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# State and Residency Differences in Hunters' Responses to Chronic Wasting Disease

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*This article examines: (a) the extent to which chronic wasting disease (CWD) may influence individuals to hunt in other states or quit hunting permanently; (b) hunters' acceptance of strategies for managing the disease; and (c) whether hunters' responses differ by residency, species hunted, and state where they hunted. Data were obtained from mail surveys (*n = *9,567) of resident and nonresident deer hunters in eight states and elk hunters in three states. Hunters were shown hypothetical scenarios depicting CWD prevalence levels and human death from the disease. At current prevalence levels in some states, few hunters would change their behavior. If conditions worsen (e.g., 50% prevalence across state, human death), up to 18% of hunters would hunt deer or elk in other states and 37% would quit hunting these species. Arizona and North Dakota hunters were most likely to alter their behavior. Given that CWD is not in these states, it may pose a new risk. In Wisconsin, where hunting is a tradition, hunters were least likely to change their behavior. Across most scenarios: (a) hunters were more likely to quit than switch states; (b) residents were more likely to quit and nonresidents would switch states; and (c) CWD testing and herd reduction were acceptable, whereas taking no action was unacceptable.*

**Keywords** chronic wasting disease, hunting, risk behavior, wildlife management, potential for conflict index

## Introduction

Chronic wasting disease (CWD) is a neurological disease of deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and moose (*Alces alces*) (CDOW, 2005; Williams, Miller, Kreeger, Kahn, & Thorne, 2002). CWD belongs to a family of transmissible spongiform encephalopathy (TSE) diseases such as bovine spongiform encephalopathy in cattle (i.e., BSE, mad cow), scrapie in sheep, and Creutzfeldt-Jakob disease in humans (McKintosh, Tabrizi, &

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Collinge, 2003). Animals infected with CWD exhibit abnormal behavior, emaciation, and excessive salivation (Williams & Young, 1980). There is no known treatment for CWD and the disease is always fatal (Williams et al., 2002). No evidence exists to suggest that CWD poses a human health risk, but transmission to humans cannot be dismissed (Belay et al., 2004; Raymond et al., 2000; Salman, 2003).

CWD has been found in free-ranging deer and elk in 11 states (Colorado, Illinois, Kansas, Nebraska, New Mexico, New York, South Dakota, Utah, West Virginia, Wisconsin, Wyoming) and two provinces (Alberta, Saskatchewan), and was recently detected in moose in Colorado (CDOW, 2005). If CWD conditions worsen, hunting participation may substantially decrease. Needham, Vaske, and Manfredo (2004), for example, reported that approximately 50% of hunters across several states would stop hunting in their state if the majority of deer or elk had CWD. The decline would be even greater (e.g., 65%) if high prevalence is combined with threats to human health such as death from CWD. Hunters also believed that CWD testing and herd reduction in affected areas were acceptable management actions; letting CWD take its natural course was unacceptable. Small sample sizes in the Needham et al. (2004) study, however, limited the ability to examine differences among states and between deer and elk hunters.

This article builds on Needham et al. (2004) by using more extensive data to explore: (a) the extent to which CWD may influence individuals to hunt in other states or stop hunting permanently; (b) hunters' acceptance of lethal and non-lethal strategies for managing the disease; and (c) whether hunters' responses differ by the state in which they hunted, residency (resident, nonresident), and species hunted (deer, elk).

### *Human Dimensions of CWD*

Participation in big game hunting has decreased in many states (Brown, Decker, Siemer, & Enck, 2000; Heberlein & Thompson, 1996). Given the similarities between CWD and related diseases that can cause human death (e.g., Creutzfeldt-Jakob) and that CWD is increasing in prevalence and spreading to new locations, wildlife agencies are concerned that this hunting decline could be exacerbated by potential unknown risks associated with CWD eroding hunters' willingness to hunt in areas where the disease is found (Vaske, Timmons, Beaman, & Petchenik, 2004). Hunting participation in some states has already decreased as a result of CWD (Heberlein, 2004; Vaske et al., 2004).

A hunting decline due to CWD is problematic for several reasons. First, decreased hunting reduces agency revenues from license sales that support operating costs (Fix, Pierce, Manfredo, & Sikorowski, 1998; Mehmood, Zhang, & Armstrong, 2003). Second, wildlife management programs (e.g., stocking programs) may be affected when funds are redirected to address CWD (Heberlein, 2004). Third, a decrease in participation limits an agency's ability to use hunters to control wildlife populations (Backman & Wright, 1993; Enck, 1996). Fourth, a decline in hunting may impact cultural traditions and the social and economic stability of communities dependent on hunting (Herman, 2003; Lamar & Donnell, 1987). Direct economic impacts would be significant to restaurants and motels, and a lack of turnover spending in communities would impact residents (Loomis & Walsh, 1997; Seidl & Koontz, 2004). Fifth, fewer hunters would weaken wildlife agencies' traditional constituent base, resulting in a loss of public support for hunting (Mehmood et al., 2003; Miller & Vaske, 2003). Finally, concerns about CWD may influence hunters to substitute deer and/or elk hunting with alternative types of hunting (e.g., pheasant hunting), which may increase demand on different hunting species and locations (Vaske, Donnelly, & Shelby, 1990).

Given these potential ramifications, researchers have examined the extent to which hunters might change their behavior in response to CWD (Gigliotti, 2004; Miller, 2003,

2004; Vaske, Needham, Newman, Manfredo, & Petchenik, 2006; Vaske et al., 2004). Studies have presented hunters with hypothetical scenarios depicting manipulated levels of CWD prevalence (e.g., 1% or 5% deer infected). Hunters reported their behavioral intentions in response to each scenario (e.g., continue or stop hunting). Between 10% and 20% of South Dakota and Wisconsin deer hunters, for example, would stop hunting in their unit if 5% to 20% of its deer were infected with CWD (Gigliotti, 2004; Vaske et al., 2006). Less than 10% of Illinois deer hunters would stop hunting if CWD was in or adjacent to the county where they hunted (Miller, 2004).

