demographic and hunting characteristics as the independent variables.

RESULTS

Means for all 6 items measuring trust in the agencies were positive and ranged from 1.28 to 1.56 (Table 1). Respondents, on average, slightly agreed that they trusted their state wildlife agency. The trust items had a high Cronbach's alpha reliability of 0.96. Means for the 4 items measuring risk to humans ranged from 2.96 to 3.54, which implied that, on average, respondents perceived slight risk to humans from CWD. Means for the 5 items measuring risk to wildlife ranged from 5.07 to 6.36, suggesting that hunters, on average, were moderately concerned about the health of deer and elk because of CWD. Reliabilities for these 2 risk indices were high at 0.95 (human risk) and 0.94 (wildlife risk). Deleting any items from the indices did not improve their reliabilities. Mean indices were computed for agency trust, risk to humans, and risk to wildlife.

Four of the 5 demographic variables were statistically related to trust (Table 2). Location of residence (farm, town, city) was the only exception. Males were more trusting of

Table 2. Wildlife agency trust and perceived risks from CWD by hunter demographic characteristics from 8 U.S. states surveyed (2004).

	Agency trust ^a				Human risk ^b				Wildlife risk ^c			
	Trust (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η	Human risk (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η	Wildlife risk (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η
Sex		2.22	0.027	0.026		0.42	0.678	0.005		0.67	0.503	0.007
Male	1.42				3.29				5.94			
Female	1.25				3.33				6.01			
Age		20.06	<0.001	0.081		3.41	0.017	0.033		1.44	0.228	0.021
18 to 30	1.24				3.14				5.90			
31 to 40	1.31				3.25				5.86			
41 to 50	1.34				3.31				5.93			
51 to 93	1.53				3.33				5.99			
Education		5.72	<0.001	0.051		8.54	<0.001	0.061		44.12	<0.001	0.138
<high school	1.72				3.42				6.22			
High school	1.46				3.38				6.16			
Associate's degree	1.36				3.32				6.10			
Bachelor's degree	1.39				3.17				5.62			
Advanced degree	1.36				3.12				5.35			
Location of residence		0.65	0.525	0.012		12.33	<0.001	0.052		23.40	<0.001	0.072
Farm	1.40				3.13				5.65			
Town	1.39				3.29				5.93			
City	1.43				3.36				6.07			
Residence of state where hunted		15.65	<0.001	0.165		8.14	<0.001	0.085		7.57	<0.001	0.078
Non-resident	1.61				3.17				5.79			
Resident	1.16				3.45				6.13			

^a Recoded on 7-point scales: -3 (Strongly Disagree), -2 (Disagree), -1 (Slightly Disagree), 0 (Unsure), 1 (Slightly Agree), 2 (Agree), 3 (Strongly Agree).

^b Coded on 9-point scales: 1 & 2 (No risk/concern), 3 & 4 (Slight risk/concern), 5, 6, & 7 (Moderate risk/concern), 8 & 9 (Extreme risk/concern).

^c Coded on 9-point scales: 1 & 2 (Not at all concerned), 3 & 4 (Slightly concerned), 5, 6, & 7 (Moderately concerned), 8 & 9 (Extremely concerned).

the state wildlife agencies than were females, but both groups were slightly in agreement that they trusted the agencies. The oldest age category (51 to 93) trusted the state agencies more than did the youngest group (18 to 30). The 2 middle categories (31 to 40 and 41 to 50) were statistically equivalent in their trust (Table 2). Respondents with <high school education were also more trusting of the agencies compared to more highly educated respondents. Non-resident hunters were also more trusting than residents. Despite the significance for 4 of these 5 tests, the effect sizes were all relatively minimal ($\eta = 0.012$ to 0.165), suggesting that significance was primarily driven by the large sample size ($n = 9,567$).

