Attitudes and Behavior of Deer Hunting Club Members Following Discovery of Chronic Wasting Disease

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Abstract: Chronic wasting disease (CWD) is a fatal neurological disease that affects cervid species including white-tailed deer (*Odocoileus virginianus*). As of 2021, it occurs in seven southeastern states, and more discoveries in the region are likely to occur. Hunter education regarding CWD is critical to obtain support for disease management actions that rely on hunter participation but potentially are in opposition to typical hunter objectives. In August 2018, we provided educational programming on CWD to 84 members of a deer hunting club in west Tennessee. After CWD was discovered in the immediate area of the club in December 2018, in spring 2019 we surveyed the attitudes and hunting behaviors of club members. When surveyed five months following discovery of CWD, 86% of respondents expressed extreme or moderate concern about CWD. The number of total deer sightings was the most important factor influencing hunter satisfaction for 70% of respondents. Reducing deer density often is used to reduce CWD prevalence rates, but 66% of respondents did not support such reductions. Despite our efforts to educate hunters and, once CWD was detected, to encourage hunters to maintain or increase harvest, doe harvest declined by 78% during the 2019 deer season. Understanding attitudes and harvest behaviors of hunters is essential to managing CWD. Hunting clubs in the southeastern United States may provide important opportunities for outreach and education before and after CWD is discovered in their areas. Our survey indicates hunter concern about CWD is great, and state wildlife agencies likely will need to develop effective educational strategies to maintain or increase doe harvest if the disease is discovered.

Key words: white-tailed deer, disease management, human dimensions, harvest management, hunter attitudes, prion diseases

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Chronic wasting disease (CWD) is a fatal neurological disease that infects North American cervids, including white-tailed deer (*Odocoileus virginianus*). CWD was first identified in Colorado in 1967 and has since been confirmed in 24 U.S. states, three Canadian provinces, and four additional countries (Centers for Disease Control and Prevention 2020). The prions that cause CWD are persistent in the environment and can be spread through contact with body fluid and waste (Mathiason et al. 2006, Tamgüney et al. 2009). Population declines in both white-tailed deer and mule deer (*Odocoileus hemionus*) have occurred after CWD was discovered in a region (Edmunds et al. 2016, DeVivo et al. 2017). Therefore, there is great interest in finding effective strategies to control the spread of CWD within and among wild deer populations.

Hunter harvest is commonly used as a management tool to reduce spread and prevalence of CWD. Millions of hunters pursue deer annually (U.S. Department of the Interior et al. 2017), and hunters serve a vital role in targeted herd reductions and reducing CWD prevalence within a population (Williams et al. 2002, Potapov et al. 2016). Hunters also provide a revenue source to state wildlife agencies that can be used to offset the costs of disease testing and targeted sharpshooting events that often are necessary following disease discovery. Unfortunately, hunters often respond negatively to CWD and disease management strategies that result in decreased deer population density, which may result in decreased hunter participation as CWD spreads (Bishop 2004, Vaske et al. 2004). In addition, many hunters are concerned about human health risks from consuming CWD-infected meat (Holsman et al. 2010). Educational efforts that address these hunter concerns can be an important aspect of effective disease management (Cooney and Holsman 2010), while failure to implement such efforts may result in a loss of hunter trust and participation, thereby reducing disease management options (Harper et al. 2015).

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Deer hunting clubs typically are fee-based groups that provide hunting access on private property. These clubs are popular across much of the southeastern United States, as the majority of hunters in the region primarily hunt on private lands (Guynn et al. 1983, Zhang et al. 2006). In Tennessee, over 90% of the land is privately owned, and access to those lands through leases and clubs can provide hunting opportunities (Tennessee Wildlife Resources Agency 2021). Many clubs lease hunting rights from industrial timber companies or other private landowners, and most have unique harvest and hunting rules that help meet member objectives such as harvest restrictions to allow bucks to reach older age classes (Nanney et al. 2015). These objectives may conflict with CWD management strategies, potentially resulting in a need for professional outreach to increase acceptance of such strategies (Belsare and Stewart 2020).