### *Conceptual Foundation and Research Questions*

Relatively low CWD prevalence levels were manipulated in previous studies and most hunters would not alter their behavior. Research on perceived risk, however, has identified two primary determinants of human behavior in response to judgments of risk: (a) high probability of a hazard occurring, and (b) consequences/severity associated with the hazard (Adams & Smith, 2001; Sjöberg, 1999; Stonehouse & Mumford, 1994; Thompson & Dean, 1996). In some free-ranging herds, the probability of encountering a deer or elk infected with CWD is relatively high, with prevalence rates exceeding 20% (Gross & Miller, 2001; Miller et al., 2000; Wolfe et al., 2002). Higher prevalence (e.g., 90%) has been noted in captive herds (Williams & Young, 1980). Although there are no known cases of human illness directly attributable to CWD (Salman, 2003; World Health Organization, 2000), researchers suggest that this risk cannot be dismissed with certainty (Belay et al., 2004; Raymond et al., 2000). Laboratory experiments, for example, have shown that transmission of CWD to humans may occur, but only rarely and inefficiently (Raymond et al., 2000). In addition, CWD is similar to related diseases (e.g., Creutzfeldt-Jacob) that can cause human health consequences, including death (McKintosh et al., 2003).

Needham et al. (2004) presented hunters with hypothetical scenarios depicting potential human health impacts (e.g., death from CWD) and low to high CWD prevalence levels (e.g., 10% to 50% deer or elk infected). Across several states, 5% of hunters reported that they would stop hunting deer or elk in their state at low prevalence levels, but up to 65% would stop if CWD ever caused human death and prevalence rates increased dramatically. Nonresident hunters were more likely than residents to report that they would stop hunting deer or elk in the state. Hunters also believed that CWD testing and herd reduction were acceptable strategies for managing CWD; taking no action and allowing the disease to take its natural course were unacceptable.

There were, however, limitations of the Needham et al. (2004) study. Given the relatively small sample of hunters from each state ($n$ = 57 to 129), generalizations could only be made about the combined deer and elk hunter population across states. Little is known about whether hunters' behavior in response to CWD may differ among states and between deer and elk hunters. Needham et al. (2004) also measured the extent to which hypothetical CWD prevalence levels and human health risks would influence hunters to stop hunting deer or elk in their state; not examined was whether hunters would quit hunting these species altogether or travel to other states to hunt them.

This article addresses these knowledge gaps by exploring three research questions. First, to what extent will hypothetical levels of CWD prevalence, distribution, and human health risks influence hunters to permanently stop hunting deer/elk or travel to other states to hunt? Second, to what extent will these CWD conditions influence hunters' acceptance of strategies for managing CWD? Finally, will desertion, displacement, and acceptance of management actions differ by state, species hunted (deer, elk), and residency (resident, nonresident)?

## Methods

### *Data Collection*

Data were obtained from mail surveys of nonresident and resident deer hunters in eight states (Arizona, Colorado, Nebraska, North Dakota, South Dakota, Utah, Wisconsin, Wyoming) and elk hunters in three states (Colorado, Utah, Wyoming), yielding a total of 22 strata (Table 1). CWD had been identified in free-ranging deer and/or elk in each of these states except Arizona and North Dakota. The wildlife/game and fish government agency of each participating state provided names and addresses of random samples of hunters 18 years of age or older who purchased a nonresident or resident license to hunt deer or elk with a gun in 2003.

Three mailings were used to administer the survey beginning in July 2004.[1] Hunters were sent a survey, postage-paid return envelope, and cover letter explaining the study. Reminder postcards were sent to non-respondents two weeks after this initial mailing. A second full mailing (i.e., survey, return envelope, cover letter) was sent to non-respondents three weeks after the postcard reminder (see Needham, Vaske, & Manfredo, 2005 for details).

**Table 1** Completed surveys and response rates for each stratum

| Strata | Mailed | Undeliverable | Completed (*n*) | Response rate |
|---|---|---|---|---|
| Arizona nonresident deer hunters | 988 | 37 | 444 | 47% |
| Arizona resident deer hunters | 1025 | 36 | 396 | 40% |
| Colorado nonresident deer hunters | 1025 | 13 | 509 | 50% |
| Colorado resident deer hunters | 1025 | 41 | 459 | 47% |
| Colorado nonresident elk hunters | 1025 | 17 | 564 | 56% |
| Colorado resident elk hunters | 1025 | 34 | 472 | 48% |
| Nebraska nonresident deer hunters | 1025 | 17 | 524 | 52% |
| Nebraska resident deer hunters | 1025 | 13 | 423 | 42% |
| North Dakota nonresident deer hunters | 1025 | 23 | 509 | 51% |
| North Dakota resident deer hunters | 1025 | 23 | 346 | 35% |
| South Dakota nonresident deer hunters | 1025 | 10 | 557 | 55% |
| South Dakota resident deer hunters | 1025 | 10 | 423 | 42% |
| Utah nonresident deer hunters | 1025 | 47 | 439 | 45% |
| Utah resident deer hunters | 1025 | 45 | 328 | 34% |
| Utah nonresident elk hunters | 832 | 51 | 337 | 43% |
| Utah resident elk hunters | 1025 | 73 | 331 | 35% |
| Wisconsin nonresident deer hunters | 1025 | 80 | 465 | 49% |
| Wisconsin resident deer hunters | 1025 | 30 | 378 | 38% |
| Wyoming nonresident deer hunters | 1025 | 19 | 475 | 47% |
| Wyoming resident deer hunters | 1025 | 79 | 308 | 33% |
| Wyoming nonresident elk hunters | 1025 | 18 | 506 | 50% |
| Wyoming resident elk hunters | 1025 | 57 | 374 | 39% |
| Total | 22320 | 773 | 9567 | 44% |

Surveys were mailed to a total of 22,320 hunters. With the exception of Arizona nonresident deer hunters and Utah nonresident elk hunters, 1,025 hunters in each stratum were sent a survey (Table 1). For these two strata, the full population of hunters was sent a survey because less than 1,025 licenses were sold. Across all 22 strata, 773 surveys were undeliverable (e.g., moved, incorrect address) and 9,567 completed surveys were returned, yielding a 44% response rate (9,567/22,320 – 773). Among the strata (Table 1), sample sizes ranged from 308 (33% response rate, Wyoming resident deer hunters) to 564 (56% response rate, Colorado nonresident elk hunters).

To check for non-response bias, hunters who completed the mail survey were compared to those who did not. A sample of 785 non-respondents (approximately 100 per state) was telephoned in November 2004 and asked 9 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, Gliner, & Morgan, 2002). Effect sizes ($V$, $r_{pb}$) were less than .15, indicating weak (Cohen, 1988) or minimal (Vaske et al., 2002) differences between the two groups. Non-response bias, therefore, was not considered to be a problem and data were not weighted based on the non-response check. In each state, however, there were more residents than nonresidents who purchased a license to hunt deer or elk with a gun in 2003. Given that more surveys were received from nonresident hunters, data were weighted to reflect the population proportions of hunters for comparisons among states and between deer and elk hunters.[2]

### *Analysis Variables*

Maps in the surveys depicted hypothetical scenarios of CWD human health risks and increasing prevalence among deer or elk in three zones across each state (Figure 1). With the exception of maps in the Arizona and North Dakota surveys, zone A represented the area where CWD had been discovered in free-ranging herds and had the highest prevalence. For Arizona and North Dakota, zone A represented the most likely area for CWD to be detected, if ever. Zone B either represented the area where CWD had been found but with lower prevalence than zone A, or was considered by the agency to be the area where CWD would spread to first from zone A. Zone C was considered by each agency to represent the least likely location for high CWD prevalence to occur. All three zones for each state were based on hunt management units and the decision of where to situate the zones was made by the state's wildlife/game and fish agency.

