

# Predicting Deer Hunter Harvest Behavior in Wisconsin's Chronic Wasting Disease Eradication Zone

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*Attempts to eradicate chronic wasting disease from free-ranging white-tailed deer (Odocoileus virginianus) in Wisconsin depend on gaining compliance of hunters to harvest deer at rates unprecedented in modern wildlife management. A mail questionnaire and hunter diaries were used to assess hunters' attitudes, effort, and harvest behavior in response to disease management strategies that have included an extended hunting season, removal of seasonal bag limits, and implementation of incentives. Logistic and linear regressions were used to test the influences of attitudinal variables and attributes of hunting experiences on the number of deer harvested. Hunting efficiency (i.e., converting chances among deer seen), number of deer seen, and willingness to harvest antlerless deer predicted harvest levels better than hunting effort (i.e., time afield) did. Individual differences among hunters' desire for venison also emerged as an important predictor of the number of deer harvested.*

**Keywords** hunter effort, harvest motivations, behavior, diary cards, chronic wasting disease

## Introduction

Wildlife managers rely on recreational hunters as a primary “tool” of population control for ungulate species across North America (Carpenter, 2000). Traditionally, this has meant allocating harvest tags and establishing season lengths through some blending of biological objectives (typically expressed as habitat carrying capacity) and public preferences for an optimal herd size (i.e., cultural carrying capacity). The emergence of wildlife diseases in free-ranging white-tailed deer (*Odocoileus virginianus*) has complicated the task of balancing traditional objectives where agencies opt to pursue radical reduction in local deer populations as a means to reduce the probability of disease transmission (Heberlein, 2004).

Shortly after chronic wasting disease (CWD) was discovered in southern Wisconsin in February 2002, for example, the Wisconsin Department of Natural Resources (WDNR) announced its intent to pursue a goal of disease eradication. In doing so, the agency initially sought to depopulate the entire wild deer herd where the disease was present to prevent it from spreading throughout the state (Heberlein, 2004). The agency enlisted deer hunters to achieve the depopulation goal and established a hunting season that ran continuously

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from June through January in a management area referred to as the disease eradication zone (DEZ). After three successive campaigns to eradicate CWD in Wisconsin, the DNR has subsequently tempered the population reduction goal from zero deer to less than five deer per square mile in the DEZ. Although summer hunting has been discontinued, the gun season in the DEZ opens one month earlier and extends one month longer than elsewhere in Wisconsin. Harvest quotas are unlimited for antlerless deer and a variety of incentives have been attempted to make progress toward the population reduction goal (Rolley, 2005).

### ***Context of Problem***

Although hunters remain the primary tool in the population reduction strategy, understanding the behavior of hunters is critical to assessing the potential for success in disease management. Regulations and season formats that encourage unlimited deer harvest run counter to legal and social norms that have evolved among deer hunters over the previous six or seven decades. Doubts have been raised about the effectiveness and ability of deer hunters to control overabundant deer when participating within more traditional deer hunting seasons (Brown et al., 2000; Riley, Decker, Enck, Curtis, & Lauber, 2003). Efforts to achieve adequate population control can be compromised when there are not enough hunters or when hunters are unwilling to harvest antlerless deer.

The question that we raised is: Can deer managers hope to entice cooperative hunter behavior in the form of increased effort and increased harvest through a combination of expanded opportunities, incentives, and support for the disease eradication program? Our primary objective in this article was to determine factors that influenced the number of deer that hunters were willing to shoot. For example, we were curious whether hunter cooperation with herd reduction would override personal concerns over the safety of eating potentially infected venison. Might hunters exhibit a reluctance to overexploit local deer populations, thereby reducing recreational benefits in future seasons? To address these issues, we developed a model that predicted hunter effort and harvest behavior in the DEZ during the extended firearm season.