Wildlife professionals routinely inform hunting clubs of deer management issues through education and outreach programs. Educational programming that explains CWD, its effects on deer populations, and appropriate management strategies can help shape attitudes and behavior both prior to and following novel outbreaks. Organized clubs provide an opportunity to reach large groups of hunters that could assist in disease control and prevalence sampling, and many already are engaged with regional state agency biologists, often through state Deer Management Assistance Programs (Collier and Krementz 2006, Hunt et al. 2006).

Although hunter behavior and attitudes following CWD discovery are well-documented, information on the response of hunters in an area where outreach was conducted prior to disease discovery is limited. Additionally, data are lacking on the response to CWD of southeastern U.S. hunting club members, an extremely important demographic for deer management in the region. Herein, we share a case study on hunter attitudes following discovery of CWD at a hunting club where we gave educational presentations on CWD both before and after this discovery. We also examined hunter harvest decisions in the season following discovery.

Methods

Ames Hunting Club was located in Fayette and Hardeman counties, Tennessee, on Ames Plantation, which was the University of Tennessee AgResearch and Education Center near Grand Junction, Tennessee. The club comprised approximately 6475 ha, and had been practicing Quality Deer Management (QDM) since 2003 (Harper et al. 2012) with a goal of producing ≥3.5-year-old bucks as well as harvesting does annually to maintain population density at approximately 8 deer per square km. The club had collected harvest data, including sex, age, weight, lactation status, and antler measurements, from every deer harvested since 2003 as well as hunter observation data for every hunt since 2006. At the time of our study, club membership had been maintained at approximately 85 hunters, and turnover in annual membership was low; 71% of members in 2019 had been members for at least five years. Presentations on deer management had been given annually at mandatory preseason meetings, and topics had included quality deer management, deer genetics, predator impacts, deer nutrition, and epizootic hemorrhagic disease. At the August 2018 meeting, prior to discovery of CWD in Tennessee, the central topic was "Chronic Wasting Disease: what this means for deer management," which focused on the biology of CWD, potential management response to an outbreak, and potential implications for hunters following discovery of CWD in their area.

In December 2018, CWD was first detected in west Tennessee near Ames Plantation, near the center of the CWD management zone that had been delineated by the Tennessee Wildlife Resources Agency. Ames Plantation confirmed CWD was present on the property with five deer testing positive from December 2018 to January 2019 (Figure 1). Presence of CWD had the potential for hindering deer management objectives of the club, as older bucks tend to have greater CWD prevalence rates, and hence greater mortality rates, than other sex-age groups (Miller and Conner