Survey maps for all eight states depicted four separate hypothetical scenarios 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 entire state).

Surveys for four states (Arizona, North Dakota, South Dakota, Wisconsin) included two additional hypothetical scenarios related to CWD prevalence and human health risks: (a) 10% prevalence in zone A, 0% in zones B and C, and "evidence shows that CWD can be transmitted to humans and hunters in the state have died from CWD"; and (b) 50% in all three zones and "evidence shows that CWD can be transmitted to humans and hunters in the state have died from CWD." The scenarios reflected the two primary determinants of behavior in response to risk—probability of encountering a hazard and consequences/severity associated with the hazard (e.g., Sjöberg, 1999; Thompson & Dean, 1996).[3] To emphasize the hypothetical nature of the scenarios, respondents were assured in the mail survey that the scenarios did not necessarily reflect current conditions or consequences to humans.

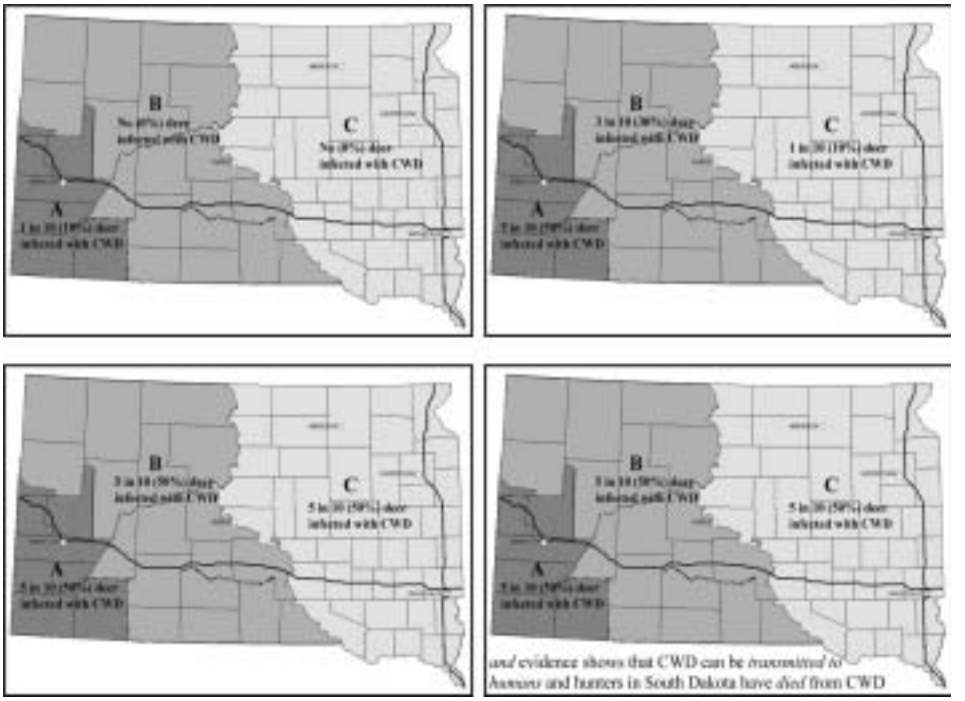


**Figure 1.** Sample maps depicting hypothetical scenarios of CWD prevalence, distribution, and human health risks. *Note.* These maps were used in the surveys for South Dakota and are provided here as an example. For six of the states, zone A represented the area where CWD had already been detected and had the highest prevalence. For Arizona and North Dakota, zone A represented the opinions of the state wildlife/game and fish agencies regarding the most likely region for CWD to be first detected, if ever. All three zones were based on hunt management units, which often transect county borders (thin lines) and interstate highways (thick lines).

To measure the extent to which CWD prevalence and human health risks may influence hunters to stop hunting or travel to other states to hunt, respondents evaluated each scenario 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 responses for each survey and elk hunting was substituted for deer hunting in surveys of elk hunters. Given that few hunters (<10%) reported that they would switch to a different zone in the state for each scenario, the first two responses were collapsed into a single category labeled "still hunt in the state."

Following each hypothetical scenario, hunters rated their acceptance of four non-lethal and lethal CWD management actions that their state wildlife/game and fish agency might take. The two non-lethal actions were: (a) take no action and allow CWD to take its natural course, and (b) continue to test deer/elk for CWD. The two lethal actions were: (a) use *trained agency staff*, and (b) use *hunters* to dramatically reduce herds in affected zones to lower the potential for CWD spreading. Hunters rated each action for each scenario on a 7-point scale of –3 "highly unacceptable" to +3 "highly acceptable."

## Results

### *Hunters' Behavioral Intentions in Response to CWD*

In total, 98% of hunters reported that they would continue hunting in the state if 10% of the deer or elk in zone A and 0% in the rest of the state had CWD (scenario 1; Table 2). At this prevalence level, which is consistent with current conditions in some states (e.g., Colorado, Wyoming), few hunters would travel to other states to hunt deer/elk (1%) or quit the activity (1%). The percentage of hunters that would stop hunting deer or elk in the state or altogether increased as CWD conditions worsened. For example, if prevalence was 50% in zone A, 30% in zone B, and 10% in zone C (scenario 3), 9% of hunters would switch to another state and 11% would quit. Up to 18% of hunters would hunt in other states and 21% would give up altogether if prevalence increased to 50% across the state (scenario 4). If this prevalence level is combined with human death from CWD (scenario 6), 17% would switch states and 37% would quit; 46% of hunters would continue hunting in the state under these conditions. Across most scenarios, hunters were more likely to quit deer or elk hunting than travel to other states to hunt.[4]

### *Differences in Hunters' Behavioral Intentions among States*

At relatively low to moderate CWD prevalence levels (scenarios 1, 2), Arizona, North Dakota, and Utah hunters were most likely to change their hunting behavior; South Dakota and Wisconsin hunters were least likely to change (Table 2). For example, if prevalence was 30% in zone A, 10% in zone B, and 0% in zone C (scenario 2), 3% of North Dakota hunters would switch states and 9% would give up altogether. In Arizona, 6% would travel to other states and an additional 6% would quit. Conversely, only 2% of Wisconsin hunters would switch states or give up permanently.

