THESIS

HUNTERS' RESPONSE TO CHRONIC WASTING DISEASE IN FOUR STATES

Submitted by

Katie M. Lyon

Department of Human Dimensions of Natural Resources

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2011

Master's Committee:

Advisor: Jerry J. Vaske

Maureen P. Donnelly
Kenneth R. Wilson

ABSTRACT

HUNTERS' RESPONSE TO CHRONIC WASTING DISEASE IN FOUR STATES

Chronic wasting disease (CWD) is a fatal transmissible spongiform encephalopathy (TSE) found in deer, elk, and moose. Although there is no evidence to suggest that CWD can be transmitted to humans, the possibility cannot be dismissed. Given similarities between CWD and other TSE diseases that cause human death (e.g., variant Creutzfeld-Jakob disease), wildlife agencies are concerned that possible unknown risks associated with CWD will erode hunters' willingness to hunt in states where the disease is found. This thesis presents two articles that examine the extent to which hunters would quit hunting in response to CWD using data from surveys (n = 3,519) of resident and nonresident deer hunters in four states.

The first paper examined how factors related and unrelated to CWD influence hunters to stop hunting deer in their state. A series of binary logistic regression models examined the influence of four dimensions of predictor variables: (a) prevalence of CWD in the state, (b) human impact, (c) perceived human health impacts from CWD, and (d) location of hunting participation (i.e., state, residency). Human death from CWD and perceived risks associated with the disease had the largest effect on hunter behavior. If CWD prevalence increases dramatically, participation in deer hunting in these four states will decrease substantially. If high prevalence is combined with human death from CWD and other significant predictors of hunter behavior, the decline will be even greater.

The second paper examined the extent to which interactions between prevalence, risk, residency, and state influence individuals to stop hunting deer in the state. Prevalence was the strongest predictor of quitting hunting in the state followed by human impact and perceived risk. State and residency were weak, but statistically significant predictors. Interactions among these predictors were hypothesized to increase potential for quitting hunting in the state. Multivariate log-linear analysis highlighted significant interactions; 12 two-way interactions, 6 three-way interactions, and 1 four-way interaction were statistically significant. Decisions to quit hunting in the state interacted with each of the five factors suggesting that they all influenced hunter behavior. The significant three-way interaction among quit hunting * perceived risk * resident, for example, indicated that nonresidents of the state who perceived greater risk were more likely to quit hunting deer in the state. This analysis illustrates the complexity of understanding hunter behavior in response to CWD.

ACKNOWLEDGEMENTS

I would like to thank several individuals for their support during my graduate studies. First, I would like to thank my advisor, Jerry Vaske, for encouraging me as an undergraduate to pursue a master's degree. I am grateful for his guidance and support, but most of all I am amazed at his patience. I would also like to thank my other committee members, Drs. Maureen Donnelly and Ken Wilson. Finally, I would like to thank Dr. Mark Needham for his assistance on earlier drafts of the two papers.

This thesis is based on a project of the Human Dimensions Committee of the Western Association of Fish and Wildlife Agencies (WAFWA). Appreciation is extended to Chris Burkett (Wyoming Game and Fish Department), Dana Dolsen (Utah Division of Wildlife Resources), Jacquie Ermer (North Dakota Game and Fish Department), Larry Gigliotti (South Dakota Department of Game, Fish and Parks), Ty Gray (Arizona Game and Fish Department), Larry Kruckenberg (Wyoming Game and Fish Department), Bruce Morrison (Nebraska Game and Parks Commission), Jordan Petchenik (Wisconsin Department of Natural Resources), Duane Shroufe (Arizona Game and Fish Department), and Linda Sikorowski (Colorado Division of Wildlife).

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I. INTRODUCTION

Chronic wasting disease (CWD) is a neurological disease affecting free-ranging and captive cervids, including deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and moose (*Alces alces*) (Baeten, Powers, Jewell, Spraker, & Miller, 2007; Williams, Miller, Kreeger, Kahn, & Thorne, 2002). CWD belongs to a family of transmissible spongiform encephalopathy (TSE) diseases, which are characterized by the conversion of normal prion proteins (PrP) to an abnormal form. Aside from CWD, well-known TSE diseases include scrapie in sheep and goats, bovine spongiform encephalopathy (BSE) or "mad cow disease" in cattle, transmissible mink encephalopathy (TME), and Creutzfeldt–Jakob disease (CJD) in humans. Characteristics of the disease include excessive salivation, loss of coordination, abnormal behavior, and emaciation. There is no known treatment for CWD and the disease is always fatal (Williams et al., 2002).

CWD was first identified in captive deer and elk in Colorado and Wyoming in the 1960s and 1970s (Williams & Young, 1980, 1982), and free-ranging herds in both states in the 1980s and 1990s (Spraker et al., 1997). The disease is currently known to exist in free-ranging herds in 15 states (Colorado, Illinois, Kansas, Maryland, Minnesota, Nebraska, New Mexico, New York, North Dakota, South Dakota, Utah, Virginia, West Virginia, Wisconsin, Wyoming) and two Canadian provinces (Alberta, Saskatchewan). CWD has also been identified in captive herds in four additional states (Michigan, Missouri, Montana, Oklahoma) and in South Korea. Evidence suggests that CWD is

likely to spread across North America and there is little wildlife managers can do to stop it (Haney, 2009; James, 2008).

Human Dimensions of CWD

The continued spread of CWD to numerous states and provinces has increased interest and concern about the disease among wildlife managers, hunters, and other stakeholders (Arnot, Laate, Unterschultz, & Adamowicz, 2009; Williams et al., 2002; Wisconsin Department of Natural Resources, 2009). While there is currently no scientific evidence that CWD poses a human health risk, wildlife agencies are concerned that perceptions of potential unknown risks associated with CWD may erode hunters' willingness to hunt in areas where the disease is found (Heberlein, 2004). Declines in hunting due to CWD are of concern to wildlife managers because they can: (a) reduce license sale revenues, (b) limit an agency's ability to manage game species, (c) decrease support for wildlife agencies, (d) impact other wildlife management programs (e.g., habitat improvement) if funds get diverted to address CWD, and (e) constrain cultural traditions and the social and economic stability of communities dependent on hunting (Needham, Vaske, & Manfredo, 2004). Given these potential consequences, most human dimensions research on CWD has focused on the extent to which hunters might change their behavior in response to CWD.

Behavioral Intentions

Studies conducted soon after discovery of CWD in some states showed that few hunters (< 10%) would change their hunting frequency or location (e.g., Gigliotti, 2004; Miller, 2003, 2004). At existing CWD prevalence levels, hunters were likely to watch for abnormal behavior in animals, submit animals for testing, and / or not eat meat from

harvested animals (Brown et al., 2006; Gigliotti, 2004; Miller, 2003, 2004; Vaske, Timmons, Beaman, & Petchenik, 2004). Several studies have examined hunters' response to hypothetical scenarios depicting manipulated levels of CWD prevalence (e.g., 5% of deer infected). At low levels of prevalence most hunters indicated that they would not change their hunting behavior.

Risk research, however, suggests that human behavior in response to risk is primarily influenced by two factors: (a) high probability of a hazard occurring, and (b) severe consequences associated with the hazard (Adams & Smith, 2001; Sjoberg, 1999; Thompson & Dean, 1996). Needham et al. (2007; 2004; 2006) examined the response of hunters to hypothetical scenarios of increasing CWD prevalence levels (e.g., 10 to 50% of deer infected) and human health risks (i.e., death) in eight states. Across scenarios and states: (a) hunters were more likely to quit hunting deer or elk rather than switch states to hunt these species, (b) residents were more likely to quit hunting and nonresidents were more likely to hunt in other states, and (c) novice hunters or those new to hunting were more likely to quit while veteran hunters would switch states.

An individual's behavioral decision, however, is seldom based on actual probabilities. Rather, people are influenced by other factors such as controllability (i.e., perception of being in control or having a choice), timing (i.e., whether the consequences are immediate or delayed), and media attention (Adams & Smith, 2001; Gore et al., 2009; Heberlein & Stedman, 2009; Sjöberg, 1998). The discovery of CWD in Wisconsin, for example, coincided with an outbreak of mad cow disease in Europe. Despite public officials' assurances that mad cow disease could not be transmitted to humans, a TSE disease had jumped the species barrier and caused human deaths (Heberlein, 2004).

Hunter numbers declined by about 11% in Wisconsin following the discovery of CWD (Heberlein, 2004) and research suggested that human health-related concerns associated with CWD contributed to approximately half of this decline (Vaske et al., 2004). Thus, the perceived risks associated with CWD may be an important constraint to hunting participation.

Perceptions of Risk

Perceived risk is defined as the degree to which individuals believe that they are exposed to some hazard or danger (Siegrist & Cvetkovich, 2000; Sjöberg, 2000b). Perceptions of risk are subjective and can influence decision-making and behavior under uncertainty (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Siegrist, Gutscher, & Earle, 2005). Hunters concerned about CWD, for example, may stop hunting or avoid consuming deer, elk, or moose (Miller, 2004). Factors that influence perceived risk include newness (i.e., new / old risk), knowledge (i.e., unknown / known risk), and severity of the risk (i.e., fatal / not fatal) (Fischhoff et al., 1978). CWD is a relatively new risk and has unknown consequences for human health.

Studies addressing risk perceptions of CWD have consistently shown that deer hunters are concerned or worried about the effects of CWD on human health. Two-thirds of South Dakota hunters, for example, were worried about CWD (Gigliotti, 2004). In Illinois, many hunters were concerned about effects of CWD on deer and believed that the disease could infect humans (Miller, 2004). The majority of New York hunters were concerned about effects of CWD on hunting, human health, and deer health (Brown et al., 2006). Following discovery of CWD in Wisconsin, hunters who did not hunt because of CWD were 16 times more likely than hunters to perceive risks associated with the disease

(Vaske et al., 2004). Most hunters in the eight state regional study agreed that that CWD poses a risk to humans, may cause disease in humans, and they and their families were concerned about eating deer or elk (Needham & Vaske, 2006, 2008). These findings indicate that perceptions of CWD risk could significantly impact hunting behavior.

Concerns about CWD have also been attributed to its similarity with related diseases that can cause human death (e.g., mad cow, Creutzfeldt-Jakob) (McKintosh, Tabrizi, & Collinge, 2003). Miller and Shelby (2009), for example, found that hunters perceived the risk of becoming ill from CWD and mad cow disease as similar. Needham and Vaske (2009) examined relationships between hunters' perceptions of risk associated with CWD and other hunting and wildlife hazards. Based on hunters' perceptions of five perceived personal health risks associated with CWD (e.g., become ill from CWD, concern for own health), three groups were identified: no risk (42%), slight risk (44%), and moderate risk (14%). Hunters who perceived higher personal CWD risk were most likely to: (a) be more concerned about effects of CWD on wild animal populations (e.g., threat to herd, killing entire herd), (b) report higher perceptions of risk associated with other hunting related hazards (e.g., getting lost, shot), and (c) perceive greater threats to the future of hunting (e.g., regulations, limited land and access). These findings illustrate risk sensitivity where hunters who perceived higher CWD risk had an inherent predisposition to rate all risks as large.

One recent study suggests that some of the perceived risks associated with CWD may be waning. Cooney (2008) asked Wisconsin hunters to list what immediately comes to mind when they think about CWD. A content analysis of this open-ended question revealed 12 different themes (e.g., disease is natural, no worries) and suggested that time

and experience with CWD may have tempered some of the initial concerns identified in other studies.

Overall, however, psychological factors such as perceived risk can play a substantial role in hunters' decisions to hunt. Understanding concerns and perceptions of risk related to CWD can provide insight into how hunters and other stakeholder groups might react to further increases in CWD prevalence, which is essential for determining the necessity and potential effectiveness of management techniques and information campaigns. General understanding of risk perceptions can also facilitate proactive risk management (Decker et al., 2006) and can assist in planning for the next potential wildlife disease outbreak (Vaske, Shelby, & Needham, 2009).

Thesis Purpose and Organization

The first article in this thesis (chapter two) builds on the Needham et al. (2004) study by using more extensive data (n = 3,519) to examine hunters' decisions not to hunt in the state. Needham et al. (2004) measured the extent to which (a) prevalence of CWD in the state, (b) human impact, and (c) residency influenced hunters to stop hunting deer in their state. This paper additionally examines the influence of perceived human health risks from CWD on hunters' decisions to quit hunting in the state. The second article (chapter three) builds on the first article by examining the extent to which interactions between the predictor variables (i.e., prevalence, risk, residency, and state) influence individuals to stop hunting deer in the state. Because these papers were designed for separate submissions, the introduction and methods sections are similar.

CHAPTER II. PREDICTING HUNTING PARTICIPATION IN RESPONSE TO CHRONIC WASTING DISEASE IN FOUR STATES

Introduction

Chronic wasting disease (CWD) is a naturally-occurring prion disease in deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and moose (*Alces alces*) (Baeten et al., 2007; Williams & Young, 1980, 1982). CWD belongs to a family of transmissible spongiform encephalopathy (TSE) diseases, which includes bovine spongiform encephalopathy in cattle (i.e., BSE, mad cow), scrapie in sheep, and Creutzfeldt-Jakob disease in humans (McKintosh et al., 2003). The disease causes excessive salivation, loss of coordination, abnormal behavior, emaciation, and death in all infected animals. Although there is no evidence to suggest that CWD can be transmitted to humans, as has been shown for BSE, the possibility cannot be dismissed (Belay et al., 2004; Raymond et al., 2000; Salman, 2003).

To date, CWD has been found in free-ranging cervids in 15 states (Colorado, Illinois, Kansas, Maryland, Minnesota, Nebraska, New Mexico, New York, North Dakota, South Dakota, Utah, Virginia, West Virginia, Wisconsin, Wyoming) and two Canadian provinces (Alberta, Saskatchewan). CWD has also been identified in captive herds in four additional states (Michigan, Missouri, Montana, Oklahoma) and in South Korea.

Given its similarity to mad cow disease, CWD has emerged as a disease of concern among wildlife managers, hunters, and other stakeholders (Schauber & Woolf, 2003; Williams et al., 2002). Hunting declines attributable to CWD have occurred in some states (Bishop, 2004; Heberlein, 2004; Vaske et al., 2004). If CWD conditions continue to worsen, several states may experience a substantial decrease in hunting participation (Needham et al., 2004).

This article examined the extent to which prevalence, potential and perceived human health risks of CWD influence hunters to stop hunting deer in four states (Arizona, North Dakota, South Dakota, Wisconsin). In South Dakota, a single free-ranging deer tested positive for CWD during the beginning of the 2002 hunting season; additional deer and elk tested positive in 2003 (Gigliotti, 2004). CWD was first discovered in the south central part of Wisconsin in February 2002; three white-tailed deer tested positive for the disease (Wisconsin Department of Natural Resources, 2002). At the time this study was conducted, CWD had not been diagnosed in deer or elk in Arizona or North Dakota; however, it was of concern in both states.