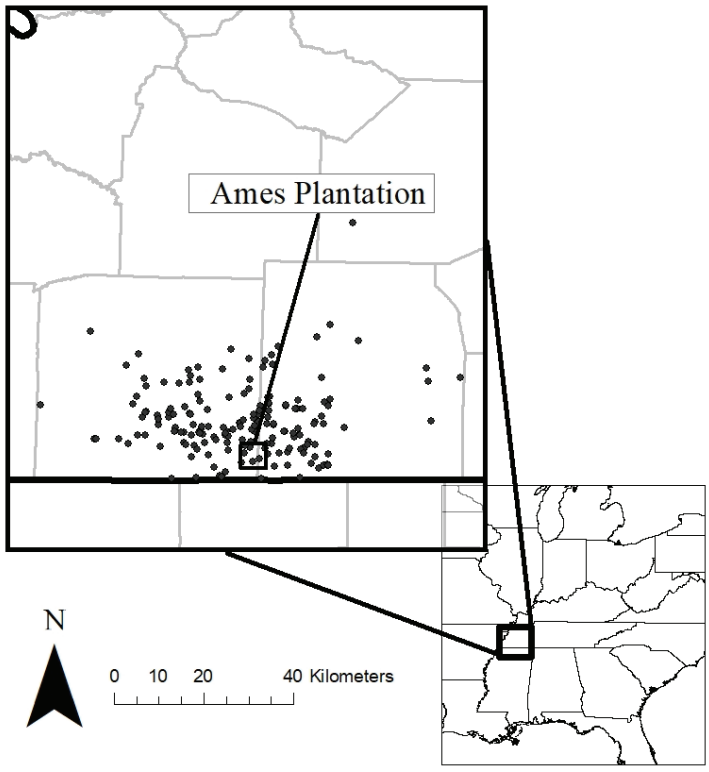

Figure 1. Locations of Ames Plantation and white-tailed deer (*Odocoileus virginianus*) that tested positive for chronic wasting disease in Tennessee at the time of survey distribution in May 2019. Tennessee border is indicated with thicker lines.

2005, Samuel and Storm 2016). Given the potential negative impact the disease could have on hunter behavior at Ames Plantation, we assessed member attitudes concerning CWD immediately after it was discovered on club property. We sent an electronic survey to the entire membership of the club (84 members) through SurveyPro, an online survey platform, in May 2019 (Appendix I). Questions were designed to measure member views on the disease and to evaluate their opinions on potential management actions that may be used to reduce CWD prevalence and spread. The survey instrument and protocol were reviewed and approved by the University of Tennessee' Institutional Review Board.

Retaining hunters to facilitate herd management actions was a major goal of the Ames Plantation deer management program, and we wanted to determine whether we could effectively encourage hunters to continue harvesting deer in a CWD-positive area. Prior to the 2019 deer-hunting season, we delivered a second program related to CWD, specifically addressing disease management and how CWD could impact hunting at Ames Plantation. Reducing deer density by maintaining or increasing harvest is strongly recommended to reduce the spread of CWD (Williams et al. 2002, Potapov et al. 2016), but harvest may instead be reduced following CWD discovery (Haus et al. 2017). To examine potential changes in hunter effort and harvest relative to previous seasons, we examined club data for the season following CWD discovery. The harvest objective for the club during this 2019 season was not to reduce herd density, but rather to maintain density at a relatively low level through harvest rates similar to previous seasons.

Results

Survey Response

We received 66 completed surveys from the 84 members for a response rate of 78%. Respondents (86%) indicated they were moderately or extremely concerned after CWD was discovered in west Tennessee in 2018, and 97% indicated their concern was had either remained unchanged or had increased in the months following discovery of the disease (Appendix 1). Only 7% of survey respondents thought the response to CWD discovery had been overblown. Approximately 70% indicated that the number of overall sightings was the aspect of deer sightings most important to their enjoyment (Table 1). We asked members which of four deer observation groups they believed was most likely to be impacted negatively by CWD, and 57% believed total deer sightings would be most affected (Table 1). However, 40% believed sightings of harvestable mature bucks would be most negatively impacted.

Although the 2018 educational program discussed the effectiveness of targeted herd density reductions used by other states to combat CWD, 67% of respondents did not support a reduction of deer density. Additionally, only 31% of respondents believed reducing deer density was the best measure to prevent spread of CWD at the local level. By comparison, lower percentages of respondents believed that the best prevention was eliminating transport of hunter-killed carcasses (23%), eliminating high-fence facilities to reduce transport of deer (20%), or other options (combination of strategies, feeding bands, etc.; 25%). However, 60% of respondents believed buck harvest restrictions should be relaxed following discovery of CWD.