When CWD prevalence was higher (e.g., 50% in a zone), Colorado hunters were most likely to report that they would hunt in other states; North Dakota hunters were most likely to quit permanently. Wisconsin hunters were least likely to report that they would alter their behavior (e.g., 65% would continue hunting in the state if 50% of the deer had CWD [scenario 4]). If hunters died from CWD at this prevalence level (scenario 6), 62% of Arizona hunters (30% switch states, 32% quit) compared to 52% of Wisconsin hunters (16% switch states, 36% quit) would change their behavior.

Across most scenarios: (a) Wisconsin and South Dakota hunters were most likely to stay in the state and not change their behavior, (b) North Dakota hunters were most likely to quit, and (c) Arizona and Colorado hunters were most likely to switch states. Responses were statistically different among states for each scenario, $\chi^2 \leq 238.39$, $p < .001$. These differences, however, were "weak" (Cohen, 1988) or "minimal" (Vaske et al., 2002) with effect sizes of $V \leq .12$.

### *Differences in Behavioral Intentions between Resident and Nonresident Hunters*

Responses from residents and nonresidents differed for all six scenarios, $\chi^2(2) \leq 1201.79$, $p < .001$, $V \leq .46$ (Table 2). Across most scenarios and states, residents were more likely to stay in their state and not change their behavior. If prevalence was 50% in all three zones (scenario 4), for example, 62% of all residents and 48% of nonresidents would continue hunting deer or elk in the state. For most scenarios and states, however, residents were more likely to give up altogether; nonresidents were more likely to travel to other states to

**Table 2**

Differences among states and between residents and nonresidents in hunters' reported behavioral intentions for each CWD scenario

| | State total (%)[1] | | | Nonresidents (%) | | | Residents (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Still hunt in state | Switch to another state | Give up altogether | Still hunt in state | Switch to another state | Give up altogether | Still hunt in state | Switch to another state | Give up altogether | $\chi^2(2)$-value[2] | *p*-value | *V* |
| Scenario 1 | | | | | | | | | | | | |
| Arizona | 96 | 2 | 2 | 97 | 3 | 1 | 96 | 2 | 2 | 3.27 | .195 | .06 |
| Colorado deer | 98 | 1 | 1 | 96 | 4 | 0 | 98 | 1 | 1 | 14.85 | .001 | .12 |
| Colorado elk | 97 | 2 | 1 | 96 | 3 | 1 | 98 | 1 | 2 | 5.13 | .077 | .07 |
| Nebraska | 98 | 1 | 1 | 95 | 5 | 0 | 99 | 1 | 1 | 19.25 | <.001 | .13 |
| North Dakota | 93 | 1 | 5 | 94 | 5 | 1 | 93 | 1 | 6 | 25.10 | <.001 | .17 |
| South Dakota | 99 | 0 | 1 | 97 | 3 | 0 | 99 | 0 | 1 | 22.28 | <.001 | .13 |
| Utah deer | 97 | 1 | 2 | 94 | 5 | 1 | 97 | 1 | 2 | 12.75 | .002 | .12 |
| Utah elk | 95 | 3 | 2 | 89 | 9 | 2 | 95 | 2 | 3 | 15.45 | <.001 | .15 |
| Wisconsin | 99 | 0 | 0 | 99 | 1 | 0 | 100 | 0 | 0 | 1.41 | .494 | .04 |
| Wyoming deer | 97 | 2 | 1 | 97 | 3 | 0 | 97 | 1 | 1 | 9.38 | .009 | .10 |
| Wyoming elk | 99 | 1 | 1 | 97 | 3 | 1 | 99 | 0 | 1 | 10.11 | .006 | .10 |
| Total | 98 | 1 | 1 | 97 | 3 | 1 | 98 | 1 | 1 | 74.84 | <.001 | .09 |
| Scenario 2 | | | | | | | | | | | | |
| Arizona | 89 | 6 | 6 | 91 | 8 | 2 | 89 | 6 | 6 | 11.59 | .003 | .12 |
| Colorado deer | 94 | 4 | 3 | 89 | 11 | 1 | 96 | 1 | 3 | 48.87 | <.001 | .21 |
| Colorado elk | 91 | 6 | 4 | 88 | 10 | 2 | 92 | 4 | 5 | 21.59 | <.001 | .14 |
| Nebraska | 96 | 2 | 3 | 88 | 12 | 1 | 96 | 1 | 3 | 54.11 | <.001 | .22 |
| North Dakota | 88 | 3 | 9 | 85 | 12 | 3 | 88 | 2 | 10 | 42.40 | <.001 | .22 |
| South Dakota | 96 | 1 | 3 | 89 | 11 | 1 | 96 | 1 | 3 | 61.22 | <.001 | .23 |
| Utah deer | 89 | 5 | 7 | 83 | 15 | 2 | 89 | 4 | 7 | 35.94 | <.001 | .21 |
| Utah elk | 90 | 5 | 5 | 78 | 19 | 3 | 91 | 4 | 5 | 37.29 | <.001 | .23 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wisconsin | 96 | 2 | 2 | 96 | 3 | 1 | 96 | 2 | 2 | 4.54 | .103 | .07 |
| Wyoming deer | 95 | 4 | 2 | 92 | 8 | 0 | 96 | 1 | 2 | 25.15 | <.001 | .17 |
| Wyoming elk | 97 | 2 | 2 | 92 | 7 | 1 | 98 | 0 | 2 | 32.01 | <.001 | .17 |
| Total | 94 | 3 | 3 | 90 | 9 | 1 | 94 | 2 | 4 | 260.57 | <.001 | .16 |
| Scenario 3 | | | | | | | | | | | | |
| Arizona | 78 | 12 | 10 | 76 | 22 | 2 | 78 | 12 | 10 | 32.38 | <.001 | .20 |
| Colorado deer | 74 | 16 | 10 | 67 | 31 | 2 | 76 | 11 | 13 | 92.74 | <.001 | .30 |
| Colorado elk | 70 | 18 | 12 | 65 | 29 | 6 | 72 | 12 | 15 | 57.82 | <.001 | .24 |
| Nebraska | 83 | 7 | 10 | 67 | 30 | 3 | 84 | 5 | 11 | 115.67 | <.001 | .33 |
| North Dakota | 75 | 7 | 18 | 67 | 26 | 6 | 75 | 6 | 19 | 76.54 | <.001 | .29 |
| South Dakota | 82 | 7 | 11 | 70 | 29 | 1 | 83 | 5 | 12 | 136.69 | <.001 | .36 |
| Utah deer | 73 | 13 | 14 | 60 | 37 | 3 | 74 | 11 | 15 | 88.53 | <.001 | .34 |
| Utah elk | 74 | 14 | 13 | 57 | 35 | 7 | 75 | 12 | 13 | 49.49 | <.001 | .27 |
| Wisconsin | 84 | 5 | 11 | 82 | 14 | 4 | 84 | 5 | 11 | 31.64 | <.001 | .19 |
| Wyoming deer | 81 | 12 | 7 | 74 | 25 | 1 | 85 | 4 | 10 | 92.96 | <.001 | .33 |
| Wyoming elk | 83 | 8 | 9 | 72 | 24 | 4 | 86 | 4 | 11 | 79.27 | <.001 | .29 |
| Total | 80 | 9 | 11 | 70 | 26 | 4 | 81 | 7 | 12 | 767.17 | <.001 | .28 |
| Scenario 4 | | | | | | | | | | | | |
| Arizona | 61 | 22 | 17 | 60 | 37 | 3 | 61 | 21 | 17 | 61.10 | <.001 | .27 |
| Colorado deer | 55 | 28 | 17 | 46 | 52 | 2 | 58 | 20 | 21 | 157.22 | <.001 | .39 |
| Colorado elk | 51 | 28 | 21 | 43 | 46 | 11 | 55 | 19 | 26 | 92.87 | <.001 | .30 |
| Nebraska | 63 | 15 | 23 | 53 | 43 | 4 | 63 | 13 | 24 | 150.51 | <.001 | .39 |
| North Dakota | 58 | 14 | 28 | 50 | 39 | 11 | 58 | 13 | 28 | 87.94 | <.001 | .32 |
| South Dakota | 64 | 16 | 21 | 51 | 46 | 3 | 64 | 14 | 22 | 166.46 | <.001 | .41 |
| Utah deer | 56 | 22 | 22 | 43 | 53 | 3 | 57 | 19 | 24 | 129.22 | <.001 | .41 |
| Utah elk | 58 | 23 | 20 | 42 | 48 | 10 | 59 | 21 | 21 | 57.76 | <.001 | .30 |
| Wisconsin | 65 | 13 | 23 | 56 | 33 | 10 | 65 | 11 | 23 | 68.34 | <.001 | .28 |