Review of Literature

Human Dimensions of CWD

Hunting participation has declined in North America (Brown, Decker, Siemer, & Enck, 2000; Heberlein & Thomson, 1996; Li, Zinn, Barro, & Manfredo, 2003; Mehmood, Zhang, & Armstrong, 2003; Miller & Vaske, 2003). Personal (e.g., age, lack of time for hunting) and situational (e.g., lack of available land to hunt, too many regulations) constraints have contributed to decreased hunter participation (Miller & Vaske, 2003). Wildlife agencies, however, are concerned that hunters' perceptions of

potential risks associated with CWD could exacerbate this decline in states where the disease is found (Gigliotti, 2004; Schauber & Woolf, 2003; Williams et al., 2002). In Wisconsin, for example, hunting participation decreased as a result of CWD (Bishop, 2004; Heberlein, 2004; Vaske et al., 2004).

Declines in hunting due to CWD are of concern to wildlife managers because the disease can: (a) reduce license sale revenues, (b) limit an agency's ability to manage game species, (c) decrease support for wildlife agencies, (d) impact other wildlife management programs (e.g., habitat improvement) if funds get diverted to address CWD, and (e) constrain cultural traditions and the social and economic stability of communities dependent on hunting (Needham et al., 2004).

Given these potential consequences of CWD, research has focused on the extent to which hunters might change their behavior in response to CWD (Gigliotti, 2004; Miller, 2003; Vaske et al., 2004). Most studies have examined hunters' response to hypothetical scenarios depicting manipulated levels of CWD prevalence (e.g., 5% of deer infected). Much of this research, however, manipulated relatively low levels of prevalence and most hunters indicated that they would not change their hunting behavior.

Risk research has identified two primary determinants of human behavior in response to disease: (a) high prevalence of a disease, and (b) severe human consequences of a disease (Adams & Smith, 2001; Sjöberg, 1999; Stonehouse & Mumford, 1994; Thompson & Dean, 1996). Needham et al. (2004), for example, found that if CWD prevalence ever increased dramatically (e.g., 50% infection rate), up to 49% of hunters would stop hunting deer or elk in several states. The decline would be even greater (e.g., 65%) if high prevalence is combined with threats to human health such as death from

CWD. In addition, nonresident hunters were more likely than residents to report that they would stop hunting.

An individual's behavioral decision, however, is seldom based on actual probabilities. Rather, people are influenced by other factors such as controllability (i.e., perception of being in control or having a choice), timing (i.e., whether the consequences are immediate or delayed), and media attention (Adams & Smith, 2001; Gore et al., 2009; Heberlein & Stedman, 2009; Sjöberg, 1998). The discovery of CWD in Wisconsin, for example, coincided with an outbreak of mad cow disease in Europe. Despite public officials' assurances that mad cow disease could not be transmitted to humans, a TSE disease had jumped the species barrier and caused human deaths (Heberlein, 2004). Hunter numbers declined by about 11% in Wisconsin following the discovery of CWD (Heberlein, 2004) and research suggested that human health-related concerns associated with CWD contributed to approximately half of this decline (Vaske et al., 2004). Thus, the perceived risks associated with CWD may be an important constraint to hunting participation.

Perceived Risk

Perceived risk is defined as the degree to which individuals believe that they are exposed to some hazard or danger (Siegrist & Cvetkovich, 2000; Sjöberg, 2000a). Perceptions of risk are subjective and can influence decision making and behavior under uncertainty (Fischhoff et al., 1978; Siegrist et al., 2005). Hunters concerned about CWD, for example, may stop hunting or avoid consuming deer, elk, or moose (Miller, 2004). Factors that influence perceived risk include newness (i.e., new / old risk), knowledge (i.e., unknown / known risk), and severity of the risk (i.e., fatal / not fatal) (Fischhoff et

al., 1978). CWD is a relatively new risk and has unknown consequences for human health.

Studies addressing risk perceptions of CWD have consistently shown that deer hunters are concerned or worried about the effects of CWD on human health (Brown et al., 2006; Gigliotti, 2004; Miller, 2004). Majorities of hunters in eight states agreed that CWD may be a risk to humans, and that their families were concerned about eating deer or elk meat because of CWD (Needham & Vaske, 2006; Needham et al., 2006). The majority of Wisconsin hunters who did not hunt in 2002 were moderately or strongly influenced by perceived risks associated with CWD (Vaske et al., 2004), indicating that perceptions of CWD risk could significantly impact hunting behavior.

Using preliminary data (n = 659) from a regional study, Needham et al. (2004) examined the extent to which prevalence of CWD in the state, human impact, and residency influenced hunters to stop hunting deer in their state. This article builds upon Needham et al. (2004) by (a) using more extensive data (n = 3,519) and (b) incorporating additional variables (i.e., perceived risk, state) into the model. Three questions are addressed. First, to what extent do various hypothetical degrees of CWD prevalence and distribution in the state influence deer hunters' decision to quit hunting in a state? Second, to what extent will hypothetical (as described in the survey) and perceived human health risks affect hunter's decisions to quit hunting? Third, what other factors (state, residency) influence dropout decisions?

Methods

Description of Sample

Data were obtained from mail surveys of resident and nonresident deer hunters in Arizona, North Dakota, South Dakota, and Wisconsin (n = 3,519). CWD had been identified in free-ranging deer in South Dakota and Wisconsin but not Arizona or North Dakota. The study population consisted of hunters who were 18 years of age or older and purchased a nonresident or resident license to hunt deer with a gun in 2003. Random samples of hunter names, addresses, and telephone numbers were obtained from the wildlife / game and fish agency of each participating state.

Three mailings were used to administer the surveys beginning July 2004. Hunters were sent a survey, postage-paid return envelope, and cover letter. Non-respondents were sent a postcard reminder two weeks after this initial mailing. A second full mailing (i.e., survey, return envelope, letter) was sent to non-respondents three weeks after the postcard reminder. Surveys were mailed to a total of 8,163 hunters. Across all states and strata, 249 surveys were undeliverable (e.g., moved, incorrect addresses) and 3,519 completed mail surveys were returned, yielding a 44% response rate (3,519 / 8,163 – 249). Sample sizes were 1,976 for nonresident hunters (50% response rate) and 1,543 (39% response rate) for residents (for details, see Needham, Vaske, & Manfredo, 2006).

To check for non-response bias, hunters who completed a survey were compared to those who did not. A sample of 785 non-respondents (376 nonresidents, 409 residents) was telephoned in November 2004 and asked nine survey questions. Responses to five questions were statistically different ($p < .001$) between respondents and non-respondents, but statistical significance is inflated by large sample sizes (Vaske, 2008).

Effect sizes (V, r_{pb}) were < .15, indicating "weak" (Cohen, 1988) or "minimal" (Vaske, 2008) differences between the two groups. Non-response bias was thus not deemed a problem and data were not weighted based on the non-response check. In each state, however, more residents than nonresidents purchased a license to hunt deer with a gun in 2003. Given the sampling design, more surveys were received from nonresidents than residents. The data were weighted to reflect the population proportions of hunters.

Independent Variables

Computer generated maps were used to depict hypothetical situations of varying CWD human health risks (e.g., human death) and increasing levels of CWD prevalence among deer in three zones across each state. In two of the states (South Dakota, Wisconsin), zone A represented the area where the disease had been detected in free-ranging populations and had the highest prevalence. For Arizona and North Dakota, zone A represented the most likely region for CWD to be detected. The decision of where to situate zone A was made by each wildlife/game and fish agency. For all state maps, zones B and C were similar in size. For most states, CWD had not been detected in free-ranging deer in zone C, which was considered by each agency to be the least likely location for high rates of CWD infection to occur. All three zones for each state were based on hunt management units.

Maps in the surveys depicted four separate hypothetical situations of increasing CWD prevalence and distribution: (a) 10% prevalence in zone A, 0% in zones B and C; (b) 30% in zone A, 10% in zone B, 0% in zone C; (c) 50% in zone A, 30% in zone B, 10% in zone C; and (d) 50% in all three zones (i.e., across the entire state). Two additional hypothetical situations depicted prevalence levels and human health risks: (a)

10% prevalence in zone A, 0% in zones B and C, and "a hunter in the state has died from eating CWD infected deer meat;" and (b) 50% prevalence in all three zones and "a hunter in the state has died from eating CWD infected deer meat." These situations reflect the two main predictors of disease-related behavior – disease prevalence and human health risks (Amnon, 2002; Sugihantono et al., 2003; Yates, 1992). To emphasize the hypothetical nature of these situations, survey respondents were assured that the situations were "imaginary" (hypothetical) and did not necessarily reflect current conditions or consequences to humans.

Prevalence. Prevalence was computed by averaging the percent prevalence in each of the three zones. This resulted in four prevalence values: (a) 3% prevalence statewide (10% in zone A, 0% in zone B, and 0% in zone C), (b) 13% prevalence statewide (30% in zone A, 10% in zone B, and 0% in zone C), (c) 30% prevalence statewide (50% in zone A, 30% in zone B, and 10% in zone C), and (d) 50% prevalence statewide (50% in zones A, B, and C).

Human impact. Human health risk was a dummy variable coded as 0 "no effect of CWD on human health" and 1 "CWD transmissible to humans and hunters have died from CWD."

Perceived risk. Individuals' perceived risk regarding CWD was assessed using a 6-item standardized index (Cronbach alpha = .91). The first question in the index asked respondents to what extent they disagreed or agreed that because of CWD, they have concerns about eating deer meat. Responses were measured on a 7-point scale from: (1) strongly disagree to (7) strongly agree. A second question asked respondents because of CWD, how concerned are you about your own personal health. Responses were measured

on a 9-point scale from: (1) not at all concerned to (9) extremely concerned. The remaining four questions asked respondents to indicate how much risk they associated with (a) inadvertently eating meat from an animal infected with CWD, (b) contracting a disease caused by CWD, (c) becoming ill as a result of contracting a disease caused by CWD, and (d) death as a result of contracting a disease caused by CWD. Responses were measured on a 9-point scale from: (1) no risk to (9) extreme risk. Since questions were asked on different scales, scores were standardized.

State and residency. The four states were dummy coded with South Dakota being the reference group. The residency dummy variable was coded as 0 "nonresident hunter" and 1 "resident hunter."

Dependent Variable

To measure the extent to which CWD prevalence, distribution, and human health risks influenced hunters' willingness to continue hunting in their state, respondents evaluated each hypothetical situation and indicated if they would: (a) hunt deer in the zone in the state that they hunt deer in most often; (b) hunt deer in the state, but switch to a different zone; (c) give up deer hunting in the state, but hunt deer in another state; or (d) give up deer hunting altogether. The respective state name was provided in the response items for each survey. For analysis purposes, the first two response items were collapsed into one category labeled 0 "still hunt deer in the state;" the last two items were recoded into 1 "stop hunting deer in the state."

Data Analysis

Four binary logistic regression equations were used to estimate the percentage of hunters that would stop hunting deer in their state as a function of the independent variables (i.e., prevalence, human impact, perceived risk, state, residency).

Results

The first logistic regression examined the influence of CWD prevalence on the probability that Arizona, North Dakota, South Dakota or Wisconsin deer hunters will stop hunting deer in the state. This analysis resulted in the following equation:

$$ln(\text{odds}) = -2.362 + .047(\text{P}) \quad (1)$$

where P = the average CWD prevalence in the state (Nagelkerke $R^2 = .21$). The predicted odds of hunters stopping deer hunting in the state is given by the equation, odds = $\exp^{ln(\text{odds})}$. The calculation, odds/(1 + odds), estimates the percentage of hunters that will stop hunting deer in the state. Table 1 shows that the percentage of hunters that will stop hunting deer in the state increases as prevalence and distribution increase. As prevalence increases, the percent stopping hunting increased from 10% (10% CWD prevalence in zone A, 0% in zones B and C) to 50% (50% CWD prevalence across state).

Table 2.1 Probabilities that Hunters will Stop Hunting Deer in the State for Each Situation Related to CWD Prevalence (Model 1)

Prevalence			
Zone A (%)	Zone B (%)	Zone C (%)	Probability
10	0	0	.10
30	10	0	.15
50	30	10	.28
50	50	50	.50

The second logistic regression examined the influence of CWD prevalence and potential human impact (i.e., no evidence that CWD poses a health risk to humans, hunter death from CWD) on the probability that hunters will stop hunting deer in the state. The resulting equation was:

$$ln(\text{odds}) = -2.701 + .045(\text{P}) + 1.110(\text{D}) \quad (2)$$

where D = dummy variable of 0 "no effect of CWD on human health" and 1 "CWD transmissible to humans, hunter death from CWD" (Nagelkerke $R^2 = .26$). If CWD is not shown to be transmissible to humans and 10% of the deer in zone A are infected with the disease, 7% of hunters would stop hunting deer in Arizona, North Dakota, South Dakota or Wisconsin (Table 2). This percentage increased to 39% if 50% of the deer across the entire state are infected with CWD. If a hunter ever dies from CWD and 50% of the deer are infected, 66% of hunters would stop hunting deer in these states.

Table 2.2 Predicted Probabilities that Hunters will Stop Hunting Deer in the State for Each Situation Related to CWD Prevalence and Potential Human Impact (Model 2)

	Prevalence				
Scenario	Zone A (%)	Zone B (%)	Zone C (%)	Human Impact	Probability
1	10	0	0	No	.07
2	30	10	0	No	.11
3	50	30	10	No	.21
4	50	50	50	No	.39
5	10	0	0	Death	.19
6	50	50	50	Death	.66

The third logistic regression explored the effect of CWD prevalence, human impact, and perceived human health risk on the probability that hunters will stop hunting deer in the state. This analysis resulted in the following equation:

$$ln(\text{odds}) = -2.840 + .048(\text{P}) + 1.167(\text{D}) + .621(\text{R}) \quad (3)$$

where R = perceived risk (Nagelkerke R^2 = .31). In Scenario 1, where 10% of deer are infected in zone A and no human impact occurs, only 3% of hunters who perceived no risk would quit hunting compared to 31% of hunters that perceived high risk (Table 3). If 50% of deer are infected across the state and a human death occurs, about half of hunters that perceived no human health risks associated with CWD would quit hunting. However, if hunters perceived a high amount of risk, given the same situation, the probability of quitting was 93%.