Fifty-eight percent of survey respondents were likely or very likely to continue hunting at Ames Plantation in the future. Additionally, 20% stated they were unlikely or very unlikely to hunt in any area of west TN where CWD had been detected (Table 2). Food safety was discussed during the 2018 presentation, and 94% of respondents had some level of concern for eating deer meat that may be infected with CWD. When asked about what they felt the greatest change to hunting that CWD would bring, 29% responded fewer older bucks, 24% responded fewer deer, and 23% responded fear associated with eating deer meat. There also was concern about the future of hunting with CWD, as 56% believed CWD would reduce hunting participation and opportunity, and 24% believed the deer population would be lowered and hunting changed permanently. These feelings also were reflected in the 76% of respondents who believed CWD would continue spreading with increasing infection rates.

Table 1. Response of members of Ames Hunting Club, Fayette and Hardeman counties, Tennessee, in 2019 indicating importance of various aspects of deer sightings and potential impact of CWD. Bucks eligible for harvest were those scoring at least 317.5 cm (125 inches) on the Boone and Crockett scale or those at least 4 years old.

Aspects of deer sightings	Most important to hunting satisfaction	Most likely to be negatively impacted by CWD
Total deer sightings	70%	57%
Total buck sightings	7%	3%
Total antlerless sightings	2%	0%
Sightings of harvestable bucks	21%	40%

Table 2. Response of members of Ames Hunting Club, Fayette and Hardeman counties, Tennessee, in 2019 to questions regarding their likelihood to continue hunting at Ames or in nearby locations with CWD.

Response	Likelihood to continue membership at Ames in 2019/2020	Likelihood to continue hunting on any property in west TN where CWD has been detected
Definitely not	6%	2%
Unlikely	4%	18%
Neutral	31%	15%
Likely	24%	26%
Definitely continue	34%	39%

Harvest and Hunter Response

During the 2019 deer season, the first season after the discovery of CWD, members hunted 44% fewer hours than the average of the previous five seasons, decreasing from 98.9 (±1 SE = 7.5) hours per member to 43 hours per member in 2019. Doe harvest in 2019 was 81% lower than the average of the previous five seasons, decreasing from 161.8 does per year (±20.9) to 31 does in 2019 (Figure 2). However, deer observations per hour were similar to previous seasons at 0.92 deer/hour in 2019 compared to 0.76 (±0.03) deer/hour from 2014–2018. Buck harvest was only 11% below the average of the previous five seasons, with 0.3 mature bucks/hunter in 2019 compared to 0.34 (±0.02) mature bucks/hunter from 2014–2018. However, hours per mature buck observation was less in 2019 (30.4 hours) compared to 47.5 (±2.9) hours for 2014–2018, suggesting that the number of mature bucks had not declined. Observed doe:buck ratio was similar in 2019 (1.28) compared to the previous five seasons (1.23 ±0.1).

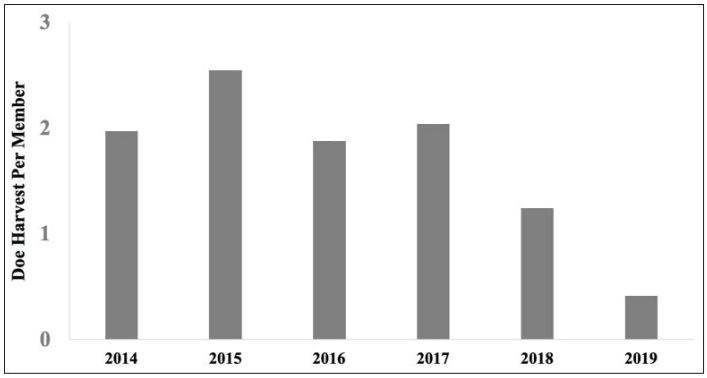

Figure 2. Annual doe harvest from 2014–2019 per Ames Hunting Club member in Fayette and Hardeman counties, Tennessee.