Continued

**Table 2**
Continued

| | State total (%)[1] | | | Nonresidents (%) | | | Residents (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Still hunt in state | Switch to another state | Give up altogether | Still hunt in state | Switch to another state | Give up altogether | Still hunt in state | Switch to another state | Give up altogether | $\chi^2(2)$-value[2] | *p*-value | *V* |
| Wyoming deer | 62 | 26 | 13 | 53 | 46 | 2 | 67 | 13 | 20 | 142.43 | <.001 | .42 |
| Wyoming elk | 62 | 19 | 19 | 48 | 45 | 6 | 65 | 13 | 22 | 125.44 | <.001 | .38 |
| Total | 61 | 18 | 21 | 48 | 44 | 8 | 62 | 14 | 24 | 1201.79 | <.001 | .35 |
| Scenario 5 | | | | | | | | | | | | |
| Arizona | 72 | 12 | 16 | 75 | 20 | 5 | 72 | 11 | 17 | 37.35 | <.001 | .21 |
| North Dakota | 74 | 6 | 20 | 69 | 20 | 11 | 75 | 5 | 20 | 48.78 | <.001 | .23 |
| South Dakota | 82 | 4 | 14 | 77 | 17 | 6 | 83 | 3 | 15 | 72.20 | <.001 | .26 |
| Wisconsin | 80 | 5 | 15 | 83 | 10 | 7 | 80 | 5 | 16 | 19.17 | <.001 | .15 |
| Total | 79 | 6 | 16 | 81 | 12 | 7 | 79 | 5 | 16 | 93.29 | <.001 | .16 |
| Scenario 6 | | | | | | | | | | | | |
| Arizona | 39 | 30 | 32 | 35 | 57 | 8 | 39 | 29 | 33 | 102.52 | <.001 | .35 |
| North Dakota | 40 | 17 | 44 | 33 | 46 | 21 | 40 | 15 | 45 | 98.31 | <.001 | .34 |
| South Dakota | 45 | 17 | 38 | 33 | 56 | 11 | 46 | 15 | 40 | 205.76 | <.001 | .46 |
| Wisconsin | 48 | 16 | 36 | 37 | 44 | 19 | 49 | 14 | 38 | 97.59 | <.001 | .34 |
| Total | 46 | 17 | 37 | 36 | 46 | 18 | 47 | 15 | 38 | 415.13 | <.001 | .34 |

[1]Based on weighted data. Differences among states: scenario 1 $\chi^2(20) = 119.59$, $p < .001$, $V = .09$; scenario 2 $\chi^2(20) = 210.59$, $p < .001$, $V = .11$; scenario 3 $\chi^2(20) = 238.39$, $p < .001$, $V = .12$; scenario 4 $\chi^2(20) = 218.57$, $p < .001$, $V = .11$; scenario 5 $\chi^2(6) = 58.27$, $p < .001$, $V = .10$; scenario 6 $\chi^2(6) = 74.02$, $p < .001$, $V = .11$.

[2]Represents differences between nonresident and resident hunters.

hunt. For example, if 50% of deer or elk were infected with CWD and the disease caused human death (scenario 6), 15% of all residents would travel to other states and 38% would give up permanently. Conversely, 46% of all nonresidents would switch states and only 18% would quit under these conditions.

### *Differences in Behavioral Intentions between Deer and Elk Hunters*

Both deer and elk hunters were surveyed in Colorado, Utah, and Wyoming. For each of these states, however, behavioral intentions in response to each hypothetical scenario were not significantly different at $p < .001$ between deer and elk hunters, $\chi^2(2) = 0.64$ to 11.00, $p = .004$ to .728. In addition, effect sizes ($V \leq .08$) showed "weak" (Cohen, 1988) or "minimal" (Vaske et al., 2002) differences between these two groups.

### *Hunters' Acceptance of Management Actions in Response to CWD*

Hunters' acceptance of the four CWD management actions (e.g., continue to test, use hunters to reduce herds in affected areas) was analyzed using the potential for conflict index (PCI) and a related graphic approach for communicating results (see Manfredo, Vaske, & Teel, 2003; Vaske et al., 2006 for reviews). PCI ranges from 0 to 1; a large PCI indicates high potential for conflict regarding acceptance of a management action.