Table 2.3 Predicted Probabilities that Hunters will Stop Hunting Deer in the State for Each Situation Related to CWD Prevalence, Human Impact, and Perceived Risk (Model 3)

	Prevalence				Probability	
Scenario	Zone A (%)	Zone B (%)	Zone C (%)	Human Impact	No Risk	Extreme Risk
1	10	0	0	No	.03	.31
2	30	10	0	No	.05	.42
3	50	30	10	No	.10	.61
4	50	50	50	No	.22	.81
5	10	0	0	Death	.09	.59
6	50	50	50	Death	.48	.93

The final logistic regression explored the effect of CWD prevalence, human impact, perceived human health risk, and location on the probability that resident or nonresident hunters will stop hunting deer in the state. The resulting equation for the final model was:

$$ln(\text{odds}) = -2.73 + .048(\text{P}) + 1.187(\text{D}) + .661(\text{R}) - .417(\text{Resident}) + .027(\text{AZ}) + .338(\text{ND}) - .266(\text{WI}) \quad (4)$$

where Resident = residency dummy variable of 0 “nonresident hunter” and 1 “resident hunter;” AZ = Arizona dummy variable; ND = North Dakota dummy variable; and WI =

Wisconsin dummy variable (South Dakota is the reference group, Nagelkerke R^2 = .33). Similar to the previous model, hunters were more likely to quit as CWD prevalence, human impact, and perceived risk increased. Nonresidents and North Dakota hunters were more likely to quit while Wisconsin hunters were least likely to quit (Table 2.4). This model correctly classified 78% of hunters and explained 33% of the variance in hunters' decisions to quit hunting.

Table 2.4 Final Logistic Regression Model Predicting Resident and Non-resident Hunters that will Stop Hunting Deer in the State (Model 4)

Predictor	β	*SE*	Odds ratio	Wald statistic	*p*-value
Constant	-2.73	.05	.07	2853.14	< .001
Prevalence	.05	<.01	1.05	2580.30	< .001
Human impact	1.19	.04	3.28	983.39	< .001
Personal risk	.66	.02	1.94	878.46	< .001
Resident	-.42	.04	.66	122.06	< .001
Arizona	.03	.05	1.03	.28	.599
North Dakota	.34	.05	1.40	45.37	< .001
Wisconsin	-.27	.05	.77	25.34	< .001

Each model showed a significantly better statistical fit over the previous model (Table 2.5). Prevalence alone explained 21% of the variance in hunters' decision to quit hunting in the state. Human impact and perceived human health risks each explained an additional 5% variance when added to the model; state and residency only explained an additional 2% variance. Models 3 and 4 both correctly classified 78% of the hunters.

Table 2.5 Logistic Regression Model Comparison

Model	Variables in Equation	Nagelkerke R^2	-2*LL*	$\Delta\chi^2$	df	*p*-value
0	Constant only	---	23471.35	---	---	---
1	Model 0 + Prevalence	.21	20386.20	3085.15	1	< .001
2	Model 1 + Manipulated human health risk from CWD	.26	19446.01	940.19	2	< .001
3	Model 2 + Perceived human health risk from CWD	.31	18605.51	840.50	3	< .001
4	Model 3 + Residency and State	.33	18345.56	259.95	7	< .001

Discussion

This article examined the extent to which potential CWD prevalence and human health risks influenced deer hunters' decision to continue hunting deer in a state. The study also examined differences among four states and between resident and nonresident deer hunters. Findings demonstrated that potential conditions related to the disease could influence a large portion (e.g., over 50%) of deer hunters to change their hunting behavior; this number was even greater if hunters perceived that there are human health risks related to CWD (e.g., over 80%).

State and residence effects were small. In Wisconsin, where there is a strong deer hunting tradition (Heberlein, 2004; Vaske et al., 2004), hunters were least likely to change their behavior. Perhaps hunters in this state were also more likely to discount hypothetical information because of their real-world experience with CWD. This study took place two years after the discovery of CWD in Wisconsin, where intense media coverage made CWD a salient issue (Heberlein & Stedman, 2009). In states where CWD had not been found at the time of this study (Arizona, North Dakota), hunters were most likely to change their behavior. Humans often attribute higher risk to hazards that are new

or unknown (e.g., CWD) and this risk can influence behavior (e.g., Fischhoff et al., 1978; Sjöberg, 2000a; Slovic, 1987). Similar to Needham et al. (2004), nonresident hunters were less likely than residents to continue hunting deer in the state as CWD conditions worsened. Findings have implications for management, theory, and research.

Management Implications

The prevalence of CWD in any state varies by location, and the sex and age of the deer (e.g., yearlings vs. adults). Given CWD prevalence levels (i.e., scenario 1) in some states (e.g., Wisconsin, South Dakota), our findings suggest approximately 10% of hunters would stop hunting deer in the state. This suggests that agencies may experience only minor declines in revenue from hunting license sales if CWD conditions do not worsen. This is consistent with other studies (Gigliotti, 2004; Miller, 2004; Needham et al., 2004; Petchenik, 2003; Vaske et al., 2004) and implies that almost all hunters will continue hunting deer in their state if CWD conditions do not dramatically deteriorate. As prevalence increases, however, the likelihood of hunters quitting increases, even when perceived risks are low and no human death has occurred. If half of the deer ever have CWD, perceived risk is high, and human death occurs from the disease (i.e., scenario 6), approximately 93% of hunters would switch to other states or give up hunting altogether.

Findings reported in this paper and by others (e.g., Gore et al., 2009; Heberlein & Stedman, 2009; Vaske et al., 2009) suggest that psychological factors such as perceived risk play a substantial role in hunters' decisions to hunt. Although human death from CWD is unlikely, some studies suggest that many hunters are concerned about their health and think that they are at risk of becoming ill from the disease (Needham & Vaske, 2006; Vaske et al., 2004). Other studies indicate few hunters are concerned about

potential human health impacts of CWD (Cooney & Holsman, 2010; Gigliotti, 2004; Holsman & Petchenik, 2006; Miller, 2004). Understanding risk perceptions is essential for determining the necessity and potential effectiveness of management techniques and information campaigns (Vaske et al., 2009). General understanding of risk perceptions can also facilitate proactive risk management (Decker et al., 2006) and can assist in planning for the next potential wildlife disease outbreak (Vaske et al., 2009).

To mitigate the potential negative consequences of CWD wildlife agencies should (a) continue to educate hunters about CWD and (b) stress that there is no link between CWD and human health. Most agency information and education campaigns correctly state that there is no evidence that CWD poses a human health risk. However, they also advise hunters to take precautions such as testing animals for CWD and wearing gloves when processing animals. While agencies likely communicate these precautionary messages for legal reasons, the ambiguity in the messages suggests a risk may be present. Concern about CWD could also stem from its similarity to related diseases that can cause human death (e.g., mad cow, Creutzfeldt-Jakob) (McKintosh et al., 2003). Miller and Shelby (2009), for example, found that hunters perceived the risk of becoming ill from CWD and mad cow disease as similar. Understanding how CWD is perceived by hunters and other stakeholders is an important component of managing the disease. Wildlife agencies should take these issues into consideration when developing CWD communication campaigns and planning their long-term response to CWD (Vaske, Needham, Stafford, Green, & Petchenik, 2006).

Theoretical Implications

Declining hunter involvement is a complex, multidimensional issue that cannot be explained simply. This study indicates that in addition to the specific situational variables (i.e., potential CWD conditions), psychological concepts such as perceived risk play an important role in hunters' decisions to hunt. At current conditions, individuals that perceive high risk are 10 times more likely to quit hunting than those who perceive no risk. Research such as this facilitates an understanding of how concerns and perceptions of risk related to CWD affect hunters' decisions.

Results also have implications for predictive potential. The notion of predictive potential refers to the likelihood that one variable can explain variation in a second variable (Vaske, 2008). Social-psychological theory suggests that when two variables are measured at the same level of specificity the predictive potential increases (Fishbein & Ajzen, 1975; Whittaker, Vaske, & Manfredo, 2006). According to this "specificity" principle, specific variables are more likely to predict specific behaviors than more general measures. For example, specific situational (e.g., prevalence, human death) and psychological (e.g., perceived risk from CWD) variables would be expected to account for relatively more variability in hunter decisions than general sociodemographic variables (e.g., state, residency). In this study, human impact was the strongest predictor of hunting intentions, followed by perceived risk. Consistent with social psychological theory and the specificity principle, specific situational (human impact) and psychological predictors (perceived risk) had more predictive power than the sociodemographic indicators. Support for the specificity principle has implications for developing general models that explain human behavior.

Future Research

To increase the generalizability of these findings, the following future research considerations are offered. First, the findings presented here are limited to resident and nonresident deer hunters across four states that purchased a license to hunt deer with a gun in 2003. Results may not generalize to (a) hunters in other states, (b) hunters participating in different forms of hunting (e.g., archery) or (c) other species that have CWD (e.g., elk, moose).

Second, this article examined hunters' perceived health risks associated with CWD (e.g., become ill from CWD). Risk analysis literature (e.g., Fischhoff et al., 1978; Sjöberg, 2000a), for example, suggests that perceived risk varies depending on whether the hazard is new (unknown risk) or old (known risk). Data collection for this study occurred within two years from when CWD was discovered in South Dakota and Wisconsin. The other two states examined in this study, Arizona and North Dakota, represent states that were unaffected by CWD. In these states, the risks associated with CWD were still relatively new and unknown. Whether responses are similar in states where CWD has been commonplace for many years (e.g., Colorado, Wyoming) remains a question for future empirical research.

Third, people tend to believe that they are at less risk than others (i.e., risk denial) (Sjöberg, 2000a; Slovic, 1999). Risks that hunters may perceive for family members, other hunters, or society in general were not examined. This study also did not examine other risks associated with CWD (e.g., risk of losing opportunities to hunt a healthy animal). Given the contentious nature of many human dimensions problems such as CWD, continuing to draw on the risk literature to examine risk perceptions and other

CWD risks may facilitate a better understanding of the challenges faced by wildlife managers.

Fourth, it is important to emphasize that these results are based on hypothetical scenarios depicting conditions that do not necessarily reflect current CWD prevalence levels or threats to humans. Because of the long time between exposure to CWD and the development of disease, years of continued follow-up testing is required to be able to say what the risk, if any, of CWD is to humans. Given the long incubation period of CWD and its slow rate of natural expansion, these types of surveillance and eradication programs can be time consuming, controversial, expensive, and draw resources from other wildlife issues (Heberlein, 2004; Williams et al., 2002).

Finally, few studies have examined the human dimensions of other wildlife diseases. The theoretical concepts used in CWD research (e.g., knowledge, risk perceptions, beliefs, attitudes, behavioral responses) could be applied to other zoonotic diseases to facilitate understanding of the human component of wildlife diseases and broaden the generalizability, reliability and validity of the findings. For example, obtaining a general understanding of risk perceptions can facilitate proactive risk management (Decker et al., 2006) and can assist in planning for other potential wildlife disease outbreaks (Vaske et al., 2009).

CHAPTER III. CWD PREVALENCE, PERCEIVED HUMAN HEALTH RISKS AND STATE INFLUENCES ON DEER HUNTING PARTICIPATION

Introduction

Chronic wasting disease (CWD) is a naturally-occurring neurodegenerative disease in deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and moose (*Alces alces*) (Baeten et al., 2007; Williams & Young, 1980, 1982). CWD belongs to a family of transmissible spongiform encephalopathy diseases, which includes bovine spongiform encephalopathy in cattle (i.e., BSE, mad cow), scrapie in sheep, and Creutzfeldt-Jakob disease in humans (McKintosh et al., 2003). Characteristics of the disease include excessive salivation, loss of coordination, abnormal behavior, and emaciation. There is no known treatment for CWD and the disease is always fatal (Williams et al., 2002). To date, CWD has been found in free-ranging cervids in 15 states (Colorado, Illinois, Kansas, Maryland, Minnesota, Nebraska, New Mexico, New York, North Dakota, South Dakota, Utah, Virginia, West Virginia, Wisconsin, Wyoming) and two Canadian provinces (Alberta, Saskatchewan). CWD has also been identified in captive herds in four additional states (Michigan, Missouri, Montana, Oklahoma) and in South Korea. "The disease continues to spread and shows no signs of slowing down" (Haney, 2009, p. 8).

Given its similarity to mad cow disease, CWD has emerged as a disease of concern among wildlife managers, hunters, and other stakeholders (Arnot et al., 2009; Williams et al., 2002; Wisconsin Department of Natural Resources, 2009). Although

there is no evidence that CWD can be transmitted to humans, as has been shown for BSE, the possibility cannot be dismissed (Belay et al., 2004; Raymond et al., 2000; Salman, 2003). Wildlife agencies are concerned that possible unknown risks associated with CWD will erode hunters' willingness to hunt in states where the disease is found (Needham et al., 2004). Hunting declines attributable to CWD, for example, have occurred in Wisconsin (Bishop, 2004; Heberlein, 2004; Vaske et al., 2004). If CWD conditions continue to worsen, other states may experience a substantial decrease in hunting participation (Needham et al., 2004). This article examined the extent to which factors related to CWD influenced hunters to stop hunting deer in Arizona, North Dakota, South Dakota, and Wisconsin.

Human Dimensions of CWD

Hunting participation has declined in North America (Brown et al., 2006; Heberlein & Thomson, 1996; Li et al., 2003; Mehmood et al., 2003). Personal (e.g., age, lack of time for hunting) and situational (e.g., lack of available land to hunt, too many regulations) constraints have contributed to this decrease in hunter participation (Miller & Vaske, 2003). Hunters' perceptions of potential risks associated with CWD could exacerbate this decline (Gigliotti, 2004; Schauber & Woolf, 2003; Williams et al., 2002).

Declines in hunting due to CWD are of concern to wildlife managers because they can: (a) reduce license sale revenues, (b) limit an agency's ability to manage game species, (c) decrease support for wildlife agencies, (d) impact other wildlife management programs (e.g., habitat improvement) if funds get diverted to address CWD, and (e) constrain cultural traditions and the social and economic stability of communities dependent on hunting (Needham et al., 2004). Given these potential consequences of

CWD, research has focused on the extent to which hunters might change their behavior in response to CWD (Gigliotti, 2004; Vaske et al., 2004).

Disease-related research has identified two primary predictors of human behavior change in response to disease: (a) high prevalence of a disease, and (b) severe human consequences of a disease (Adams & Smith, 2001; Sjöberg, 1999; Stonehouse & Mumford, 1994; Thompson & Dean, 1996). Needham et al. (2004), for example, found that if CWD prevalence ever increased dramatically (e.g., 50% infection rate), up to 49% of hunters would stop hunting deer or elk in several states. The decline would be even greater if high prevalence is combined with threats to human health such as death from CWD. In addition, nonresident hunters were more likely than residents to report that they would stop hunting.

An individual's behavioral decision is seldom based on actual probabilities. Rather, people are influenced by factors such as controllability (i.e., perception of being in control or having a choice), timing (i.e., whether the consequences are immediate or delayed), and media attention (Adams & Smith, 2001; Sjöberg, 1998). The discovery of CWD in Wisconsin, for example, coincided with an outbreak of mad cow disease in Europe. Despite public officials' assurances that mad cow disease could not be transmitted to humans, a TSE disease had crossed the species barrier and caused human deaths (Heberlein, 2004). Hunter numbers declined by about 11% in Wisconsin following the discovery of CWD in the state (Heberlein, 2004) and research suggested that human health-related concerns associated with CWD contributed to approximately half of this decline (Vaske, Needham, Stafford, et al., 2006). Thus, perceived risks associated with CWD constrained hunting participation.