Differences between categories of each demographic variable for the human risk index were also significant in 4 of the 5 tests (Table 2). For these analyses, however, the exception was sex, as males and females perceived equivalent levels of risk to humans from CWD ($t = 0.42$, $P = 0.678$). Similar to trust, the oldest age group (51 to 90) reported the highest level of human risk and the youngest (18 to 30) perceived the lowest risk. The 2 middle age categories were once again statistically equivalent. Also similar to trust, the least educated group (less than high school) perceived the highest levels of human risk, whereas the most educated (advanced degree) perceived the lowest risk (Table 2). Unlike trust, human risk differed by location of residence. Individuals living on farms expressed the least amount of human risk, whereas those in cities expressed the highest human risk. Resident hunters expressed more human risk from CWD than did nonresidents. All means ranged from

3.12 to 3.45, suggesting that regardless of the variable, respondents perceived a slight risk of CWD to humans and that the statistical significance was again largely a function of the sample size. Further support for this is evident from the effect size values, which were all $\eta \leq 0.085$ (i.e., minimal relationships).

Three of the 5 demographic variables were statistically related to perceived risk of CWD to wildlife; sex and age were the exceptions (Table 2). All mean comparisons for the categories of education differed, except for the 2 lowest levels (<high school and high school) that were statistically equivalent, with risk decreasing as education increased. Hunters living on farms perceived the lowest risk of CWD to wildlife, whereas those in cities perceived the highest risk to wildlife. Resident hunters also reported higher wildlife risk than did nonresidents. Means for wildlife risk ranged from 5.35 to 6.22 (i.e., all moderate risks) and all effect sizes were minimal ($\eta = 0.007$ to 0.138).

Table 3 shows relationships between hunting characteristics (presence or absence of CWD in state, type of hunter, years hunting in state, harvest success) and both risk and trust. Three of the 4 tests related to trust were statistically significant. Those who had hunted in a state without CWD reported more trust in the state agencies than those who hunted in a state with the disease, although both groups were in the slightly trust range. Deer and elk hunters were statistically equivalent in their trust (Table 3). Individuals who had hunted in the state >20 years were significantly less trusting than those who had hunted ≤ 3 years. Hunters who had harvested a deer or elk were slightly more trusting than

Table 3. Wildlife agency trust and perceived risks from CWD by hunting characteristics of hunters from 8 U.S. states surveyed (2004).

	Agency trust ^a				Human risk ^b				Wildlife risk ^c			
	Trust (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η	Human risk (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η	Wildlife risk (X̄)	<i>t</i> or <i>F</i>	<i>P</i>	η
CWD present in the state at the time of the study ^d		7.20	<0.001	0.070		4.62	<0.001	0.045		3.83	<0.001	0.041
No	1.62				3.13				5.75			
Yes	1.37				3.33				5.98			
Are you a:		1.91	0.057	0.020		2.07	0.038	0.021		7.40	<0.001	0.075
Deer hunter	1.43				3.27				5.84			
Elk hunter	1.37				3.35				6.21			
How many years have you hunted deer/elk in this state?		37.56	<0.001	0.111		7.31	<0.001	0.049		10.53	<0.001	0.058
1 to 3	1.61				3.20				5.80			
4 to 9	1.51				3.24				5.84			
10 to 20	1.31				3.31				6.02			
21 to 70	1.23				3.41				6.11			
Did you harvest a deer/elk this year?		4.43	<0.001	0.048		6.86	<0.001	0.073		8.67	<0.001	0.091
No	1.34				3.41				6.15			
Yes	1.47				3.17				5.75			

^a Recoded on 7-point scales: -3 (Strongly Disagree), -2 (Disagree), -1 (Slightly Disagree), 0 (Unsure), 1 (Slightly Agree), 2 (Agree), 3 (Strongly Agree).

^b Coded on 9-point scales: 1 and 2 (No risk /concern), 3 and 4 (Slight risk /concern), 5, 6, and 7 (Moderate risk /concern), 8 and 9 (Extreme risk /concern).

^c Coded on 9-point scales: 1 and 2 (Not at all concerned), 3 and 4 (Slightly concerned), 5, 6, and 7 (Moderately concerned), 8 and 9 (Extremely concerned).