Discussion

Our data provide information on the attitudes and behaviors of hunting club members early after the discovery of CWD as well as giving insights into the effectiveness of CWD-focused educational programing received by these hunters. Although we cannot say with certainty that hunter concern shifted following our educational programs, we believe that providing outreach education on CWD prior to disease discovery did produce awareness, interest, and concern from hunters about potential implications of the disease. For example, we detected a very high level of concern about the disease among club members relative to what has been reported elsewhere (Heberlein and Stedman 2009, Gigliotti 2010). After CWD was discovered but before its high prevalence at Ames Plantation subsequently was determined (see below), most members believed that CWD would dramatically change deer hunting and continue to spread across the region. These attitudes likely are partly attributable to our outreach efforts. Similar programming elsewhere could help prevent hunters from letting fear of CWD lead them to engage in behaviors that contribute to disease spread.

Educational programming from wildlife professionals provides hunters with science-based information on what has happened in other areas and what may occur in their area in the near future, and can help them prepare mentally for potential changes. In particular, we believe more information should be provided prior to CWD discovery on management approaches for reducing its spread and prevalence in a population. Though most hunters on Ames Plantation still were not in favor of reducing deer density to manage CWD following our second program, deer density there was already considerably lower than in most other areas where CWD has been detected (Blanchong et al. 2006, Evans et al. 2016). If deer density had been greater at Ames Plantation, member attitudes toward reducing density may have been different. Still, lack of member support for density reduction appears in contrast to their general fear of CWD, so it is possible that outreach programs have a bigger effect on hunter opinions than on hunter behavior.

According to our survey, members believed CWD would be most likely to negatively impact mature buck sightings and total deer sightings, yet neither deer observations nor buck harvest was lower in 2019. Despite this lack of change, member harvest decisions shifted dramatically with knowledge that CWD-positive deer were present. Many factors influence deer harvest, but we believe from our survey results and from conversations with club members that the primary reason for the sharp decline in doe harvest was concern about consuming CWD-infected meat. This concern appears to have led many members to harvest a buck in 2019 and then stop hunting. The sharp decline in doe harvest is problematic because hunters are the only viable population management tool currently available at Ames Plantation. Decreased deer harvest at Ames Plantation following the initial discovery of CWD is consistent with findings elsewhere (Holland et al. 2020).

Deer hunting clubs practicing QDM are common in the southeastern United States, and CWD likely will change deer management on these clubs if discovered on or near those properties. Within several months of CWD being discovered at Ames Plantation, most members believed buck harvest restrictions should be reduced. Interestingly, presence of CWD did not influence harvest or observations of mature bucks at Ames Plantation during the first season after discovery. Although high CWD prevalence at this property was documented after initial discovery (see below), on other properties with CWD it is possible that some QDM-focused buck restrictions could remain in place if prevalence rates remain low. Unfortunately, it will be difficult to continue QDM at

Ames Plantation if doe harvest is not maintained. The ability to maintain or increase doe harvest becomes even more challenging if hunters respond to CWD presence by hunting elsewhere. At the Ames Plantation, more than 40% of the membership were unsure of their likelihood to continue hunting there following discovery of CWD. Membership data from 2019 indicated a decline of 35% (84 to 55 members) from 2018. In 2020, only 40 of the 55 members returned.

The major decline in membership that occurred at Ames Plantation likely was driven by high CWD prevalence rates. In 2019, 13 of the 21 bucks harvested were CWD positive, for a prevalence rate of 62%. Doe prevalence rate in 2019 was 21% (7/33 tested), still relatively high given that 45% of the does tested were younger than 3.5 years old. In 2020, the prevalence rate among bucks was 66% (27/41), and the doe prevalence rate was 22.5% (18/80). These high prevalence rates and the spatial distribution of CWD in Tennessee suggest CWD likely was present at Ames Plantation for many years prior to discovery and highlights the importance of testing to detect the disease before hunters face such high prevalence rates (Jennelle et al. 2014). We find it noteworthy that mature buck sightings and harvest had not declined following such high disease prevalence, but it is possible they would decline subsequently if management strategies were not changed.