Perceived Risk

Perceived risk is defined as the degree to which individuals believe that they are exposed to some hazard or danger (Siegrist & Cvetkovich, 2000; Sjöberg, 2000b). Perceptions of risk are subjective and can influence decision making and behavior under uncertainty (Fischhoff et al., 1978; Siegrist et al., 2005). Hunters concerned about CWD, for example, may stop hunting or avoid consuming deer, elk, or moose (Miller, 2004). Factors that influence perceived risk include newness (i.e., new / old risk), knowledge (i.e., unknown / known risk), and severity of the risk (i.e., fatal / not fatal) (Fischhoff et al., 1978). CWD presents relatively new risks and has unknown consequences for human health.

Studies addressing risk perceptions of CWD have consistently shown that deer hunters are concerned or worried about the effects of CWD on human health (Brown et al., 2006; Gigliotti, 2004; Miller, 2004). Majorities of hunters in eight states agreed that CWD may be a risk to humans, and that their families were concerned about eating deer or elk meat because of CWD (Needham & Vaske, 2006; Needham et al., 2006). The majority of Wisconsin hunters who did not hunt in 2002 were moderately or strongly influenced by perceived risks associated with CWD (Vaske et al., 2004), indicating that perceptions of CWD risk could significantly impact hunting behavior.

Based on previous research (Lyon & Vaske, 2010; Needham et al., 2004), two hypotheses are advanced. First, we hypothesize that (a) prevalence, (b) potential human death, (c) perceived personal health risk, (d) presence of CWD in the state, and (e) residency influence the probability of quitting hunting in a given state. Second, we

hypothesize that interactions among the predictors will increase the potential for quitting hunting in a state.

Methods

Description of Sample

Data were obtained from mail surveys of resident and nonresident deer hunters in Arizona, North Dakota, South Dakota, and Wisconsin (n = 3,519). At the time of this study, CWD had been identified in free-ranging deer in South Dakota and Wisconsin but not Arizona or North Dakota. The study population consisted of hunters who were 18 years of age or older and purchased a nonresident or resident license to hunt deer with a gun in 2003. Random samples of hunter names, addresses, and telephone numbers were obtained from the wildlife / game and fish agency of each participating state.

Three mailings were used to administer the surveys beginning July 2004. Hunters were sent a survey, postage-paid return envelope, and cover letter. Non-respondents were sent a postcard reminder two weeks after this initial mailing. A second full mailing (i.e., survey, return envelope, letter) was sent to non-respondents three weeks after the postcard reminder. Surveys were mailed to a total of 8,163 hunters. Across all states and strata, 249 surveys were undeliverable (e.g., moved, incorrect addresses) and 3,519 completed mail surveys were returned, yielding a 44% response rate (3,519 / 8,163 – 249). Sample sizes were 1,975 for nonresident hunters (50% response rate) and 1,543 (39% response rate) for residents (for details, see Needham et al., 2006).

To check for non-response bias, hunters who completed a survey were compared to those who did not. A sample of 785 non-respondents (376 nonresidents, 409 residents) was telephoned in November 2004 and asked nine survey questions. Responses to five

questions were statistically different ($p < .001$) between respondents and non-respondents, but statistical significance is inflated by large sample sizes (Vaske, 2008). Effect sizes (V, r_{pb}) were < .15, indicating "weak" (Cohen, 1988) or "minimal" (Vaske, 2008) differences between the two groups. Non-response bias was thus not deemed a problem and data were not weighted based on the non-response check. In each state, however, more residents than nonresidents purchased a license to hunt deer with a gun in 2003. Given the sampling design, more surveys were received from nonresidents than residents. The data were weighted to reflect the population proportions of hunters (see Needham et al., 2006)

Independent Variables

Computer generated maps were used to depict hypothetical situations of varying CWD human health risks (e.g., human death) and increasing levels of CWD prevalence among deer in three zones across each state. In two of the states (South Dakota, Wisconsin), zone A represented the area where the disease had been detected in free-ranging populations and had the highest prevalence. For Arizona and North Dakota, zone A represented the most likely region for CWD to be detected, if ever. The decision of where to situate zone A was made by each wildlife/game and fish agency. For all state maps, zones B and C were similar in size. CWD had not been detected in free-ranging deer in zone C and was considered by each agency to be the least likely location for high rates of CWD infection to occur. All three zones for each state were based on hunt management units.

Maps in the surveys depicted four separate hypothetical situations of increasing CWD prevalence and distribution: (a) 10% prevalence in zone A, 0% in zones B and C;

(b) 30% in zone A, 10% in zone B, 0% in zone C; (c) 50% in zone A, 30% in zone B, 10% in zone C; and (d) 50% in all three zones (i.e., across the entire state). Two additional hypothetical situations depicted prevalence levels and human health risks: (a) 10% prevalence in zone A, 0% in zones B and C, and "a hunter in the state has died from eating CWD infected deer meat;" and (b) 50% prevalence in all three zones and "a hunter in the state has died from eating CWD infected deer meat." These situations reflect the two main predictors of disease-related behavior—disease prevalence and human health risks. To emphasize the hypothetical nature of these situations, survey respondents were assured that the situations were "imaginary" (hypothetical) and did not reflect current conditions or consequences to humans.

Prevalence. Prevalence was computed by averaging the percent prevalence in each of the three zones. This resulted in four prevalence values: (a) 3% prevalence statewide (10% in zone A, 0% in zone B, and 0% in zone C), (b) 13% prevalence statewide (30% in zone A, 10% in zone B, and 0% in zone C), (c) 30% prevalence statewide (50% in zone A, 30% in zone B, and 10% in zone C), and (d) 50% prevalence statewide (50% in zones A, B, and C).

Human death. Human health risk was a dummy variable coded as 0 "no effect of CWD on human health" and 1 "CWD transmissible to humans and hunters have died from CWD."

Perceived risk. Individuals' perceived risk regarding CWD was assessed using a 6-item standardized index (Cronbach's alpha = .91). One question in the index asked respondents to what extent they disagreed or agreed that because of CWD, they have concerns about eating deer meat. Responses were measured on a 7-point scale from: (1)

strongly disagree to (7) strongly agree. A second question asked respondents because of CWD, how concerned are you about your own personal health. Responses were measured on a 9-point scale from: (1) not at all concerned to (9) extremely concerned. The remaining four questions asked respondents to indicate how much risk they associated with (a) inadvertently eating meat from an animal infected with CWD, (b) contracting a disease caused by CWD, (c) becoming ill as a result of contracting a disease caused by CWD, and (d) death as a result of contracting a disease caused by CWD. Responses were measured on a 9-point scale from: (1) no risk to (9) extreme risk. All responses were converted to standardized scores to account for differences in scale width.

State and residency. States were dummy coded as 0 'non-CWD state' (Arizona and North Dakota) and 1 'CWD state' (South Dakota and Wisconsin). The residency dummy variable was coded as 0 "nonresident hunter" and 1 "resident hunter."

Dependent Variable

To measure the extent to which CWD prevalence, distribution, and human health risks influence hunters' willingness to continue hunting in their state, respondents evaluated each hypothetical situation and indicated if they would: (a) hunt deer in the zone in the state that they hunt deer in most often; (b) hunt deer in the state, but switch to a different zone; (c) give up deer hunting in the state, but hunt deer in another state; or (d) give up deer hunting altogether. The respective state name was provided in the response items for each survey. For analysis purposes, the first two response items were collapsed into one category labeled 0 "still hunt deer in the state;" the last two items were recoded into 1 "stop hunting deer in the state."

Data Analysis

Bivariate and multivariate analyses were used to examine relationships among the variables. Bivariate analyses assessed the percentage of hunters that would stop hunting deer in a state as a function of the five predictor variables: (a) CWD prevalence, (b) hypothetical human death from CWD, (c) perceived human health risks from CWD, (d) state (no known CWD in state [Arizona, North Dakota] vs. CWD in state [South Dakota, Wisconsin]), and (e) residency (resident vs. nonresident hunter). The likelihood ratio chi-square was used to assess whether statistical differences occurred between the two groups (i.e., continue hunting or quit hunting in a state) across the five predictor variables; the Spearman correlation was used as a measure of effect size.

Interactions among the various levels of the five predictors were hypothesized to influence the likelihood of hunters changing their plans to hunt in the future. Backward step-wise hierarchical log-linear analysis was used to model the multivariate relationships among the variables. In log-linear models all variables are considered as independent. The null hypothesis was that each variable was independent of one another and that no associations existed. The independence hypothesis was rejected (i.e., associations exist) when low probabilities (e.g., $p < .05$) of significance were observed. Partial log likelihood chi-squares were used to test for variable associations in the multiple contingency tables (Knoke & Burke, 1980). The hierarchical model measured the associations among the six variables in the model: quit hunting, CWD prevalence, hypothetical human death, perceived human health risks, state, and residency.

Results

Bivariate analysis

Across the entire sample, 27% of respondents indicated that they would stop hunting because of CWD (Table I). All five independent variables were statistically significant predictors of stopping hunting in the state and thus provide evidence to support the first hypothesis. The greater the prevalence of CWD in the state the more likely hunters were to quit. At the lowest hypothetical prevalence level, 13% indicated that they would no longer hunt in the state. When prevalence reached 50% statewide, 52% said that they would stop hunting. The difference in these distributions was statistically significant ($\chi^2 = 3{,}338.46$, $p < .001$, $r = .37$).

If CWD were to cause human death, respondents were significantly more likely to stop hunting in the state ($\chi^2 = 1{,}187.99$, $p < .001$, $r = .25$). Forty-three percent indicated that they would quit hunting in the hypothetical scenarios where a hunter had died due to CWD; only 19% said they would stop in the "no human death" scenarios. When hunters' perceived extreme risks associated with CWD, 46% would stop hunting in the state. By comparison, 19% would quit hunting when they perceived no CWD related risks ($\chi^2 = 600.27$, $p < .001$, $r = .17$).

Whether or not CWD had been detected in the state and the respondents' state of residency were also significant predictors of hunters' behavioral intentions. Individuals who had hunted in states that did not have CWD were slightly more likely (30%) to stop hunting than those who had hunted in a CWD state (25%). Nonresidents (29%) were slightly more likely to quit than residents (24%). These relationships, however, were not strong for either the presence of CWD in a state or residency ($r = -.05$ in both cases).

Table 3.1 Bivariate Analyses of Stopping Hunting Due to CWD

Independent variable	Likely to stop hunting because of CWD: No %	Likely to stop hunting because of CWD: Yes %	χ^2	*p*	*r*
Entire sample	73	27			
Hypothetical prevalence of CWD			3,338.46	<.001	.37
10% zone A, 0% zone B, 0% zone C	87	13			
30% zone A, 10% zone B, 0% zone C	91	9			
50% zone A, 30% zone B, 10% zone C	76	24			
50% zone A, 50% zone B, 50% zone C	48	52			
Hypothetical human death due to CWD			1,187.99	<.001	.25
No	81	19			
Yes	57	43			
Perceived human health risk of CWD			600.27	<.001	.17
No risk	81	19			
Slight risk	70	30			
Moderate risk	60	40			
Extreme risk	54	46			
CWD present in state			58.17	<.001	-.05
No	70	30			
Yes	75	25			
Resident of state			58.63	<.001	-.05
No	71	29			
Yes	76	24			

Multivariate analysis

Hypothesis two predicted that the five independent variables would interact to increase the likelihood of stopping hunting. A multivariate log-linear analysis identified 12 significant 2-way interactions, six 3-way interactions, and one significant 4-way interaction (Table 3.2). The 5- and 6-way interactions were not significant.

Table 3.2 Hierarchical Log-Linear Model for 2-, 3-, and 4-way Interactions

Significant interactions [1]	*df*	Partial χ^2	*p*
4-way interaction			
Quit Hunting*Prevalence*Human Impact*CWD State	3	12.77	.005
3-way interactions			
Quit Hunting*Prevalence*Human Impact	3	173.99	<.001
Quit Hunting*Prevalence*CWD State	3	50.64	<.001
Quit Hunting*Perceived Risk*CWD State	3	21.10	<.001
Quit Hunting*Perceived Risk*Resident	3	16.06	.001
Quit Hunting*CWD State*Resident	1	5.74	.017
Perceived Risk*CWD State*Resident	3	55.05	<.001
2-way interactions			
Quit Hunting*Prevalence	3	3011.91	<.001
Quit Hunting*Human Impact	1	768.46	<.001
Quit Hunting*Perceived Risk	3	777.46	<.001
Quit Hunting*CWD State	1	64.67	<.001
Quit Hunting*Resident	1	112.70	<.001
Prevalence*Human Impact	3	6527.35	<.001
Prevalence*Perceived Risk	9	114.30	<.001
Prevalence*CWD State	3	7.90	.048
Prevalence*Resident	3	17.78	<.001
Human Impact*Perceived Risk	3	25.53	<.001
Perceived Risk*CWD State	3	23.55	<.001
Perceived Risk*Resident	3	140.01	<.001
Tests that K-way effects are zero			
1	10	21,987.99	<.001
2	39	12,087.27	<.001
3	76	357.29	<.001
4	79	33.70	1.00
5	42	13.57	1.00
6	9	4.01	.91

[1] Only significant ($p < .05$) effects are shown

The 2-way associations indicate that decisions to quit hunting in the state interacted with each of the five factors suggesting that they all influenced hunter

behavior. The significant 3-way interaction quit hunting * perceived risk * resident, for example, indicated that nonresidents of the state who perceived greater risk were more likely to quit hunting deer in the state. In the 4-way interaction, stopping hunting increased: (a) when prevalence increased, (b) a human death attributable to CWD had occurred, and (c) if CWD had been detected in the state. Under the worst case scenario (i.e., 50% prevalence statewide, human death, a *non-CWD* state), 64% of the respondents would stop hunting in the state (Table 3.3). If the prevalence of CWD was 50% statewide, a human death had occurred, and the disease had been detected in the state, 60% would quit hunting. Consistent with past research, if CWD is concentrated in a single area at relatively low prevalence levels, few hunters would quit the activity.

Table 3.3 Multivariate Relationships Among Stopping Hunting, Prevalence, Hypothetical Human Death and Presence of CWD in the State[1]

		Hypothetical prevalence of CWD in:			Likely to stop hunting because of CWD	
CWD present in the state	Hypothetical human death	Zone A (%)	Zone B (%)	Zone C (%)	No (%)	Yes (%)
No	No	10	0	0	95	5
		30	10	0	88	12
		50	30	10	74	26
		50	50	50	57	43
	Yes	10	0	0	72	28
		50	50	50	36	64
Yes	No	10	0	0	98	2
		30	10	0	94	6
		50	30	10	79	21
		50	50	50	58	42
	Yes	10	0	0	80	20
		50	50	50	40	60

[1] This table is the significant 4-way interaction in Table 3.2.