^d CWD was present in all states except Arizona and North Dakota at the time of this study.

those who were not successful. Given that means ranged from 1 to 2 on the response scale, hunters in all categories indicated that they slightly to moderately agreed they trusted the state wildlife agencies. The minimal effect sizes (i.e., $\eta \leq 0.111$) further support the observation.

All 4 of the hunting characteristics were significantly related to human risks from CWD (Table 3). Respondents who had hunted in a state where CWD was present perceived more risk than did those who hunted in a state without the disease. Elk hunters reported slightly more risk of CWD to humans than did deer hunters. Individuals who hunted deer or elk in the state for >20 years perceived more human risk than did those who hunted ≤ 3 years. Hunters who did not harvest a deer or elk perceived more risk of CWD to humans compared to successful hunters. All of the effect sizes, however, were $\eta < 0.073$, suggesting that all of these significant relationships were minimal in strength.

Results for the perceived risks of CWD to wildlife mirrored the findings for these risks to humans (Table 3). Those who perceived the most risk were those who were hunting in a state with CWD, were elk hunters, had hunted in the state for >20 years, and did not harvest an animal. All effect sizes were minimal ($\eta < 0.091$).

A series of hierarchical linear regression models determined the relative importance of each of the demographic and hunting characteristics on trust and the risk concepts when controlling for the other variables in the models. Three separate regressions were fitted for each of the 3 dependent variables (9 models total; Table 4). For trust in state wildlife agencies to address CWD, for example, one model included 6 demographic variables (sex,

age, education, living on a farm [no or yes], living in a city [no or yes], resident vs. nonresident hunter). A second model included only the 4 hunting characteristics (CWD presence in the state, deer vs. elk hunter, years hunting deer or elk in the state, harvested an animal). The full model included the 6 demographic variables and the 4 hunting characteristics as predictors. The set of 3 regressions was also run for both the risk of CWD to humans and the risk of CWD to wildlife.

Results for the model with demographics predicting trust in agencies to address CWD showed that age, education, and being a resident of the state where they hunted were significant predictors (Table 4). Older individuals, those with less education, and nonresidents were more likely to trust the agencies. This model, however, only explained 4.0% of the variance in trust. For the model with hunting characteristics predicting trust, CWD presence, years hunting in the state, and harvesting an animal were significant. Respondents who hunted in states without CWD, those with less experience hunting deer or elk in the state, and hunters who successfully harvested an animal were more likely to trust the agencies. The hunter characteristics model explained only 1.7% of the variance in trust. In the full model, 6 of the 10 predictors were significant: age, education, being a resident hunter, CWD presence, years hunting in the state, and harvesting an animal (Table 4). However, the significant predictors only explained 4.8% of the variance.

For the model with demographics predicting risks of CWD to humans, 4 of the 6 predictors were significant; the exceptions were sex and living in a city. The significant

Table 4. Effects of demographic and hunting characteristics on perceived wildlife agency trust and risks from CWD of hunters from 8 U.S. states surveyed (2004).

	Dependent variables – Trust and risks ^a					
	Reduced models			Entire – full models		
	Agency trust	Human risk	Wildlife risk	Agency trust	Human risk	Wildlife risk
Demographic characteristics						
Sex ^b						
Age ^c	0.08	0.05		-0.11	0.04	
Education ^d	-0.05	-0.06	-0.14	-0.05	-0.06	-0.14
Live on a farm ^e		-0.05	-0.06		-0.06	-0.06
Live in a city ^f			0.05			
Resident of state where hunted ^g	-0.16	0.09	0.07	-0.11	0.08	0.06
R ² (Socio-demographic model)	4.0%	1.5%	3.0%			
Hunting characteristics						
CWD present in state hunted ^h	-0.07	0.04		0.07	0.04	0.02
Deer or elk hunter ⁱ			0.06			0.06
Years hunting in state ^j	-0.10	0.05	0.06	-0.09		0.03
Harvested an animal ^k	0.04	-0.07	-0.08	0.04	-0.06	-0.07
R ² (Hunt or hunter characteristics model)	1.7%	1.0%	1.5%			
R ² (Entire /full model)				4.8%	2.0%	4.0%

^a Cell entries are standardized regression (beta) coefficients.