Future education efforts and research should focus on ways to continue engaging hunters in doe harvest following CWD discovery, and identifying steps necessary to test harvested deer to help alleviate concerns about eating the meat. Publications and online resources that describe best practices to reduce disease risk and safe processing of deer from CWD zones assist in educating hunters (Williams et al. 2018). Disease and population management efforts depend on continued hunter interest, and outreach efforts can play an important role in engaging and informing hunters on CWD.

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Appendix I

2019 CWD and Hunting Experience at Ames Plantation

Section A: Your Hunting Experience at Ames Plantation

1. How long have you been a member at Ames Plantation Hunting Club?

_____

Mean Response: 8.3 years (±0.6)

2. Prior to discovery of CWD, how would you rate your overall experience over the time of your membership in the Ames Hunting Club? (circle number that best fits your response)

Poor 1 2 3 4 5 6 7 8 9 10 Outstanding

Mean Response: 7.9 (±0.2)

3. If you have been a member of or hunted as a guest in other QDM programs, how do you rate the Ames QDM program with other programs? If you have not participated in other programs, leave blank.

a. Ames not as good: **3%**
b. Ames about the same: **30.3%**
c. Ames better: **66.7%**

4. In the past 5 years, was your satisfaction with the Ames QDM program?

a. Increasing: **14.9%**
b. Remaining about the same: **53.7%**
c. Decreasing: **31.3%**

5. Upon finding out that CWD had been discovered at Ames Plantation, what was your initial emotional response? Please circle the answer that best fits your response.

a. Not at all concerned: **0%**
b. Only slightly concerned: **14.5%**
c. Moderately concerned: **26.1%**
d. Extremely concerned: **59.4%**

6. After talking with other hunters about CWD at Ames, how has your initial concerns changed?

a. I am more concerned: **15.9%**
b. I am less concerned: **2.9%**
c. My concern has not changed: **81.2%**

7. Do you feel concern over CWD is:

a. overblown, other places have it and deer herds there are OK: **7.3%**
b. well-merited, because it can negatively impact the herd and hunting: **72.5%**
c. not strong enough, because the herd will decline and hunting will suffer: **18.8%**
d. Other (please specify): **1.5%**

8. How long do you think CWD has been at Ames Plantation?

a. 1–2 years: **12.1%**
b. 3–4 years: **40.9%**
c. 5 years: **31.8%**
d. 10+years: **4.5%**
e. Unknown: **10.6%**

9. Which group in the observation data is most important to your satisfaction?

a. overall deer sightings: **70.2%**
b. total buck sightings: **7.5%**
c. total antlerless sightings: **1.5%**
d. sightings of bucks that meet current restrictions: **20.9%**

10. Which group in the observation data do you expect CWD most likely to negatively impact?

a. overall deer sightings: **56.7%**
b. total buck sightings: **3%**
c. total antlerless sightings: **0%**
d. sightings of bucks that meet current restrictions: **40.3%**

11. Deer density at Ames has been estimated at 20 deer per square mile (though the accuracy of this estimate is unknown). Many state wildlife agency disease experts recommend a reduction in deer density to 20 deer per square mile or lower to help prevent spread of the disease. Do you think deer density should be lowered additionally at Ames Plantation now that CWD has been discovered?

YES: **33.3%** NO: **66.6%**

12. Do you think the age restriction or antler restriction at Ames should be reduced now that CWD has been discovered?

YES: **59.7%** NO: **40.3%**

13. Do you believe body characteristics alone (without antler restrictions) are sufficient to administer buck restrictions at Ames?