Discussion

The results supported the first hypothesis that CWD prevalence, potential human death, perceived personal health risk, presence of CWD in the state, and residency influence hunting participation. In the bivariate analyses, prevalence was the strongest predictor of stopping hunting in the state followed by human death and perceived risk. The presence of CWD in a state and residency were weak, but statistically significant predictors. Nonresidents were more likely to quit than residents. Ancillary analyses indicated that North Dakota hunters were the most likely to quit hunting, while Wisconsin hunters were the least likely.

Interactions among the predictors were hypothesized to increase the potential for stopping hunting in the state. Multivariate analysis confirmed that the decision to stop hunting interacted with all five predictors and suggested that combinations of these predictors increase the probability of quitting. The 4-way interaction, for example, revealed that 60% or more of our respondents would stop hunting if CWD prevalence ever reached 50% statewide and a human death attributable to CWD had occurred. These findings support our second hypothesis and have implications for management, theory, and research.

Management Implications

The Wisconsin Department of Natural Resources sold 688,540 gun deer hunting licenses in 2001. After the discovery of CWD in 2002, the agency sold 618,945 licenses (WDNR, 2008). This dramatic single-year reduction (≈ 11%) in license sales was the largest in the state's history. Although research has shown that about half of this decline can be attributed to CWD (Vaske et al., 2004), CWD impacted hunting participation.

Since 2002, gun deer hunting license sales in Wisconsin have rebounded somewhat and leveled off. The yearly average number of license sales between 2003 and 2008 was 644,217 (range = 641,432 in 2007 to 649,955 in 2004). This average, however, is still substantially below license sales prior to the detection of CWD.

The prevalence of CWD in any state varies by location, and the sex and age of the deer (e.g., yearlings vs. adults). In the western Dane and eastern Iowa counties of Wisconsin, the prevalence of disease has increased in adult males from approximately 10% in 2002 to 16% in 2008 (WDNR, 2009). At these prevalence levels our findings would suggest that approximately 10% of hunters would stop hunting deer in the state. If CWD conditions worsen, this decline is likely to be even more dramatic.

Biological and social data, however, do not necessarily correlate 1 to 1. Findings reported in this paper and by others (e.g., Gore et al., 2009; Heberlein & Stedman, 2009; Vaske, 2010; Vaske et al., 2009) suggest that psychological factors such as perceived risk play a substantial role in hunters' decisions to hunt. Understanding concerns and perceptions of risk related to CWD can provide insight into how hunters and other stakeholder groups might react to further increases in CWD prevalence, which is essential for determining the necessity and potential effectiveness of management techniques and information campaigns. General understanding of risk perceptions can also facilitate proactive risk management (Decker et al., 2006) and can assist in planning for the next potential wildlife disease outbreak (Vaske et al., 2009).

Hunter response to CWD is a function of the interaction among multiple variables. For example, respondents in our sample who had hunted in a non-CWD state were more likely to stop hunting than those who had hunted in a state with CWD.

Although the statistical effect size was "minimal" (Vaske, 2008), there was an effect that interacted with the psychological variables to influence behavioral intentions. The multivariate analyses presented here highlight the importance of moving beyond bivariate analyses and exploring the possible interactions between variables that can impact hunting participation.

Finally, our analyses reinforce the need for managers to (a) continue to inform hunters about CWD and (b) stress that there is no link between CWD and human health. Most agency information and education campaigns state that there is no evidence that CWD poses a human health risk (Eschenfelder, 2006). 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 may be present. Although agencies are likely to continue to communicate precautionary messages primarily for legal reasons, this ambiguity in the messages may influence perceptions of risk. Hunters may believe that mixed messages suggest that wildlife agencies are uncertain about CWD, which may influence trust and risk evaluations (Needham & Vaske, 2008; Vaske et al., 2004). Concern about CWD could also stem from its similarity to related diseases that can cause human death (e.g., mad cow, Creutzfeldt-Jakob) (McKintosh et al., 2003). Miller and Shelby (2009), for example, found that hunters perceived the risk of becoming ill from CWD and mad cow disease as similar. Wildlife agencies should take these issues into consideration when developing CWD communication campaigns and planning their long-term response to CWD (Vaske, Needham, Newman, Manfredo, & Petchenik, 2006).

Future Research

To increase the generalizability of these findings, the following future research considerations are offered. First, the findings presented here are limited to resident and nonresident deer hunters that purchased a license to hunt deer with a gun in Arizona, North Dakota, South Dakota, and Wisconsin in 2003. Results may not generalize to (a) hunters in other states, (b) hunters participating in different forms of hunting (e.g., archery) or (c) other species that have CWD (e.g., elk, moose).

Data for this study were obtained within two years from when CWD was discovered in South Dakota and Wisconsin. The other two states, Arizona and North Dakota, represented states unaffected by CWD when the study was conducted. In these states, the risks associated with CWD were still relatively new and unknown. Whether responses are similar in states where CWD has been commonplace for many years (e.g., Colorado, Wyoming) remains a question for future empirical research.

Second, this article examined hunters' perceived health risks associated with CWD (e.g., become ill from CWD). However, people tend to believe that they are at less risk than others (i.e., risk denial) (Sjöberg, 2000a; Slovic, Fischoff, & Lichtenstein, 1981). Risks that hunters may perceive for family members, other hunters, or society in general were not examined. This study also did not examine other risks associated with CWD (e.g., risk of losing opportunities to hunt a healthy animal). Given the contentious nature of human dimensions problems such as CWD, continuing to draw on the risk literature to examine risk perceptions and other CWD risks may facilitate a better understanding of the challenges faced by wildlife managers.

Third, it is important to emphasize that these results are based on hypothetical scenarios depicting conditions that do not necessarily reflect current CWD prevalence levels or threats to humans. As noted in the introduction, however, "chronic wasting disease continues to spread and shows no signs of slowing down" (Haney, 2009, p. 8). Because of the long time between exposure to CWD and the development of disease, years of continued testing of harvested and live animals is required to be able to say what the risk, if any, of CWD is to humans.

CHAPTER IV. CONCLUSION

The preceding chapters extended the literature on the human dimensions of chronic wasting disease by revealing (a) the extent to which perceived risk influences hunter decisions, and (b) the complexity of understanding hunter behavior. This chapter briefly summarizes the major findings of this thesis and their management, theoretical, and research implications.

Summary of Findings

The first article in this thesis (chapter two) examined the extent to which potential CWD prevalence and human health risks influenced deer hunters' decision to continue hunting deer in a state. This article extended the Needham et al. (2004) study by using more extensive data (n = 3,519) to describe the extent to which factors related to CWD influenced hunters to hunt in other states or quit hunting. In addition to the variables used in the Needham et al. (2004) study (i.e., distribution, prevalence, human health risks), perceived human health risks and state were included in the model. Results showed that at low CWD prevalence levels (i.e., less than 10% across the state), few hunters would quit hunting deer in the state. The majority of hunters would change their behavior if prevalence ever reached 50% and humans died from CWD (66% would quit). Arizona and North Dakota hunters were most likely to change their behavior; Wisconsin hunters were least likely to change. As CWD conditions worsened, nonresidents were more likely to quit than residents.

Chapter three built on the second chapter by examining the individual and combined influence of CWD prevalence, perceived human health risks, CWD vs. non-CWD state, and state of residency on hunters' decisions to stop hunting deer in Arizona, North Dakota, South Dakota, and Wisconsin. CWD prevalence, potential human death, perceived personal health risk, presence of CWD in the state, and residency all influence hunting participation. Prevalence was the strongest predictor of quitting hunting in the state followed by hypothetical human death and perceived risk. The presence of CWD in a state and residency were weak, but statistically significant predictors. North Dakota hunters were the most likely to quit hunting, while Wisconsin hunters were the least likely. Multivariate analyses identified interaction effects among all five of the predictor variables indicating that that combinations of these variables exacerbate declines in hunting participation.

Management Implications

The prevalence of CWD in any state varies by location, and the sex and age of the deer (e.g., yearlings vs. adults). In the western Dane and eastern Iowa counties of Wisconsin, for example, adult males exhibit the highest degree of disease prevalence. Despite efforts to eradicate the disease, prevalence of CWD has increased in adult males in Wisconsin's core monitoring area from approximately 10% in 2002 to 16% in 2008 (WDNR, 2009). At these prevalence levels our findings would suggest that approximately 10% of hunters would stop hunting deer in the state. If CWD conditions worsen, this decline is likely to be even more dramatic.

The influence of biological and social factors, however, do not necessarily hold equal weight when making decisions. Findings reported in this thesis and by others (e.g.,

Gore et al., 2009; Heberlein & Stedman, 2009; Vaske et al., 2009) suggest that psychological factors such as perceived risk play a substantial role in hunters' decisions to hunt. Understanding concerns and perceptions of risk related to CWD can provide insight into how hunters and other stakeholder groups might react to further increases in CWD prevalence, which is essential for determining the necessity and potential effectiveness of management techniques and information campaigns (Vaske et al., 2009). General understanding of risk perceptions can also facilitate proactive risk management (Decker et al., 2006) and can assist in planning for the next potential wildlife disease outbreak (Vaske et al., 2009).

Although human death from CWD is unlikely, many hunters are concerned about their health and think that they are at risk of becoming ill from the disease (Needham & Vaske, 2006). Most agency information and education campaigns state that there is no evidence that CWD poses a human health risk (Eschenfelder, 2006). 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 may be present. Although agencies are likely to continue to communicate precautionary messages primarily for legal reasons, this ambiguity in the messages may influence perceptions of risk. Hunters may believe that mixed messages suggest that wildlife agencies are uncertain about CWD, which may influence trust and risk evaluations (Needham & Vaske, 2008; Vaske et al., 2004). Concern about CWD could also stem from its similarity to related diseases that can cause human death (e.g., mad cow, Creutzfeldt-Jakob) (McKintosh et al., 2003). Miller and Shelby (2009), for example, found that hunters perceived the risk of becoming ill from CWD and mad cow disease as similar. Wildlife

agencies should take these issues into consideration when developing CWD communication campaigns and planning their long-term response to CWD (Vaske, Needham, Newman, et al., 2006). To mitigate the potential negative consequences of CWD wildlife agencies should (a) continue to educate hunters about CWD and (b) stress that there is no link between CWD and human health.

Theoretical Implications

Declining hunter involvement is a complex, multidimensional issue that cannot be explained simply. This study indicates that in addition to the specific situational variables (i.e., potential CWD conditions), psychological concepts such as perceived risk play an important role in hunters' decisions to hunt. At current conditions, individuals that perceive high risk are 10 times more likely to quit hunting than those who perceive no risk. Research such as this facilitates an understanding of how concerns and perceptions of risk related to CWD affect hunters' decisions.

Results also have implications for predictive potential. The notion of predictive potential refers to the likelihood that one variable can explain variation in a second variable (Vaske, 2008). Social-psychological theory suggests that when two variables are measured at the same level of specificity the predictive potential increases (Fishbein & Ajzen, 1975; Whittaker et al., 2006). According to this "specificity" principle, specific variables are more likely to predict specific behaviors than more general measures. For example, specific situational (e.g., prevalence, human death) and psychological variables (e.g., perceived risk from CWD) would be expected to account for relatively more variability in hunter decisions than general sociodemographic variables (e.g., state, residency). In this study, human impact and perceived risk were the strongest predictors

of hunting intentions. Consistent with social psychological theory and the specificity principle, specific situational (human impact) and psychological predictors (perceived risk) had more predictive power than the sociodemographic indicators. Support for the specificity principle has implications for developing general models that explain human behavior.

Future Research

To increase the generalizability of these findings, the following future research considerations are offered. First, the findings presented here are limited to resident and nonresident deer hunters that purchased a license to hunt deer with a gun in Arizona, North Dakota, South Dakota, and Wisconsin in 2003. Results may not generalize to (a) hunters in other states, (b) hunters participating in different forms of hunting (e.g., archery) or (c) other species that have CWD (e.g., elk, moose).

Second, data collection for this study occurred within two years from when CWD was discovered in South Dakota and Wisconsin. The other two states examined in this study, Arizona and North Dakota, represent states that were unaffected by CWD at the time. In these states, the risks associated with CWD were still relatively new and unknown. Whether responses are similar in states where CWD has been commonplace for many years (e.g., Colorado, Wyoming) remains a question for future empirical research.

Third, this article examined hunters' perceived health risks associated with CWD (e.g., become ill from CWD). However, people tend to believe that they are at less risk than others (i.e., risk denial) (Sjöberg, 2000a; Slovic et al., 1981). Risks that hunters may perceive for family members, other hunters, or society in general were not examined.

This study also did not examine other risks associated with CWD (e.g., risk of losing opportunities to hunt a healthy animal). Given the contentious nature of human dimensions problems such as CWD, continuing to draw on the risk literature to examine risk perceptions and other CWD risks may facilitate a better understanding of the challenges faced by wildlife managers.

Fourth, it is important to emphasize that these results are based on hypothetical scenarios depicting conditions that do not necessarily reflect current CWD prevalence levels or threats to humans. Because of the long time between exposure to CWD and the development of disease, years of continued follow-up testing is required to be able to say what the risk, if any, of CWD is to humans. Given the long incubation period of CWD and its slow rate of natural expansion, these types of surveillance and eradication programs can be time-consuming, controversial, expensive, and draw resources from other wildlife issues (Heberlein, 2004; Williams et al., 2002).

Finally, few studies have examined the human dimensions of other wildlife diseases. The theoretical concepts used in CWD research (e.g., knowledge, risk perceptions, beliefs, attitudes, behavioral responses) could be applied to other zoonotic diseases to facilitate understanding of the human component of wildlife diseases and broaden the generalizability, reliability and validity of the findings. For example, obtaining a general understanding of risk perceptions can facilitate proactive risk management (Decker et al., 2006) and can assist in planning for other potential wildlife disease outbreaks (Vaske et al., 2009).

REFERENCES

Adams, A. M., & Smith, A. F. (2001). Risk perception and communication: Recent developments and implications for anaesthesia. *Anaesthesia, 56*(8), 745–755.

Amnon, L. (2002). A lifetime portfolio of risky and risk-free sexual behavior and the prevalence of AIDS. *Journal of Health Economics, 21*(6), 993–1007.

Arnot, C., Laate, E., Unterschultz, J., & Adamowicz, W. (2009). Chronic wasting disease (CWD) potential economic impact on cervid farming in Alberta. *Journal of Toxicology and Environmental Health-Part a-Current Issues, 72*, 1014–1017.

Baeten, L. A., Powers, B. E., Jewell, J. E., Spraker, T. R., & Miller, M. W. (2007). A natural case of chronic wasting disease in a free-ranging moose (*Alces alces shirasi*). *Journal of Wildlife Diseases, 43*(2), 309–314.

Belay, E. D., Maddox, R. A., Williams, E. S., Miller, M. W., Gambetti, P., & Schonberger, L. B. (2004). Chronic wasting disease and potential transmission to humans. *Emerging Infectious Diseases, 10*(6), 977–984.

Bishop, R. C. (2004). The economic impacts of chronic wasting disease (CWD) in Wisconsin. *Human Dimensions of Wildlife, 9*(3), 181–192.