Only significant beta coefficients are shown. All coefficients shown are significant at $P < 0.001$.

^b Sex variable coded 0 (male) and 1 (female).

^c Age variable coded as continuous; range = 18 to 93.

^d Education variable coded 0 (less than high school), 1 (high school), 2 (two-year associate degree), 3 (four-year college), 4 (advanced degree).

^e Lives on a farm variable coded 0 (no) and 1 (yes).

^f Lives in a city variable coded 0 (no) and 1 (yes).

^g Resident of state where hunted variable coded 0 (non-resident) and 1 (resident).

^h CWD present in state hunted variable coded 0 (no) and 1 (yes).

ⁱ Type of hunter coded 0 (deer hunter) and 1 (elk hunter).

^j Years hunting in the state variable coded as continuous; range = 1 to 70 years.

^k Animal harvested variable coded 0 (no) and 1 (yes).

Model	Independent variables	Dependent variable
1	Demographics	Agency Trust
2	Hunting Characteristics	Agency Trust
3	Demographics	Human Risk
4	Hunting Characteristics	Human Risk
5	Demographics	Wildlife Risk
6	Hunting Characteristics	Wildlife Risk
7	Demographics and Hunting Characteristics	Agency Trust
8	Demographics and Hunting Characteristics	Human Risk
9	Demographics and Hunting Characteristics	Wildlife Risk

predictors were age, education, living on a farm, and being a resident hunter (Table 4). Older individuals, those with less education, those who did not live on a farm (town was the control group), and resident hunters reported more risk to humans. These demographics explained only 1.5% of the variance in risk to humans. For the model with hunting characteristics predicting human risk, 3 of the 4 predictors were significant: CWD present in the state, years hunting in the state, and harvesting an animal (Table 4). Perceived risks to humans increase when CWD is present, years hunting in a state increases, and the hunter was unsuccessful in harvesting a deer or an elk. Similar to the trust analyses, the type of game hunted (deer or elk) was not related to perceptions of risk to humans. Hunting characteristics only explained 1% of the variance in this risk. With all 10 variables in the full model, 4 demographic factors were

significant (sex and living in a city were the exceptions) and 2 hunting variables were significant (CWD present in the state, harvesting an animal) with only 2% of the variance in this human risk being explained by these predictors.

Results for the model with demographics predicting risks of CWD to wildlife showed that 4 variables were significantly related to higher risk (lower education, not living on a farm, living in a city, resident hunter). These demographics explained 3% of the variance in wildlife risks. For the model with hunting characteristics predicting higher wildlife risk, being an elk hunter, hunting longer in the state, and not harvesting an animal were significant. Type of hunter (deer, elk) was significant in the model predicting wildlife risk, but not in the model predicting human risks. Chronic wasting disease presence was significant in the human risk model, but not in the model predicting wildlife

risk. In the final full model, 3 of the 6 demographics were significant predictors of higher risk of CWD to wildlife (sex, age, and living in a city were the exceptions) and all 4 hunting variables were significant. The demographic and hunting characteristics explained 4.0% of the variance in perceived risks of CWD to wildlife.

DISCUSSION

We examined the extent to which 2 sets of independent variables (demographics, hunting characteristics) predicted 3 concepts related to CWD (trust in state wildlife agencies to manage CWD, perceived risks to humans from CWD, perceived risks to wildlife from CWD). The independent variables were selected because researchers and practitioners have repeatedly suggested that they are related to social-psychological concepts (e.g., trust, risk) that managers are concerned with relative to wildlife in general and CWD in particular (Mankin et al. 1999, Dougherty et al. 2003, Loyd and Miller 2010, Slovic 2010, Stern 2018).