### ***Conceptual Framework***

A primary rationale for the long gun season implemented in the DEZ was the belief that hunters afforded more time will harvest more deer than they would during a traditional season. The relationship between effort (i.e., time spent afield) and harvest, however, is not necessarily linear (Frey, Conover, Borgo & Messmer, 2003; Van Deelan & Etter, 2003). Higgins-Inman and Vaughan (2002), for example, presented hunter diary data to show that bear hunters using hounds hunted more hours than would have been necessary to harvest a bear by passing-up shots at bears that were successfully treed. We hypothesized that the number of days hunted (i.e., effort) would be positively related to the number of deer harvested per hunter based on the notion that the DEZ provided gun hunting during times unavailable elsewhere in Wisconsin. We reasoned that longer seasons would attract hunters during these time periods.

### ***Understanding Harvest Behaviors***

Although there have been studies of what motivates illegal wildlife (e.g., Eliason, 1999, 2004; Muth & Bowe, Jr., 1998) and fish harvest (Finn & Loomis, 2001; Sutton, 2003;

Sutton & Ditton, 2001), few studies have specifically examined factors affecting hunters' decisions to shoot game. Recognizing that harvest decisions are likely context-specific and potentially influenced by a variety of factors, we organized our predictors based on the PRECEDE framework of behavior (Mullen, Hersey, & Iverson, 1987). This model recognizes that voluntary behaviors result from a combination of predisposing, enabling, and reinforcing factors.

Predisposing factors are the preferences and prior motives that hunters bring to an experience, including attitudes and personal characteristics that either support or inhibit the behavior (i.e., shooting deer). Enabling factors are objective characteristics of an individual, community, or environment that facilitate the behavior. Reinforcing factors are the rewards or punishments that follow the behavior or are an anticipated consequence of it (Lynch, 2000).

### ***Predisposing Factors***

We investigated the influence of six predisposing factors on hunters' harvest levels, which we defined as the number of deer harvested by an individual in the DEZ. These factors were type of hunter (e.g., buck versus antlerless), harvest threshold, efficiency, attitude toward the WDNR's eradication plan, attitude toward the population reduction goal, and perceived risk from eating deer from the DEZ. Given that the importance of harvest motivations differs among hunters (Decker & Connelly, 1989; Kellert, 1978), it is likely that hunters differ in both the number and type of deer they seek from a hunting opportunity. In our study, three variables tap different dimensions of motivation for shooting deer.

First, we hypothesized that hunters who expressed a greater willingness to shoot antlerless deer would harvest more deer than those who considered themselves to be only "buck hunters" or "trophy buck hunters." Heberlein and Kuentzel (2002) provided evidence that buck hunters differed from doe hunters in their preferences and satisfactions. Self-identification as a "buck" or "trophy" hunter may result in hunters who increase effort, but also take fewer shots as they wait for a particular animal (Kellert, 1978).

Second, selectivity in shots taken is not merely a function of hunter type and warrants consideration on its own as an influence on harvest behavior. Hunters may refrain from taking shots for ethical reasons (e.g., the deer was running), perceived skills (e.g., deer was out of range), or other situational factors. We hypothesized that hunters who optimize their shooting opportunities would harvest more deer than those who were conservative in shooting deer.

Third, the demand for venison differs among hunters (Holsman & Meinerz, 2004). We termed the number of deer that a hunter is willing to shoot for his or her own use as the "harvest threshold." Our hypothesis was that the higher a hunter's harvest threshold, the more deer he or she will shoot because a stated demand for venison serves as a behavioral intention with close specificity to the actual behavior (Ajzen & Fishbein, 1980).

Hunters' attitudes toward CWD and its management are also likely to influence hunting effort and number of deer harvested. We were particularly interested in whether hunters who supported the CWD management plan in general and the deer population reduction goal in particular would hunt more days and harvest more deer than hunters who opposed CWD eradication efforts.