Brown, T. L., Decker, D. J., Major, J. T., Curtis, P. D., Shanahan, J. E., & Siemer, W. F. (2006). Hunters' and other citizens' reactions to discovery of CWD in central New York. *Human Dimensions of Wildlife, 11*(3), 203–214.

Brown, T. L., Decker, D. J., Siemer, W. F., & Enck, J. W. (2000). Trends in hunting participation and implications for management of game species. In W. C. Gartner

& D. W. Lime (Eds.), *Trends in outdoor recreation, leisure, and tourism* (pp. 145–154). New York: CABI.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Cooney, E. E. (2008). *The role of risk perceptions in hunter support for deer density reduction as a chronic wasting disease (CWD) management strategy in Wisconsin* (M.S. Thesis). University of Wisconsin-Stevens Point.

Cooney, E. E., & Holsman, R. H. (2010). Influences on hunter support for deer herd reduction as a chronic wasting disease (CWD) management strategy. *Human Dimensions of Wildlife, 15*(3), 194–207.

Decker, D. J., Wild, M. A., Riley, S. J., Siemer, W. F., Miller, M. W., Leong, K. M., et al. (2006). Wildlife disease management: A manager's model. *Human Dimensions of Wildlife, 11*(3), 151–158.

Eschenfelder, K. R. (2006). What information should state wildlife agencies provide on their CWD websites? *Human Dimensions of Wildlife, 11*(3), 221–223.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences, 9*(2), 127–152.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Gigliotti, L. M. (2004). Hunters' concerns about chronic wasting disease in South Dakota. *Human Dimensions of Wildlife, 9*(3), 233–235.

Gore, M. L., Wilson, R. S., Siemer, W. F., Wieczorek Hudenko, H., Clarke, C. E., Sol Hart, P., et al. (2009). Application of risk concepts to wildlife management: Special issue introduction. *Human Dimensions of Wildlife, 14*(5), 301–313.

Haney, S. (2009). Chronic wasting disease continues to spread and shows no signs of slowing down. *PrioNews, 15*, 8.

Heberlein, T. A. (2004). "Fire in the Sistine Chapel": How Wisconsin responded to chronic wasting disease. *Human Dimensions of Wildlife, 9*(3), 165–179.

Heberlein, T. A., & Stedman, R. C. (2009). Socially amplified risk: Attitude and behavior change in response to CWD in Wisconsin deer. *Human Dimensions of Wildlife, 14*(5), 326–340.

Heberlein, T. A., & Thomson, E. (1996). Changes in U.S. hunting participation, 1980-90. *Human Dimensions of Wildlife, 1*(1), 85–86.

Holsman, R. H., & Petchenik, J. (2006). Predicting deer hunter harvest behavior in Wisconsin's chronic wasting disease eradication zone. *Human Dimensions of Wildlife, 11*(3), 177–189.

James, P. C. (2008). *Both sides of the fence: A strategic review of chronic wasting disease management costs and benefits* (A report prepared for the Canadian Wildlife Federation). Regina, Canada: University of Regina. Retrieved from http://ckwri.tamuk.edu/fileadmin/user_upload/PHOTOS/Deer-Research_Program/Student_papers/Both_Sides_of_the_Fence.pdf

Knoke, D., & Burke, P. J. (1980). *Log-linear models*. Beverly Hills: Sage Publications.

Li, C.-L., Zinn, H. C., Barro, S. C., & Manfredo, M. J. (2003). A cross-regional comparison of recreation patterns of older hunters. *Leisure Sciences, 25*(1), 1–16.

Lyon, K. M., & Vaske, J. J. (2010). Predicting hunting participation in response to chronic wasting disease in four states. *Human Dimensions of Wildlife, 15*(3), 208–220.

McKintosh, E., Tabrizi, S. J., & Collinge, J. (2003). Prion diseases. *Journal of Neurovirology, 9*(2), 183–193.

Mehmood, S., Zhang, D., & Armstrong, J. (2003). Factors associated with declining hunting license sales in Alabama. *Human Dimensions of Wildlife, 8*(4), 243–262.

Miller, C. A. (2003). Hunter perceptions and behaviors related to chronic wasting disease in northern Illinois. *Human Dimensions of Wildlife, 8*(3), 229–230.

Miller, C. A. (2004). Deer hunter participation and chronic wasting disease in Illinois: An assessment at time zero. *Human Dimensions of Wildlife, 9*(3), 237–239.

Miller, C. A., & Shelby, L. B. (2009). Hunters' general disease risk sensitivity and behaviors associated with chronic wasting disease. *Human Dimensions of Wildlife, 14*(2), 133–141.

Miller, C. A., & Vaske, J. J. (2003). Individual and situational influences on declining hunter effort in Illinois. *Human Dimensions of Wildlife, 8*(4), 263–276.

Needham, M. D., & Vaske, J. J. (2006). Beliefs about chronic wasting disease risks across multiple states, years, and interest groups. *Human Dimensions of Wildlife, 11*(3), 215–220.

Needham, M. D., & Vaske, J. J. (2008). Hunter perceptions of similarity and trust in wildlife agencies and personal risk associated with chronic wasting disease. *Society & Natural Resources, 21*(3), 197–214.

Needham, M. D., & Vaske, J. J. (2009). *Risk sensitivity and hunter perceptions of chronic wasting disease and other hunting risks*. Paper presented at the 3rd International Chronic Wasting Disease Symposium, Park City, Utah, July 22–24.

Needham, M. D., Vaske, J. J., Donnelly, M. P., & Manfredo, M. J. (2007). Hunting specialization and its relationship to participation in response to chronic wasting disease. *Journal of Leisure Research, 39*(3), 413–437.

Needham, M. D., Vaske, J. J., & Manfredo, M. J. (2004). Hunters' behavior and acceptance of management actions related to chronic wasting disease in eight states. *Human Dimensions of Wildlife, 9*(3), 211–231.

Needham, M. D., Vaske, J. J., & Manfredo, M. J. (2006). State and residency differences in hunters' responses to chronic wasting disease. *Human Dimensions of Wildlife, 11*(3), 159–176.

Petchenik, J. (2003). *Chronic wasting disease in Wisconsin and the 2002 hunting season: Gun deer hunters' first response* (Misc. Pub. No. PUB-SS-982 2003). Madison: Bureau of Integrated Science Services, Wisconsin Department of Natural Resources. Retrieved from http://www.dnr.state.wi.us/org/es/science/publications/PUB_SS_982_2003.pdf

Raymond, G. J., Bossers, A., Raymond, L. D., O'Rourke, K. I., McHolland, L. E., Bryant, P. K., et al. (2000). Evidence of a molecular barrier limiting susceptibility of humans, cattle and sheep to chronic wasting disease. *EMBO Journal, 19*(17), 4425–4430.

Salman, M. D. (2003). Chronic wasting disease in deer and elk: Scientific facts and findings. *Journal of Veterinary Medical Science, 65*(7), 761–768.

Schauber, E. M., & Woolf, A. (2003). Chronic wasting disease in deer and elk: A critique of current models and their application. *Wildlife Society Bulletin, 31*(3), 610–616.

Siegrist, M., & Cvetkovich, G. T. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis, 20*(5), 713–720.

Siegrist, M., Gutscher, H., & Earle, T. C. (2005). Perception of risk: The influence of general trust, and general confidence. *Journal of Risk Research, 8*, 145–156.

Sjöberg, L. (1998). Risk perception: Experts and the public. *European Psychologist, 3*(1), 1–12.

Sjöberg, L. (1999). Risk perception by the public and by experts: A dilemma in risk management. *Human Ecology Review, 6*(2), 1–9.

Sjöberg, L. (2000a). Factors in risk perception. *Risk Analysis, 20*(1), 1–12.

Sjöberg, L. (2000b). Perceived risk and tampering with nature. *Journal of Risk Research, 3*(4), 353–367.

Slovic, P. (1987). Perception of risk. *Science, 236*(4799), 280–285.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19*, 689–701.

Slovic, P., Fischoff, B., & Lichtenstein, S. (1981). Perceived risk: Psychological factors and social implications. *Proceedings of the Royal Society of London, Series A: Mathematical and Physical Sciences, 376*(1764), 17–34.

Spraker, T. R., Miller, M. W., Williams, E. S., Getzy, D. M., Adrian, W. J., Schoonveld, G. G., et al. (1997). Spongiform encephalopathy in free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*) and Rocky

Mountain elk (*Cervus elaphus nelsoni*) in northcentral Colorado. *Journal of Wildlife Diseases, 33*(1), 1–6.

Stonehouse, J. M., & Mumford, J. D. (1994). *Science, risk analysis and environmental policy decisions*. Geneva, Switzerland: UNEP.

Sugihantono, A., Slidell, M., Syaifudin, A., Pratjojo, H., Utami, I. M., Sadjimin, T., et al. (2003). Syphilis and HIV prevalence among commercial sex workers in central Java, Indonesia: Risk taking behavior and attitudes that may potentiate a wider epidemic. *AIDS Patient Care & STD's, 17*(11), 595–601.

Thompson, P. B., & Dean, W. (1996). Competing conceptions of risk. *Risk Health Safety Environment, 7*, 361–384.

Vaske, J. J. (2008). *Survey research and analysis: Applications in parks, recreation and human dimensions*. State College, PA: Venture Publishing.

Vaske, J. J. (2010). Lessons learned from human dimensions of chronic wasting disease research. *Human Dimensions of Wildlife, 15*(3), 165–179.

Vaske, J. J., Needham, M. D., Newman, P., Manfredo, M. J., & Petchenik, J. (2006). Potential for conflict index: Hunters' responses to chronic wasting disease. *Wildlife Society Bulletin, 34*(1), 44–50.

Vaske, J. J., Needham, M. D., Stafford, N. T., Green, K., & Petchenik, J. (2006). Information sources and knowledge about chronic wasting disease in Colorado and Wisconsin. *Human Dimensions of Wildlife, 11*(3), 191–202.

Vaske, J. J., Shelby, L. B., & Needham, M. D. (2009). Preparing for the next disease: The human–wildlife connection. In M. J. Manfredo, J. J. Vaske, P. J. Brown, D. J.

Decker & E. A. Duke (Eds.), *Wildlife and society: The science of human dimensions* (pp. 244–261). Washington, DC: Island Press.

Vaske, J. J., Timmons, N. R., Beaman, J., & Petchenik, J. (2004). Chronic wasting disease in Wisconsin: Hunter behavior, perceived risk, and agency trust. *Human Dimensions of Wildlife, 9*(3), 193–209.

Whittaker, D., Vaske, J. J., & Manfredo, M. J. (2006). Specificity and the cognitive hierarchy: Value orientations and the acceptability of urban wildlife management actions. *Society & Natural Resources, 19*(6), 515–530.

Williams, E. S., Miller, M. W., Kreeger, T. J., Kahn, R. H., & Thorne, E. T. (2002). Chronic wasting disease of deer and elk: A review with recommendations for management. *Journal of Wildlife Management, 66*(3), 551–563.

Williams, E. S., & Young, S. (1980). Chronic wasting disease of captive mule deer: A spongiform encephalopathy. *Journal of Wildlife Diseases, 16*(1), 89–98.

Williams, E. S., & Young, S. (1982). Spongiform encephalopathy of Rocky Mountain elk. *Journal of Wildlife Diseases, 18*(4), 465–471.

Wisconsin Department of Natural Resources. (2002). *Understanding chronic wasting disease in Wisconsin: The first steps to disease control*. Madison: Wisconsin Department of Natural Resources. Retrieved from http://www.dnr.state.wi.us/org/land/wildlife/whealth/issues/CWD/doc/cwdbook.pdf

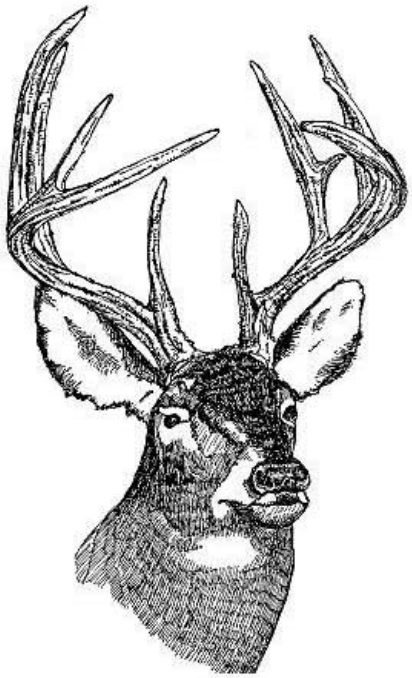
Wisconsin Department of Natural Resources. (2009). *A plan for managing chronic wasting disease in Wisconsin: The next five years* (WM-482-2008). Madison: Wisconsin Department of Natural Resources.

Yates, J. F. (1992). *Risk taking behavior*. New York: Wiley.

APPENDIX A. MAIL SURVEY INSTRUMENT ADMINISTERED TO HUNTERS (ARIZONA EXAMPLE)

Hunters' Responses to Chronic Wasting Disease in Arizona

Important Questions for Arizona Deer Hunters



All Responses Are Confidential

Please Complete This Survey. Thank You For Your Cooperation

Postage-Paid Return Envelope Provided

A Study Conducted Cooperatively By:

Arizona Game & Fish

Colorado State University

Knowledge to Go Places

Western Association of Fish and Wildlife Agencies

Most of the questions in this survey ask about your views regarding Chronic Wasting Disease (CWD) in deer in Arizona. **CWD has not yet been detected in Arizona, but the disease has been detected in three bordering states.** Before asking these questions, we would like to know a little bit about you as a hunter and your deer hunting experiences. The questions on this page ask about your deer hunting (mule deer and / or white-tailed deer) experiences in Arizona.

1 Our records show that you purchased a license to hunt deer in Arizona during the **2002** deer hunting season (fall / winter 2002). Did you go deer hunting in Arizona during the **2002** deer hunting season? **(check one)**

☐ No → if no, skip to question 6 below

☐ Yes

2 Did you harvest any deer during the **2002** deer hunting season in Arizona? **(check one)**

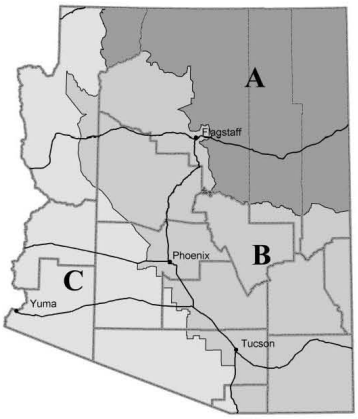
☐ No

☐ Yes → if yes, how many bucks and / or does did you harvest during the **2002** deer hunting season in Arizona? **(write responses)**

Number of **bucks** harvested _____ Number of **does** harvested _____

3 Taking everything into consideration, how would you rate the quality of your **2002** deer hunting season in Arizona? **(check one)**

☐ Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent ☐ Perfect



The above map of Arizona contains three separate zones, with Zone A (includes most of the Northern Kaibab and Mogollon Rim area) shaded the darkest, Zone B (Central Highlands and Southeast Arizona), and Zone C (Colorado River and Lowland Desert) shaded the lightest. Please answer Questions 4 through 7 on this page while looking at the above map of Arizona.