Our findings indicated that the demographic and hunting characteristics are related to trust and perceived risk to both humans and wildlife, but these relationships are complex for a number of reasons. First, the bivariate analyses showed that the 5 demographic characteristics were statistically related to trust and the risk indices in 11 of the 15 tests. The average effect size in these 15 tests, however, was minimal. For the 4 hunting characteristics (CWD presence, deer or elk hunter, years hunted in state, harvest success), 11 of the 12 tests were statistically significant; the average effect size, however, was again minimal. Our findings highlight the importance of reporting both tests of statistical significance and effect size indicators, especially when sample sizes are large, because significance is common with large sample sizes, whereas effect sizes are influenced less by sample sizes (Cohen 1988, Vaske 2019). The multivariate regression models reinforced this conclusion. If the reduced and entire models are combined, there are 60 potential beta coefficients (another effect size indicator). Thirty-nine of these betas (65%) were statistically significant, yet the average coefficient was only 0.066.

Second, several relationships between the demographic and hunting characteristics and the trust and risk indices were consistent with past research, but not all of the characteristics affected trust and risk in the same way. Specific to the regression models, sex was never statistically significant in any of the equations. Education, being a resident of the state where they hunted, and harvest success were significant in all regressions. Those respondents with lower education reported more trust and higher risks, which is similar to studies of other natural resource issues (Sjöberg 2000, Hanisch-Kirkbride et al. 2013). Resident hunters were less trusting of agencies to manage CWD and perceived higher risks associated with this disease, and this is consistent with other CWD studies (Needham and Vaske 2006). Those respondents who harvested an animal perceived higher trust and lower risks. Chronic wasting disease presence and years hunting deer or elk in the state were significant in 5 of the 6 equations. When CWD was

present, trust was lower, which is consistent with past research (Brown et al. 2006, Vaske et al. 2018). Contrary to past research, however, risk perceptions were slightly higher in CWD states (Needham and Vaske 2006, Vaske et al. 2018). Respondents who hunted longer in the state perceived lower trust and greater risks. Respondents who lived on farms perceived less risk of CWD to humans and wildlife, and elk hunters perceived greater risk to wildlife, which is consistent with past research (Needham and Vaske 2006). Interestingly, age was positively related to trust in the reduced model and negatively associated with trust in the entire model, which illustrates a phenomenon known as the Simpson paradox and suggests that the number and type of different variables in models may moderate relationships between variables and in some situations even reverse the sign, especially when beta coefficients are small, such as those reported in our results here (≤ -0.11 ; Simpson 1951, Kock 2015).

Third, the average R^2 for the 3 demographic models was only 2.8% and the average R^2 for the 3 hunting characteristics models was only 1.4%. When the 10 variable full models were examined, the average R^2 was only 3.6%. Although this is an increase in explained variance, the R^2 has to increase when the number of variables increases (Vaske 2019). Moreover, this finding implies that at least 95% of the variance in trust and both human and wildlife risks remains unexplained. The relatively low levels of explained variance are partially a result of the principle of specificity, which refers to the level of correspondence between variables (Whittaker et al. 2006, Fishbein and Ajzen 2010, Vaske 2019). When correspondence between variables in their target, action, context, and/or time is similar, correlations and beta coefficients tend to be larger. For example, correlating a specific attitude about CWD in Wisconsin during 2019 with a specific intention to hunt deer in that state in 2019 would likely produce a large correlation. However, survey questions measuring demographic and hunting characteristics are general (not specific) variables. A response to a question about a person's age is a specific number (e.g., 22, 43, 56) and an individual's sex is also specific (e.g., male, female). In the context presented here, however, demographic variables would be considered general variables; general in the sense that a person who is 43 years old is still 43 regardless of other questions in the questionnaire such as trust in an agency or perceived risks to humans and wildlife. Correlating responses for general questions (e.g., age) with those for specific cognitions (e.g., agency trust, perceived risks to humans and wildlife associated with CWD) would be predicted to result in minimal relationships according to the principle of specificity because they differ in terms of target, action, context, and time. It is likely, therefore, that other variables, such as cognitions more specific to CWD (e.g., attitudes, beliefs, knowledge, intentions), would explain more of the variance (i.e., greater R^2) in both trust and risk associated with the disease. Our findings do not imply that questions measuring demographics or other characteristics should not be included in questionnaires. On the contrary, our results supported the

premise in previous research that demographics and other characteristics can be related to perceptions of trust and risk, albeit not strongly in our case.