YES: **25.8%** NO: **74.2%**

14. How likely are you to continue your membership in the Ames Hunting Club into the 2019–20 season?

a. Definitely not: **6%**
b. Unlikely: **4%**
c. Neutral: **31%**
d. Likely: **24%**
e. Definitely continue: **34%**

15. If you no longer plan to hunt at Ames, what will be your alternative?

a. Hunt somewhere else in west TN: **41%**
b. Hunt somewhere that CWD does not occur: **47%**
c. Stop deer hunting: **12%**

Section B: CWD in West Tennessee

16. How likely are you to continue hunting deer on any property within any area of west TN (such as portion of a county) where CWD has been detected?

a. Definitely not: **2%**
b. Unlikely: **18%**
c. Neutral: **15%**
d. Likely: **26%**
e. Definitely will: **39%**

17. How do you think CWD got to west TN?

a. Don't know: **22.8%**
b. Transport of live or dead deer: **57.9%**
c. Deer movement: **10.5%**
d. Deer farming: **7%**
e. Always been here: **1.8%**

18. How long do you think CWD has been in west TN?

a. 1–2 years: **11.4%**
b. 3–4 years: **3.3%**
c. 5–6 years: **29.5%**
d. 7–8 years: **37.3%**
e. 10+years: **3.3%**

19. How would you rate TWRA's response to the discovery of CWD in west TN?

a. Poor: **3%**
b. Fair: **17%**
c. Good: **29%**
d. Very good: **42%**
e. Excellent: **9%**

20. Were you able to observe TWRA personnel at the check-in station at Ames or at another location during the collection weekends?

YES: **74%** NO: **26%**

21. How concerned are you about eating deer meat that may potentially contain the disease?

a. Not at all: **6%**
b. Slightly: **9%**
c. Concerned: **26%**
d. Moderately: **21%**
e. Extremely: **38%**

22. Would you eat deer meat from an area where CWD has been detected without having it tested?

YES: **15%** NO: **85%**

23. In general, spread of CWD is addressed at the local level (to limit prevalence rates where CWD occurs, and to help prevent spread of CWD into adjacent areas and counties) and at the state level and across states (to help prevent spread of CWD into new areas not close to where it occurs presently). Which of these do you think is most important?

a. Emphasis at local level: **60%**
b. Emphasis at state level: **40%**

24. What do you think is the best prevention of spread of CWD at the local level? Check all that apply

a. reducing deer density: **31%**
b. eliminating transport of hunter-killed carcasses: **23%**
c. eliminating high-fence facilities (to reduce transport of live deer): **20%**
d. other (please specify)

25. What do you think is the best prevention of spread of CWD at the state level?

a. reducing deer density: **20%**
b. eliminating transport of hunter-killed carcasses: **38%**
c. eliminating use of urine-based lures: **0%**
d. eliminating high-fence facilities (to reduce transport of live deer): **22%**
e. other (please specify): **20%**

26. State wildlife agencies recommend increased deer harvest in areas where CWD has been discovered to adequately sample for the disease. In many cases, the spread of CWD into new across the country has been linked to transport of live deer among fenced facilities, including high-

fence deer hunting reserves. Do you believe additional deer also should be harvested within these facilities to sample for CWD?

YES: **94%** NO: **6%**

27. What is the single-biggest change you anticipate CWD will bring?

a. fewer deer: **24%**
b. fewer older bucks: **29%**
c. fear associated with eating deer meat: **23%**
d. fewer hunters: **14%**
e. other: **11%**

28. What do think will ultimately happen with regard to the spread of CWD (check one)?

a. CWD will be eliminated soon: **0%**
b. CWD will be eliminated, but will take time: **14%**
c. CWD will be confined to where it is, but it will not be eliminated: **8%**
d. CWD will be confined to where it is, but it will not be eliminated and infection rates will increase: **3%**
e. CWD will spread into adjacent counties and beyond with increasing infection rates: **76%**

29. What do you think will ultimately happen with regard to the future of deer hunting in west TN and beyond?

a. Will have no impact: **0%**
b. Will have some impact in short-term, but hunting will eventually return to way it was: **20%**
c. Will reduce hunting opportunity and hunter participation: **56%**
d. Deer population will ultimately be lowered drastically and hunting as we know it will never be the same: **24%**