One predisposing factor that could negatively impact effort and harvest levels was the perceived risk of eating potentially infected venison. Hunters have expressed some general concern about risks posed by CWD to deer populations (Holsman & Meinerz, 2004;

Petchenik, 2003), but the personal concern does not appear to have influenced hunter decisions to harvest deer (Gigliotti, 2004; Miller, 2003), or to keep hunting in an area where deer have contracted an epizootic disease (Bull, Lupi, & Peyton, 2004; Needham, Vaske, & Manfredi, 2004; Petchenik, 2003). None of these studies, however, specifically addressed potential concerns over CWD to create reluctance among participating hunters to harvest deer, especially when the primary motivation was to obtain meat. We hypothesized that high concern over the safety of venison from the DEZ would reduce the number of deer that hunters harvested.

### ***Enabling Factors***

We explored the role of three enabling factors on harvest levels: (a) access to land, (b) lack of perceived time constraints, and (c) actual amount of hunting effort (i.e., days afield). Constraints of time and access to hunting have been shown to significantly reduce hunting participation and effort (Miller & Vaske, 2003). We hypothesized that hunters with adequate land access in the DEZ who did not feel constrained by time would exert more effort and harvest more deer than those who perceived time or land access as constraints. We also hypothesized that hunters who hunted more would harvest more deer.

### ***Reinforcing Factors***

As part of the deer reduction effort, the WDNR implemented a number of policies to increase harvest levels in addition to allowing unlimited antlerless tags. One policy that served as an incentive to shooting an additional deer (beyond the single deer allowed under the traditional quota system) was an "Earn-A-Buck" (EAB) rule that required hunters to shoot and register an antlerless deer before receiving a buck tag. We hypothesized that motivation to comply with EAB would result in higher harvest levels. Similar to the implied intention of a hunter's harvest threshold, hunters indicating a motivation to comply with EAB are expressing a desire to shoot at least two deer. We hypothesized that those motivated by EAB would harvest more deer than hunters who were not motivated by it.

The WDNR also attempted several types of monetary incentives to promote deer harvest. We explored two of these incentives in this study. First, landowners were eligible for a \$200 cash reward if a deer that tested positive for CWD was harvested on his or her land. Hunters who harvested a CWD-positive deer also received a \$200 reward (\$400 if they were the landowner). Second, every time a hunter registered a deer in the DEZ, he or she was placed into a drawing for \$20 rewards drawn in a lottery. We hypothesized that both of these programs would increase harvest levels among hunters who indicated that cash incentives increased their hunting effort.

Finally, the human dimensions literature has consistently shown that deer sightings are among the most important influences on hunter satisfaction (Gigliotti, 2000). Hunter perception of the likelihood of harvesting game appears to directly influence their effort (Miller & Vaske, 2003; Van Deelen & Etter, 2003), their willingness to obtain antlerless deer permits (Frawley, 2002), and their tolerance for hunter crowding (Heberlein & Kuentzel, 2002). We reasoned that seeing deer would be an important reinforcing factor that would positively influence hunters to spend more time afield in the DEZ and consequently harvest more deer.

## Methods

### *Data Collection*

A self-administered survey comprised of diary cards and a questionnaire was sent to a random sample ( $n = 1,166$ ) of resident gun-deer hunters during the 2004 hunting season. The sample provided by the WDNR consisted of hunters ( $\geq 18$  years old) who registered at least one deer in the DEZ during the previous hunting season. Because the WDNR does not collect information from hunters on where they hunt at the time of license transactions, using past registration stubs provided the only means to link deer hunters to management units within the DEZ.