As we noted earlier, risk perceptions can change over time. For example, before the discovery of CWD in Wisconsin, few people in the state had an attitude toward this disease (Stafford et al. 2007). Following the discovery, newspapers in Wisconsin published, on average, more than one article about CWD per day during 2002 (Heberlein and Stedman 2009). Hunters quickly developed an attitude toward CWD and perceived risks from this disease, which affected their behavior with license sales for the 2002 Wisconsin firearm deer season, declining by 90,000 following the discovery of CWD in the state (Vaske et al. 2004). Given that our data reported here were collected in 2004, the information provides a baseline for future investigations into relationships between demographic and hunting characteristics and both risk and trust related to CWD. Most CWD studies, including those using the same data that we used here, have investigated risks and trust in isolation, but not examined how these concepts relate to hunter demographics and other characteristics (Needham and Vaske 2006, 2008; Vaske and Lyon 2011). Over time, risk perceptions and behaviors in Wisconsin and some other states have changed with people now slightly less concerned about some effects of CWD, such as eating deer infected with the disease (Holsman et al. 2010; Vaske and Miller 2018, 2019; Holland et al. 2020). Contrary to risk, results from studies of agency trust associated with CWD showed mixed findings (Vaske et al. 2004, Needham and Vaske 2008, Harper et al. 2015, Vaske et al. 2018, Schroeder et al. 2021). Trust declined in some states, whereas it increased or remained the same in others. Our study provides a baseline for future research where we would expect that relationships between demographic and hunting characteristics and both trust and risk should remain similar to what we reported here (Vaske et al. 2001, Vaske and Manfredo 2012). Relationships between cognitions and background characteristics tend to be quite weak and remain relatively stable over time (Vaske et al. 2001, Vaske and Manfredo 2012).

Although our results did not show strong relationships between perceived risks and demographic and hunting characteristics, there is a certain segment of the population inherently predisposed to rate all risks as large (Sjöberg 2000). This phenomenon is known as risk sensitivity (Miller and Shelby 2009, Needham et al. 2017, Vaske and Miller 2019). Miller and Shelby (2009), for example, used cluster analysis to identify 3 clusters: no, slight, and moderate risk groups. The moderate risk-sensitive group reported the lowest hunting participation, were the most likely to change their hunting behavior due to the presence of CWD, and believed that CWD was a risk to humans. Needham et al. (2017) built on these findings and found that their most risk sensitive group of hunters was less informed and knowledgeable about CWD, but did not differ in demographic characteristics (sex, marital status, education, community size, age) compared to those who

perceived fewer risks. It is important to measure risk perceptions to determine the extent that groups of the population are sensitive to all potential risks (Miller and Shelby 2009; Vaske and Miller 2018, 2019). It is equally important to track perceptions of both risk and agency trust associated with CWD over time, and this represents a topic for continued empirical investigation.

MANAGEMENT IMPLICATIONS

Wildlife managers can use findings from studies of demographic and hunting characteristics to identify groups of the population or their clientele who need specific kinds of information and then tailor messaging and information campaigns to fit these specific target markets (Schuler et al. 2016). Given the weak relationships we found between demographic and hunting characteristics and both trust and risk associated with CWD, however, managers may not need to always target specific groups based on their demographics or hunting characteristics. The weak relationships suggest that managers should be cautious when using these characteristics for targeting communication messages about CWD to specific groups of hunters based on these characteristics because other groups with similar perceptions may be ignored. Instead, communications about CWD should be directed to all hunters and contain factual information about this disease presented in a manner that is understandable, efficient to digest, free of bias, and uses multiple ways of disseminating messages (e.g., traditional media, social media, hunting regulation publications). There has been some research on methods for communicating about CWD (e.g., Eschenfelder 2006, Vaske et al. 2006), but more is needed for informing managers of the most effective and efficient approaches.

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