*Non-lethal actions.* Across all six hypothetical scenarios of CWD prevalence, distribution, and human health risk, hunters in each state believed that agency testing of deer and elk for CWD is moderately to highly *acceptable* (Figure 2). The small PCI values (.03 to .15) across states and scenarios revealed little potential for conflict among hunters regarding this strategy. Conversely, hunters reported that it would be moderately to highly *unacceptable* for agencies to take no action and allow CWD to take its natural course. Hunters in each state generally agreed (PCI = .06 to .21) that this strategy was unacceptable for all scenarios. For these two non-lethal management actions, differences among states, between nonresidents and residents, and between deer and elk hunters were relatively "weak" or "minimal" ($r_{pb}$, $\eta \leq .14$) across scenarios (Cohen, 1988; Vaske et al., 2002).

*Lethal actions.* On average, hunters in each state believed that it would be slightly to moderately acceptable for agencies to allow *hunters* to dramatically reduce deer and/or elk populations in affected zones to lower the potential for CWD spreading (Figure 3). Acceptance of this action slightly increased as CWD prevalence and human health risks increased. For most scenarios, this action was slightly more acceptable in some states (e.g., Nebraska, Wisconsin) than others (e.g., Utah, Wyoming). State, residency (resident, nonresident), and species (deer, elk hunters) differences, however, were relatively "weak" or "minimal" ($r_{pb}$, $\eta \leq .17$) across the six hypothetical scenarios (Cohen, 1988; Vaske et al., 2002).

Hunters' acceptance of allowing *trained agency staff* to reduce herds in affected zones was close to neutral for scenarios depicting low to moderate CWD prevalence. Acceptance of this action, however, substantially increased as CWD prevalence and human health risks increased. This action was slightly less acceptable in some states (e.g., Utah, Wyoming) compared to others (e.g., Nebraska, North Dakota), but differences among all strata (states, species, residency) were relatively "weak" or "minimal" ($r_{pb}$, $\eta \leq .16$) for each scenario (Cohen, 1988; Vaske et al., 2002).

Given the larger PCI values, these two lethal actions (PCI = .16 to .68) were more controversial than the two non-lethal actions (PCI = .03 to .21). PCI values in most states

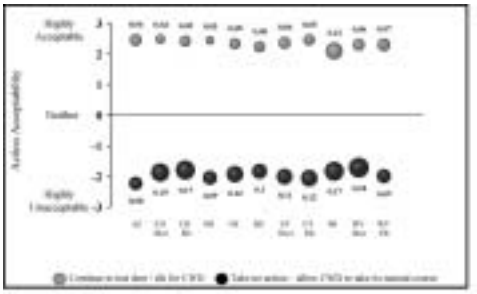

Figure 2a Scenario 1

Continue to test: $F(10, 9305) = 8.61$, $p < .001$, $\eta = .10$
Take no action: $F(10, 9229) = 7.33$, $p < .001$, $\eta = .09$

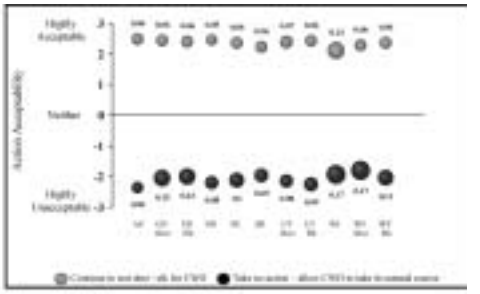

Figure 2b Scenario 2

Continue to test: $F(10, 9179) = 6.97$, $p < .001$, $\eta = .09$
Take no action: $F(10, 9180) = 8.71$, $p < .001$, $\eta = .10$

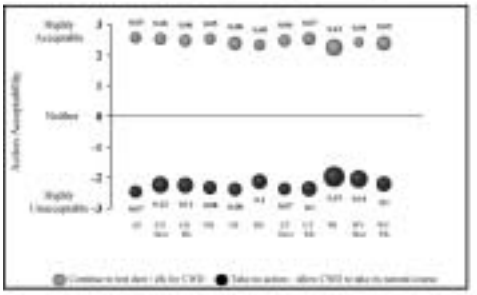

Figure 2c Scenario 3

Continue to test: $F(10, 9028) = 5.23$, $p < .001$, $\eta = .08$
Take no action: $F(10, 9097) = 8.69$, $p < .001$, $\eta = .10$

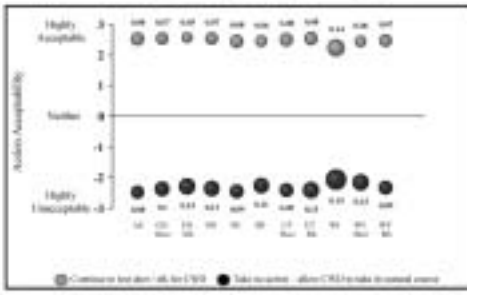

Figure 2d Scenario 4

Continue to test: $F(10, 9023) = 4.43$, $p < .001$, $\eta = .07$
Take no action: $F(10, 9073) = 5.63$, $p < .001$, $\eta = .08$

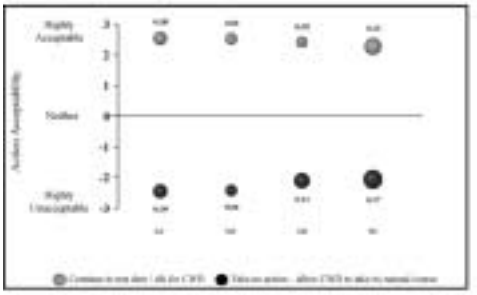

Figure 2e Scenario 5

Continue to test: $F(3, 3302) = 7.56$, $p < .001$, $\eta = .08$
Take no action: $F(3, 3309) = 15.27$, $p < .001$, $\eta = .12$

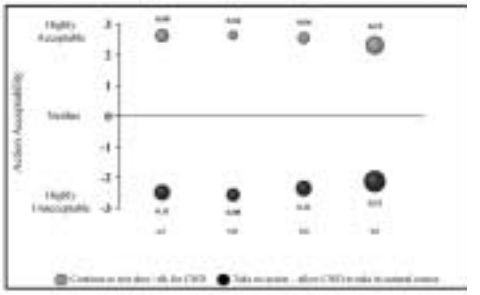

Figure 2f Scenario 6

Continue to test: $F(3, 3287) = 11.97$, $p < .001$, $\eta = .10$
Take no action: $F(3, 3313) = 12.89$, $p < .001$, $\eta = .11$

**Figure 2.** Hunters' acceptance of *non-lethal* management actions for each CWD scenario. *Note*. Numbers for each bubble are the potential for conflict index (PCI). The center of each bubble is the mean acceptability of the scenario. AZ = Arizona, CO = Colorado, ND = North Dakota, NE = Nebraska, SD = South Dakota, UT = Utah, WI = Wisconsin, WY = Wyoming. Residents' and non-residents' acceptance of "taking no action" was not significantly different for 47 of the 52 tests across scenarios and states; statistically significant differences were observed for 5 tests, but effect sizes were minimal ($r_{pb} \leq .11$). Residents' and nonresidents' acceptance of "continue to test" was not significantly different for 46 of the 52 tests across scenarios and states; statistically significant differences were observed for 6 tests, but effect sizes were minimal ($r_{pb} \leq .14$). Deer and elk hunters' acceptance was not significantly different across scenarios and states ($r_{pb} \leq .06$).