4 In which zone(s) did you hunt deer during the **2002** deer hunting season? **(check all that apply)**

☐ Zone A ☐ Zone B ☐ Zone C

5 About how many **days** did you hunt deer in each zone during the **2002** deer hunting season? **(write responses; put "0" if you did not hunt in the zone)**

Number of days in Zone A _____ Number of days in Zone B _____ Number of days in Zone C _____

6 In which zone(s) have you **ever** hunted deer in your life? **(after looking at the above map, check all that apply)**

☐ Zone A ☐ Zone B ☐ Zone C ☐ I have never hunted deer in Arizona

7 In which ***one*** zone have you hunted deer the most often in your life? **(check one)**

☐ Zone A ☐ Zone B ☐ Zone C ☐ I have never hunted deer in Arizona

Now we would like to ask about your involvement in deer hunting. The questions on this page ask about your deer hunting experiences (mule deer and / or white-tailed deer) in Arizona and any other areas where you have hunted deer in your life.

1 In total, about how many years have you hunted deer ***in Arizona***? **(write response)**

Number of years _____

2 In total, about how many years have you hunted deer ***in your life***? **(write response)**

Number of years _____

3 To what extent do you disagree or agree with each of the following statements related to your level of involvement in deer hunting? **(circle one number for *each* statement that most closely matches your response)**

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
If I stopped deer hunting, an important part of my life would be missing.	1	2	3	4	5	6	7
Deer hunting is an annual tradition that has become important to me over the years.	1	2	3	4	5	6	7
Participation in deer hunting is a large part of my life.	1	2	3	4	5	6	7
Given the deer hunting skills and knowledge that I have developed over the years, it is important that I continue to hunt deer.	1	2	3	4	5	6	7
Testing / improving my deer hunting skills is more important to me than harvesting a deer.	1	2	3	4	5	6	7
Given the amount of effort I have put into becoming a deer hunter, it would be difficult for me to find another activity to replace deer hunting.	1	2	3	4	5	6	7
Over the years, I have accumulated a lot of deer hunting equipment.	1	2	3	4	5	6	7
Over the years, I have invested a lot of money in deer hunting equipment.	1	2	3	4	5	6	7
I spend a lot of my time learning about the newest deer hunting equipment on the market.	1	2	3	4	5	6	7
I mainly hunt deer to bring the meat home to eat.	1	2	3	4	5	6	7
A hunting trip can be successful to me even if no deer are harvested.	1	2	3	4	5	6	7
I mainly hunt deer to harvest a trophy deer.	1	2	3	4	5	6	7

4 Did you (or do you intend to) hunt deer in Arizona during the **2003** deer hunting season (fall / winter 2003)? **(check one)**

☐ No ☐ Yes ☐ Unsure

5 If you are able to obtain a tag / license, do you intend to hunt deer in Arizona during the **2004** deer hunting season (fall / winter 2004)? **(check one)**

☐ No ☐ Yes ☐ Unsure

Chronic Wasting Disease (CWD) is a fatal brain disease of deer and elk believed to be caused by an abnormal protein called a prion. In the early stages of the disease, infected animals may appear healthy. In later stages, infected animals may display one or more symptoms such as: weight loss, lack of energy, "droopy" appearance, and excessive salivation. Infected animals eventually die. The origin and transmission of CWD is not well understood. The questions on this page and on most of the remaining pages of this survey ask about your knowledge and opinions regarding CWD. **CWD has not yet been detected in Arizona, but the disease has been detected in three bordering states (Colorado, Utah, New Mexico).**

1 Prior to receiving this survey, do you feel that you had enough information about each of the following CWD related topics? **(circle one number for *each* statement that most closely matches your response)**

Do you feel that you had enough information about…	Definitely No	Probably No	Probably Yes	Definitely Yes
…A. what states have deer with CWD?	1	2	3	4
…B. what type(s) of wildlife species can have CWD?	1	2	3	4
…C. what causes CWD in wildlife?	1	2	3	4
…D. possible livestock health risks associated with CWD?	1	2	3	4
…E. possible human safety risks associated with CWD?	1	2	3	4
…F. precautions that hunters should take because of CWD?	1	2	3	4
…G. what the Arizona Game and Fish Department is doing about CWD concerns in Arizona?	1	2	3	4

2 From the list of CWD related topics in Question 1 (above), please state ***three* topics** that you would want more information about. **(write up to *three letters* that match your responses; leave lines blank if you would not want more information)**

Letter(s) _____ _____ _____

3 Do you think that the Arizona Game and Fish Department should provide hunters with more information on CWD? **(check one)**

☐ No ☐ Yes, a little bit more ☐ Yes, a lot more ☐ Unsure

4 Do you think that the Arizona Game and Fish Department has given CWD too little attention, about the right amount, or too much attention? **(check one)**

☐ Too little ☐ About right ☐ Too much ☐ Unsure

5 To what extent do you disagree or agree with each of the following statements related to CWD? **(circle one number for *each* statement that most closely matches your response, NA = not applicable)**

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree	
The threat of CWD has been exaggerated.	1	2	3	4	5	6	7	
CWD poses some risk to deer, but not to humans.	1	2	3	4	5	6	7	
CWD may pose some risk to humans, but not enough is known to be sure.	1	2	3	4	5	6	7	
CWD can possibly cause disease in humans if they eat meat from animals infected with it.	1	2	3	4	5	6	7	
Because of CWD, I have concerns about eating deer meat.	1	2	3	4	5	6	7	NA
Because of CWD, members of my family (for example: spouse, children) have concerns about eating deer meat.	1	2	3	4	5	6	7	NA

6 How much risk do you think is associated with each of the following incidents happening to you during or as a consequence of your deer hunt? **(circle one number for *each* statement that most closely matches your response)**

	No Risk		Slight Risk		Moderate Risk			Extreme Risk	
Being in a car accident traveling to / from the hunting site.	1	2	3	4	5	6	7	8	9
Getting lost while hunting.	1	2	3	4	5	6	7	8	9
Getting shot by another hunter.	1	2	3	4	5	6	7	8	9
Accidentally shooting myself.	1	2	3	4	5	6	7	8	9
Having a heart attack while hunting.	1	2	3	4	5	6	7	8	9
Inadvertently eating meat from an animal infected with CWD.	1	2	3	4	5	6	7	8	9
Contracting a disease caused by CWD.	1	2	3	4	5	6	7	8	9
Becoming ill as a result of contracting a disease caused by CWD.	1	2	3	4	5	6	7	8	9
Death as a result of contracting a disease caused by CWD.	1	2	3	4	5	6	7	8	9

7 Because of CWD, how concerned are you about the ***health of the deer population in Arizona***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

8 Because of CWD, how concerned are you for ***your own personal health***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

9 We would like to know how concerned you would be about eating meat from a wild deer harvested by you or another hunter in a management unit where **CWD ***had not*** previously been found in other wild deer**. Below are three possibilities for eating wild deer meat. For each possibility, how concerned would you be about eating meat from this deer?
(circle one number for *each* statement that most closely matches your response)

How concerned would you be about eating meat from this deer if it…	Not at all Concerned	Slightly Concerned	Moderately Concerned	Extremely Concerned (I would not eat the meat)	Unsure
…was not tested for CWD?	1	2	3	4	5
…was tested and the result was negative, (CWD was not detected in the animal)?	1	2	3	4	5
…was tested and the result was positive, (CWD was detected in the animal)?	1	2	3	4	5

10 Now we would like to know how concerned you would be about eating meat from a wild deer harvested by you or another hunter in a management unit where **CWD ***had*** previously been found in other wild deer**. Below are three possibilities for eating wild deer meat. For each possibility, how concerned would you be about eating meat from this deer?
(circle one number for *each* statement that most closely matches your response)

How concerned would you be about eating meat from this deer if it…	Not at all Concerned	Slightly Concerned	Moderately Concerned	Extremely Concerned (I would not eat the meat)	Unsure
…was not tested for CWD?	1	2	3	4	5
…was tested and the result was negative, (CWD was not detected in the animal)?	1	2	3	4	5
…was tested and the result was positive, (CWD was detected in the animal)?	1	2	3	4	5

11 During the **2002** deer hunting season in Arizona, was your deer submitted for CWD testing? **(check one)**

☐ Yes → if yes, did you wait until you had the test results before eating any of the deer meat? **(check one)**
- ☐ No
- ☐ Yes

☐ No → if no, please tell us why you did not have your deer tested for CWD. **(check all that apply)**
- ☐ I did not harvest any deer in Arizona in 2002
- ☐ I did not hunt in an area where CWD had been detected in deer
- ☐ I did not know that CWD testing was available in Arizona
- ☐ I did not want to take the time to submit / drop off the deer head
- ☐ I did not think that CWD posed any risk to me
- ☐ I did not know enough about CWD testing in Arizona
- ☐ I knew that CWD had not been detected in deer in Arizona
- ☐ I trusted my own butchering skills
- ☐ I planned to mount the deer head
- ☐ I had no intentions of eating the deer meat
- ☐ Notification of the test results took too long
- ☐ The test was too costly
- ☐ I did not trust CWD testing results

12 During the **2002** deer hunting season in Arizona, did you limit your deer hunting because of concerns about CWD? **(check one)**
- ☐ No, I went deer hunting in Arizona **more often** than in past years
- ☐ No, I went deer hunting in Arizona **about the same amount** as I always do
- ☐ Yes, I went deer hunting in Arizona **less often** than in past years because of concerns about CWD
- ☐ Yes, I **never** went deer hunting in Arizona in 2002 because of concerns about CWD
- ☐ I went deer hunting in Arizona **less often** than in past years, but this had nothing to do with concerns about CWD
- ☐ I **never** went deer hunting in Arizona in 2002, but this had nothing to do with concerns about CWD

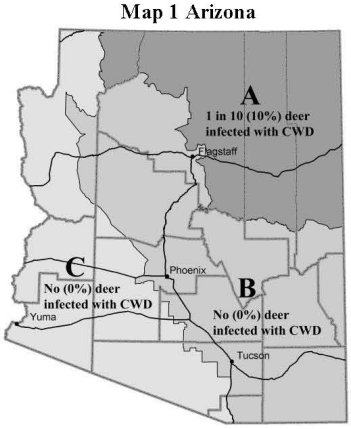
Please read this information before answering the questions on the next page: CWD has not yet been detected in wild deer or elk in Arizona. However, CWD has been detected in three bordering states (Colorado, Utah, New Mexico).

The four situations described in the following pages are **IMAGINARY** (hypothetical). **They do not reflect current conditions or consequences to humans**. There is no evidence to suggest that CWD poses a health risk to humans. However, your responses to each of these **IMAGINARY** situations are very important for understanding what hunters would do in response to CWD if conditions changed or CWD was ever found in Arizona. **Please respond to *each* question for *each* of the following situations as if the conditions had existed during your most recent deer hunting season in Arizona.**

Please read each situation very carefully, look at the map, and then answer all of the questions that follow each situation.

Imaginary Situation 1

Map 1 Arizona



Imaginary Situation 1. Imagine these conditions existed in Arizona, when you were considering whether or not to go deer hunting:

- **CWD had been found in: 1 in 10 (10%) deer in Zone A, but in no (0%) deer in Zones B and C**

There is no evidence that CWD poses a health risk to humans
It is known that testing deer for CWD is available in Arizona and is 99% accurate

1 Given Situation 1 **(see map 1)**, what would you do? **(check one)**

- ☐ Hunt deer in the zone in Arizona that I hunt deer in most often – which zone is that? **(check one)** ☐ A ☐ B ☐ C
- ☐ Hunt deer in Arizona, but switch to a different zone – which zone(s)? **(check all that apply)** ☐ A ☐ B ☐ C
- ☐ Give up deer hunting in Arizona, but hunt deer in another state – which state(s)? **(write response)** _____
- ☐ Give up deer hunting altogether

2 Given Situation 1, how concerned would you be about the ***health of the deer population in Arizona***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

3 Given Situation 1, how concerned would you be for ***your own personal health***? **(check one)**

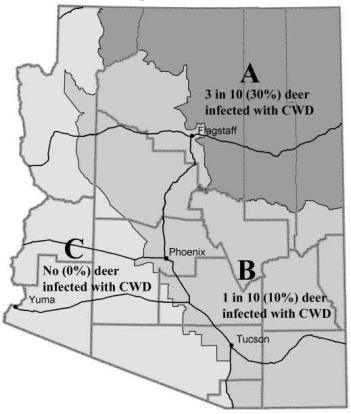
☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

4 Given Situation 1, how unacceptable or acceptable would it be for the Arizona Game and Fish Department to take each of the following actions? **(circle one number for *each* statement that most closely matches your response)**

How acceptable is it for the Arizona Game and Fish Department to…	Highly Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
…take no action and allow CWD to take its natural course.	1	2	3	4	5	6	7
…continue to test deer for CWD.	1	2	3	4	5	6	7
…use *trained agency staff* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7
…use *hunters* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7

Imaginary Situation 2

Map 2 Arizona



Imaginary Situation 2. Imagine these conditions existed in Arizona, when you were considering whether or not to go deer hunting:

- **CWD had been found in: 3 in 10 (30%) deer in Zone A, 1 in 10 (10%) deer in Zone B, but in no (0%) deer in Zone C**

There is no evidence that CWD poses a health risk to humans

It is known that testing deer for CWD is available in Arizona and is 99% accurate

1 Given Situation 2 **(see map 2)**, what would you do? **(check one)**

- ☐ Hunt deer in the zone in Arizona that I hunt deer in most often – which zone is that? **(check one)** ☐ A ☐ B ☐ C
- ☐ Hunt deer in Arizona, but switch to a different zone – which zone(s)? **(check all that apply)** ☐ A ☐ B ☐ C
- ☐ Give up deer hunting in Arizona, but hunt deer in another state – which state(s)? **(write response)** _____
- ☐ Give up deer hunting altogether

2 Given Situation 2, how concerned would you be about the ***health of the deer population in Arizona***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

3 Given Situation 2, how concerned would you be for ***your own personal health***? **(check one)**

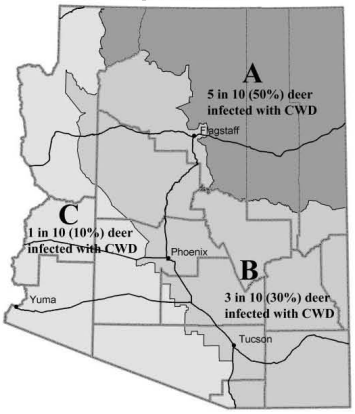
☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

4 Given Situation 2, how unacceptable or acceptable would it be for the Arizona Game and Fish Department to take each of the following actions? **(circle one number for *each* statement that most closely matches your response)**