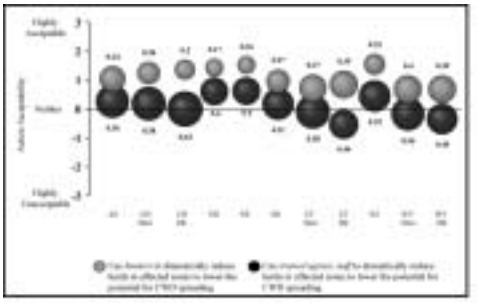

Figure 3a Scenario 1

Use hunters: $F(10, 9316) = 26.81$, $p < .001$, $\eta = .17$
Use agency staff: $F(10, 9305) = 25.68$, $p < .001$, $\eta = .16$

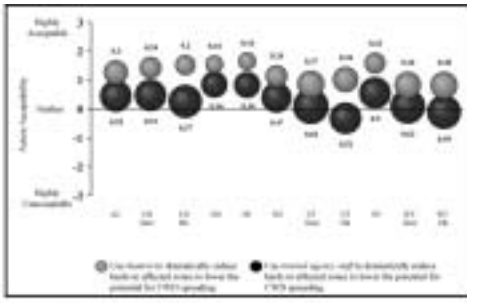

Figure 3b Scenario 2

Use hunters: $F(10, 9272) = 24.60$, $p < .001$, $\eta = .16$
Use agency staff: $F(10, 9243) = 23.13$, $p < .001$, $\eta = .16$

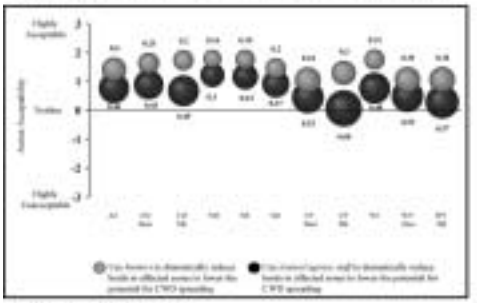

Figure 3c Scenario 3

Use hunters: $F(10, 9167) = 20.64$, $p < .001$, $\eta = .15$
Use agency staff: $F(10, 9143) = 20.20$, $p < .001$, $\eta = .15$

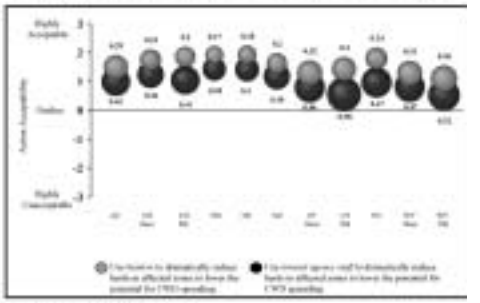

Figure 3d Scenario 4

Use hunters: $F(10, 9119) = 17.65$, $p < .001$, $\eta = .14$
Use agency staff: $F(10, 9090) = 15.44$, $p < .001$, $\eta = .13$

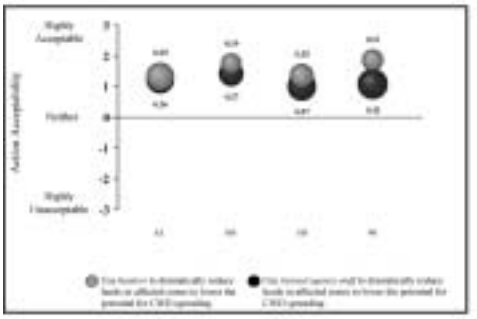

Figure 3e Scenario 5

Use hunters: $F(3, 3325) = 16.87$, $p < .001$, $\eta = .12$
Use agency staff: $F(3, 3334) = 5.64$, $p < .001$, $\eta = .07$

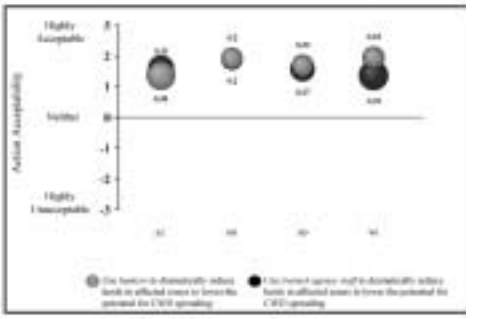

Figure 3f Scenario 6

Use hunters: $F(3, 3324) = 15.04$, $p < .001$, $\eta = .12$
Use agency staff: $F(3, 3336) = 9.12$, $p < .001$, $\eta = .09$

**Figure 3.** Hunters' acceptance of *lethal* management actions for each CWD scenario. *Note*. Numbers for each bubble are the potential for conflict index (PCI). The center of each bubble is the mean acceptability of the scenario. AZ = Arizona, CO = Colorado, ND = North Dakota, NE = Nebraska, SD = South Dakota, UT = Utah, WI = Wisconsin, WY = Wyoming. Residents' and nonresidents' acceptance of "use agency staff" was not significantly different for 38 of the 52 tests across scenarios and states; statistically significant differences were observed for 14 tests, but effect sizes were minimal ($r_{pb} \leq .14$). Residents' and nonresidents' acceptance of "use hunters" was not significantly different for 49 of the 52 tests across scenarios and states; statistically significant differences were observed for 3 tests, but effect sizes were minimal ($r_{pb} \leq .13$). Deer and elk hunters' acceptance was not significantly different across scenarios and states ($r_{pb} \leq .10$).

also suggested that using trained agency staff to reduce herds in affected zones to lower the probability of CWD spreading (PCI = .20 to .68) had a greater potential for conflict among hunters than allowing hunters themselves to perform this task (PCI = .16 to .40). In most states, however, these lethal actions were more acceptable and had a lower potential for conflict as CWD conditions (prevalence, distribution, human risk) worsened.