How acceptable is it for the Arizona Game and Fish Department to…	Highly Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
…take no action and allow CWD to take its natural course.	1	2	3	4	5	6	7
…continue to test deer for CWD.	1	2	3	4	5	6	7
…use *trained agency staff* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7
…use *hunters* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7

Imaginary Situation 3

Map 3 Arizona



Imaginary Situation 3. Imagine these conditions existed in Arizona, when you were considering whether or not to go deer hunting:

- **CWD had been found in: 5 in 10 (50%) deer in Zone A, 3 in 10 (30%) deer in Zone B, and 1 in 10 (10%) deer in Zone C**

There is no evidence that CWD poses a health risk to humans
It is known that testing deer for CWD is available in Arizona and is 99% accurate

1 Given Situation 3 **(see map 3)**, what would you do? **(check one)**

- ☐ Hunt deer in the zone in Arizona that I hunt deer in most often – which zone is that? **(check one)** ☐ A ☐ B ☐ C
- ☐ Hunt deer in Arizona, but switch to a different zone – which zone(s)? **(check all that apply)** ☐ A ☐ B ☐ C
- ☐ Give up deer hunting in Arizona, but hunt deer in another state – which state(s)? **(write response)** _____
- ☐ Give up deer hunting altogether

2 Given Situation 3, how concerned would you be about the ***health of the deer population in Arizona***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

3 Given Situation 3, how concerned would you be for ***your own personal health***? **(check one)**

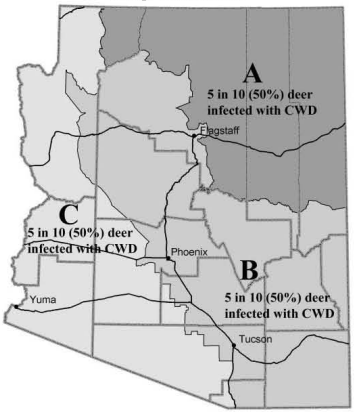
☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

4 Given Situation 3, how unacceptable or acceptable would it be for the Arizona Game and Fish Department to take each of the following actions? **(circle one number for *each* statement that most closely matches your response)**

How acceptable is it for the Arizona Game and Fish Department to…	Highly Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
…take no action and allow CWD to take its natural course.	1	2	3	4	5	6	7
…continue to test deer for CWD.	1	2	3	4	5	6	7
…use *trained agency staff* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7
…use *hunters* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7

Imaginary Situation 4

Map 4 Arizona



Imaginary Situation 4. Imagine these conditions existed in Arizona, when you were considering whether or not to go deer hunting:

- **CWD had been found in: 5 in 10 (50%) deer across the entire state (in Zones A, B, and C)**

There is no evidence that CWD poses a health risk to humans
It is known that testing deer for CWD is available in Arizona and is 99% accurate

1 Given Situation 4 **(see map 4)**, what would you do? **(check one)**

- ☐ Hunt deer in the zone in Arizona that I hunt deer in most often – which zone is that? **(check one)** ☐ A ☐ B ☐ C
- ☐ Hunt deer in Arizona, but switch to a different zone – which zone(s)? **(check all that apply)** ☐ A ☐ B ☐ C
- ☐ Give up deer hunting in Arizona, but hunt deer in another state – which state(s)? **(write response)** _____
- ☐ Give up deer hunting altogether

2 Given Situation 4, how concerned would you be about the ***health of the deer population in Arizona***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

3 Given Situation 4, how concerned would you be for ***your own personal health***? **(check one)**

☐ Not at all concerned ☐ Slightly concerned ☐ Moderately concerned ☐ Extremely concerned

4 Given Situation 4, how unacceptable or acceptable would it be for the Arizona Game and Fish Department to take each of the following actions? **(circle one number for *each* statement that most closely matches your response)**

How acceptable is it for the Arizona Game and Fish Department to…	Highly Unacceptable	Moderately Unacceptable	Slightly Unacceptable	Neither	Slightly Acceptable	Moderately Acceptable	Highly Acceptable
…take no action and allow CWD to take its natural course.	1	2	3	4	5	6	7
…continue to test deer for CWD.	1	2	3	4	5	6	7
…use *trained agency staff* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7
…use *hunters* to dramatically reduce herds in affected zones to lower the potential for CWD spreading.	1	2	3	4	5	6	7

1 What circumstances ***related to CWD*** would cause you to ***give up deer hunting in Arizona, but hunt deer in a different state***? (**write response**) _____

_____

2 What circumstances ***related to CWD*** would cause you to ***give up deer hunting altogether***? (**write response**) _____

_____

The remaining questions on this page ask about your opinions regarding the research and management of CWD in your state.

1 The Arizona Game and Fish Department is responsible for managing Arizona's wildlife resources. To what extent do you disagree or agree with each of the following statements regarding your **trust** in the Arizona Game and Fish Department. **(circle one number for *each* statement that most closely matches your response)**

I **trust** the Arizona Game and Fish Department to…	Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither	Slightly Agree	Moderately Agree	Strongly Agree
…provide the best available information on CWD issues.	1	2	3	4	5	6	7
…provide me with enough information to decide what actions I should take regarding CWD.	1	2	3	4	5	6	7
…provide truthful information about human safety issues related to CWD.	1	2	3	4	5	6	7
…provide timely information regarding CWD issues.	1	2	3	4	5	6	7
…make good deer management decisions regarding CWD issues.	1	2	3	4	5	6	7
…properly address CWD in Arizona.	1	2	3	4	5	6	7

2 How believable would you rate each of the following types of CWD information provided by the Arizona Game and Fish Department? **(circle one number for *each* statement that most closely matches your response)**

	Not at all Believable		Slightly Believable		Moderately Believable			Highly Believable		Unsure
Biological information about CWD.	1	2	3	4	5	6	7	8	9	0
Information about human safety issues related to CWD.	1	2	3	4	5	6	7	8	9	0
Information about deer management strategies due to CWD.	1	2	3	4	5	6	7	8	9	0

3 Taking everything into consideration, how would you grade the Arizona Game and Fish Department for handling CWD concerns in Arizona (even though CWD has not yet been identified in Arizona)? **(check one)**

☐ A+ ☐ A ☐ A- ☐ B+ ☐ B ☐ B- ☐ C+ ☐ C ☐ C- ☐ D ☐ F

4 In Arizona, funding for CWD research and management is limited and there is a need for new funds. What is the maximum amount that you would be willing to contribute (pay funds) **per year *in addition* to your hunting license fee** to help the Arizona Game and Fish Department **research** and /or **manage** CWD in the state? **(write responses; put "0" if you feel that you would not be willing to contribute funds)**

In addition to my hunting license fee…

…I would be willing to contribute _____ dollars for **CWD research** (for example: testing / monitoring)

…I would be willing to contribute _____ dollars for **CWD management** (for example: herd reduction and / or education)

5 About how often do you obtain information about ***hunting in Arizona*** from each of the following sources?
(circle one number for *each* statement that most closely matches your response)

	Never		Sometimes		Often
A. Newspaper(s).	1	2	3	4	5
B. Television news.	1	2	3	4	5
C. Other television program(s) (for example: on Discovery Channel, PBS).	1	2	3	4	5
D. Radio station(s).	1	2	3	4	5
E. Arizona Game and Fish Department internet website.	1	2	3	4	5
F. Other internet website(s).	1	2	3	4	5
G. Hunting / sportsmen's club meeting(s).	1	2	3	4	5
H. Hunting / sportsmen's club newsletter(s).	1	2	3	4	5
I. Hunting / outdoors magazine(s) and / or book(s).	1	2	3	4	5
J. Other type(s) of magazine(s) and / or book(s).	1	2	3	4	5
K. Arizona Game and Fish Department hunting regulations.	1	2	3	4	5
L. Other Arizona Game and Fish Department publication(s) (for example: brochures, direct mailings, magazines).	1	2	3	4	5
M. Arizona Game and Fish Department personnel / employees.	1	2	3	4	5
N. Publication(s) of conservation group(s) (for example: Ducks Unlimited).	1	2	3	4	5
O. Friend(s) or family member(s) / word of mouth.	1	2	3	4	5
P. Exhibition(s) / trade show(s).	1	2	3	4	5

6 From the list of information sources in Question 5 (above), please state the ***one* main source** from which you would ***prefer*** to obtain information regarding ***CWD issues in Arizona***. **(write only *one letter* that matches your response)**

Letter _____

7 About how often have you done each of the following activities related to CWD?
(circle one number for *each* statement that most closely matches your response)

How often have you...	Never	1 or 2 Times	3 or 4 Times	5 or More Times
...read newspaper article(s) about CWD?	1	2	3	4
...watched television news report(s) about CWD?	1	2	3	4
...watched other television program(s) about CWD?	1	2	3	4
...watched video(s) / DVD(s) about CWD?	1	2	3	4
...listened to radio news / radio program(s) about CWD?	1	2	3	4
...read about CWD on the Arizona Game and Fish Department internet website?	1	2	3	4
...read about CWD on other internet website(s)?	1	2	3	4
...discussed CWD at hunting / sportsmen's club meeting(s)?	1	2	3	4
...read about CWD in hunting / sportsmen's club newsletter(s)?	1	2	3	4
...read about CWD in magazine(s) and / or book(s)?	1	2	3	4
...read about CWD in Arizona Game and Fish Department publication(s) (for example: regulations, brochures)?	1	2	3	4
...discussed CWD issues with Arizona Game and Fish Department personnel / employees?	1	2	3	4
...read about CWD in publication(s) of conservation group(s)?	1	2	3	4
...discussed CWD issues with friend(s) or family member(s)?	1	2	3	4
...listened to live presentation(s) about CWD (for example: talk by Game and Fish Department personnel, public meeting)?	1	2	3	4

Now we would like to ask you a few more questions about your hunting experiences. The questions on this page ask about your deer hunting experiences (mule deer and / or white-tailed deer) in Arizona and any other areas where you have hunted deer in your life.

1 What ***one*** type of deer hunting do you do most often in Arizona? **(check one)**

- ☐ Gun (for example: rifle, shotgun)
- ☐ Bow / Archery
- ☐ Muzzleloading
- ☐ I have never hunted deer in Arizona

2 People go deer hunting for many reasons. Listed below are several reasons why deer hunting may be important to you. Please indicate how important each of these reasons is in influencing you to go deer hunting.
(circle one number for *each* statement that most closely matches your response)

	Not at all Important	Slightly Important	Moderately Important	Extremely Important
Harvesting a deer.	1	2	3	4
Bringing deer meat home to eat.	1	2	3	4
Harvesting only a trophy deer.	1	2	3	4
Controlling the number of deer in the herd.	1	2	3	4
Helping to control the spread of CWD.	1	2	3	4
Being in nature.	1	2	3	4
Experiencing solitude.	1	2	3	4
Being with friends or family.	1	2	3	4
Experiencing the challenge of the hunt.	1	2	3	4
Testing / improving my hunting skills.	1	2	3	4
Having / using the right hunting equipment.	1	2	3	4
Getting physical exercise.	1	2	3	4

3 For some people, deer hunting may be one of the most important interests in their lives. For others, it may be just one of a number of interests they have; something that they enjoy, but to which they are not strongly committed. If you could ***not*** participate in deer hunting, would you: **(check one)**

- ☐ Not miss it at all
- ☐ Miss it slightly
- ☐ Miss it more than most of your other activities
- ☐ Miss it more than all of your other activities

4 Considering all of your other ***wildlife-oriented activities***, how many substitutes do you have for deer hunting? In other words, if you could ***not*** participate in deer hunting, how many other different wildlife-oriented activities are there that you enjoy doing just as much or more? **(check one)**

- ☐ I have **no** substitutes for deer hunting
- ☐ I have only **a few** substitutes for deer hunting
- ☐ I have **some** substitutes for deer hunting
- ☐ I have **many** substitutes for deer hunting

5 If you could never go deer hunting again, what ***one*** **wildlife-oriented activity** would you likely do instead? Please be as specific as possible (for example: duck hunting, bear hunting, fishing, wildlife viewing). **(write only *one* response)** _____

_____

6 Is the ***one activity*** that you listed in Question 5 (above) a substitute that would give you the same level of satisfaction or benefit that you get from deer hunting? **(check one)**

- ☐ Definitely no
- ☐ Probably no
- ☐ Probably yes
- ☐ Definitely yes

Finally, we would like to ask you a few questions about yourself to help us understand the different characteristics of hunters and to allow us to compare your answers with those of other hunters. **Your answers are totally confidential**.

1 Are you: **(check one)** ☐ male ☐ female

2 How old are you? **(write response)** _____ years old

3 What is your **current** marital status? **(check one)**
- ☐ Married or living with partner
- ☐ Not married or not living with a partner (for example: divorced, separated, widowed, single)

4 **Including yourself**, how many people are **currently** living in your household? **(write response)** _____ person(s)

5 How many people **under 18 years of age** are **currently** living in your household? **(write response)** _____ person(s)

6 How would you describe your **current** residence or community? **(check one)**
- ☐ Large city with 250,000 or more people
- ☐ City with 100,000 to 249,999 people
- ☐ City with 50,000 to 99,999 people
- ☐ Small city with 25,000 to 49,999 people
- ☐ Town with 10,000 to 24,999 people
- ☐ Town with 5,000 to 9,999 people
- ☐ Small town / village with less than 5,000 people
- ☐ A farm or rural area

7 What is the **highest** level of education that you have achieved? **(check one)**
- ☐ Less than high school diploma
- ☐ High school diploma or GED
- ☐ 2-year associates degree or trade school
- ☐ Some college at a 4-year institution
- ☐ 4-year college degree (for example: Bachelors degree)
- ☐ Advanced degree beyond 4-year degree (for example: Masters, Ph.D., Medical doctor, Law degree)

8 Finally, which of the following broad categories best describes your **current** approximate **annual household** income before taxes? **(check one)**
- ☐ Less than $10,000
- ☐ $10,000 - $29,999
- ☐ $30,000 - $49,999
- ☐ $50,000 - $69,999
- ☐ $70,000 - $89,999
- ☐ $90,000 - $109,999
- ☐ $110,000 - $129,999
- ☐ $130,000 - $149,999
- ☐ $150,000 or more

THANK YOU FOR COMPLETING THIS SURVEY, YOUR INPUT IS VERY IMPORTANT

PLEASE RETURN THE COMPLETED SURVEY AS SOON AS POSSIBLE IN THE ENCLOSED ADDRESSED AND POSTAGE-PAID ENVELOPE

If you have questions about this survey, please contact Mark Needham (970 491 4865, mneedham@cnr.colostate.edu) or Jerry Vaske (970 491 2360, jerryv@cnr.colostate.edu) in the Human Dimensions in Natural Resources Unit at Colorado State University.

If you have questions or would like information about Chronic Wasting Disease or other hunting-related issues in Arizona, please contact the Arizona Game and Fish Department website: www.gf.state.az.us or Ty Gray (602 789 3527, tgray@gf.state.az.us).