## Discussion

This article described the extent to which CWD prevalence, distribution, and human health risks could influence hunters': (a) willingness to hunt in other states or give up the activity altogether, and (b) acceptance of strategies for managing CWD. At relatively low prevalence levels (scenario 1), which are similar to current conditions in some states (e.g., Colorado, Wyoming), almost all hunters would continue hunting deer or elk in their state. This is consistent with other studies (Gigliotti, 2004; Miller, 2004; Vaske et al., 2006) and suggests that agencies will likely suffer only minor declines in revenues from license sales if CWD conditions do not worsen.

Contrary to some human dimensions research on CWD (Gigliotti, 2004; Miller, 2003, 2004; Vaske et al., 2006), however, this article also demonstrated that potential conditions related to CWD could influence a large proportion of deer and elk hunters to alter their behavior. Although unlikely to occur, CWD can reach high prevalence levels in deer and elk populations (Gross & Miller, 2001; Miller et al., 2000; Williams & Young, 1980), and the potential for human susceptibility to CWD may exist (Belay et al., 2004; Raymond et al., 2000). Consistent with Needham et al. (2004), the majority of hunters would not hunt in their state if CWD prevalence and human health risks dramatically increased (e.g., 50% prevalence, human death).

Among hunters who would change their behavior, most would give up deer or elk hunting permanently rather than travel to other states to hunt. This suggests that CWD could have a serious impact on the future of big game hunting. In states where CWD has not been found (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, Slovic, Lichtenstein, Read, & Combs, 1978; Sjöberg, 2000; Slovic, 1987). In Wisconsin, where deer hunting has a culturally significant history (Heberlein, 2004; Vaske et al., 2004), hunters were least likely to change their hunting behavior.

North Dakota hunters were most likely to give up deer hunting altogether, whereas Arizona and Colorado hunters were among the most likely to switch to other states. These findings may be partially explained by income. Arizona and Colorado hunters had the highest annual household incomes (48% ≥ $70,000 per year); North Dakota hunters had the lowest (30% ≥ $70,000 per year). Arizona and Colorado hunters may be more willing to switch states because they have the financial capability of affording the necessary expenditures (e.g., lodging, travel, nonresident hunting license fee). Many North Dakota hunters may quit because they are unable to afford to hunt in other states.

Identical to Needham et al. (2004), nonresident hunters were less likely than residents to continue hunting deer or elk in the state as CWD conditions worsened. Many nonresidents would travel to other states to hunt. Declining numbers of nonresident hunters would significantly reduce agency revenues because nonresidents pay higher fees for hunting licenses. In addition, residents were more likely to permanently quit deer or elk hunting. Although residents pay less for hunting licenses than nonresidents, a decline in resident hunters could also impact agency revenues because residents constitute the largest proportion of hunters in most states.

Taken together, findings suggested that if CWD prevalence increases dramatically, deer and/or elk hunting participation will significantly decrease in several states. If high prevalence is combined with threats to human health, hunting declines could be even greater. Although high prevalence and human death from CWD are unlikely, agencies should anticipate some decline in license revenues, reduced support for wildlife management, negative impacts on cultural and family traditions, and economic instability of communities dependent on hunting (Needham et al., 2004). These potential consequences of a hunting decline due to CWD suggest the need for agencies and other stakeholders to engage in long-term proactive CWD planning and management efforts.

Results also showed that hunters in all strata (state, species, residency) believed that irrespective of CWD prevalence levels and human health risks, taking no action and allowing CWD to take its natural course are unacceptable. CWD testing and allowing hunters to reduce herds in affected areas to lower the potential for CWD spreading are acceptable strategies for managing the disease. There was disagreement among hunters regarding the acceptability of using trained agency staff to reduce herds, especially at low to moderate CWD prevalence levels (scenarios 1, 2). Acceptance of this action, however, increased as prevalence and human health risks increased. Given the slow rate of natural expansion and long incubation period of CWD, these surveillance and eradication efforts can be expensive, time consuming, controversial, and draw resources from other wildlife issues (Heberlein, 2004; Williams et al., 2002). These complications provide rationale for determining the extent to which various lethal and non-lethal actions may provide long-term solutions for managing CWD, and whether these actions are logistically and politically feasible.

There was similarity across states in hunters' responses to CWD, highlighting the value of researching issues on a regional scale whenever possible. Given this consistency, broad strategies across states (i.e., regional, national level) could be appropriate for responding to CWD. Any response to CWD, however, requires careful planning and considerable input from stakeholders with economic, recreational, governmental, and ecological interests in hunting, wildlife, and CWD (Decker, Brown, & Siemer, 2001).

It is important to emphasize that these results are based on hypothetical scenarios depicting CWD conditions that do not necessarily reflect current prevalence levels or threats to humans. Increased testing of harvested animals (i.e., postmortem sampling), advancements in lymphoid and tonsillar biopsy procedures for testing live animals (i.e., antemortem sampling), and continued in-vitro laboratory experiments of CWD in human cells may provide a more realistic assessment of CWD prevalence levels and human health risks (Raymond et al., 2000; Sigurdson et al., 1999; Wild, Spraker, Sigurdson, O'Rourke, & Miller, 2002). Long-term research including panel/longitudinal designs is needed to determine the extent to which hunters actually change their behavior in response to actual CWD conditions.

Findings are also limited to resident and nonresident hunters in eight states that purchased a license to hunt deer or elk with a gun in 2003. Results may not generalize to different types of hunting (e.g., archery) or other species with CWD (e.g., moose). Moreover, hunters may choose alternative behaviors in response to CWD (e.g., hunt other species) and support different management actions (e.g., selectively harvest animals that appear to have CWD) that were not examined here. Research on the human dimensions of CWD, however, is still in its infancy. Researchers are encouraged to examine these and other human dimensions of CWD issues.

## Notes

1. The mail survey was pre-tested in each state in 2003 with hunters who purchased a license to hunt in 2002 ($n$ = 659). Details are reported in Needham et al. (2004).
2. The non-response check contained several questions used here for measuring hunters' behavior and acceptance of management actions in response to hypothetical CWD conditions. See Needham et al. (2005) for weighting details.
3. Further support for using prevalence and human health risks as determinants of hunter behavior in response to CWD was obtained from open-ended questions in the pre-test that asked hunters to list circumstances related to CWD that would cause them to give up deer/elk hunting in the state or permanently. The most dominant responses were related to CWD prevalence (89%) and potential human health risks/death (77%).
4. Ancillary analyses of hunters in each state, residents and nonresidents, and deer and elk hunters showed no substantial relationship between zones in which respondents hunted in 2003 or in their life and behavioral intentions in response to each scenario.

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