Each hunter in the sample was mailed diary cards covering three separate periods of the DEZ season: (a) October 28 to November 19, 2004 (“pre-traditional” period), (b) November 20–28, 2004 (“traditional” period), and (c) November 29, 2004 to January 2, 2005 (“post-traditional” period). Hunters were instructed to use the diary cards to record dates and number of hours they hunted, as well as the number of deer seen, deer harvested, and motivations for harvesting each animal taken. The season was divided into three periods to shorten the time between contacts with hunters to encourage a higher response rate. Hunters were instructed to take the diary cards with them into the field to minimize recall bias. They were also instructed to return the cards blank if they did not hunt during a given period. Hunters also received a 12-page questionnaire in January 2005. This questionnaire measured hunters’ beliefs about CWD, risk perceptions, opinions about management including the motivational influence of monetary incentives, demographic information, and general hunting behaviors and preferences.

Duplicate copies of all instruments (i.e., 3 diary cards, questionnaire) were sent in successive mailings up to the fourth contact (a second copy of the questionnaire was sent to non-respondents). Respondent diary cards and questionnaires were matched using a unique identification number. Response rates for the three diary cards after adjusting for nondeliverables were: (a) diary 1 (52%), (b) diary 2 (52%), and (c) diary 3 (40%). Thirty-eight percent of DEZ hunters returned all three diary cards. The response rate to the DEZ questionnaire was 56%. A non-response telephone survey ( $n = 44$ ) was conducted in February 2005 using a subset of questionnaire items. Based on a comparison of responses between mail and telephone respondents, no statistically significant differences were detected. Analyses in this article used hunters who only completed and returned all four instruments ( $n = 418$ ).

### *Measurement of Variables*

*Independent variables.* The independent variables used in the model included the predisposing, enabling, and reinforcing factors described earlier (Table 1). “Hunter type” measured the self-concept of hunters relative to their preference to hunting bucks over antlerless deer and was coded as 0 (a buck hunter) or 1 (open to harvesting an antlerless deer). Harvest threshold was measured by asking “What is the maximum number of deer you are willing to harvest from the DEZ for your own use in a single season?”

“Harvest efficiency” was based on bivariate scatterplots of the number of deer each hunter harvested against the number of deer seen, thus indicating that many hunters, especially unsuccessful hunters, were passing up shot opportunities. Harvest efficiency accounted for differences in hunter optimization, or conversion, of harvest opportunities as a possible predictor of total individual harvest. Harvest efficiency was the ratio of number of deer harvested divided by the number of deer seen.

**Table 1**

Summary of hypothesized influences on hunter effort and number of deer harvested by gun deer hunters in the DEZ of southwest Wisconsin during the 2004 season

Independent variable	Hypothesized effect on being over/under harvest threshold	Results of preliminary logistic regression analysis
Hunter type (Antlerless versus buck)	Positive	Significant
Harvest threshold amount	Positive	Not applicable
Harvest efficiency	Positive	Significant
Attitude toward CWD eradication plan	Positive	Not significant
Attitude toward reducing deer population to <5 deer per sq. mi.	Positive	Not significant
Perceived risk of eating deer from DEZ	Negative	Not significant
Available time to hunt	Positive	Not significant
Access to land in DEZ	Positive	Not significant
Actual time spent hunting (Effort)	Positive	Significant
Number of deer seen while hunting	Positive	Significant
Motivation to comply with Earn-A-Buck requirement	Positive	Significant
Motivation to win \$20 drawing for harvesting deer	Positive	Significant

Attitudinal variables tested were respondents opinion of the WDNR's CWD management plan (4-point scale from "too aggressive" to "not aggressive enough"), attitude toward the DEZ deer population goal (5-point scale from "strongly agree" to "strongly disagree"), and personal perceived risk of eating venison from the DEZ (4-point scale from "very concerned" to "not at all concerned"). Perceived time constraints and land access constraints were measured as yes/no items. Reinforcing factors included the importance of complying with EAB on the first deer harvested (yes/no [reported on diary cards]), chance to earn \$200 for shooting a CWD-positive deer (yes/no), and chance to win a \$20 lottery drawing (yes/no). Finally, effort (total days hunted [continuous]) and number of deer seen (continuous), were measured on diary cards.

### ***Dependent Variables***

We used binary logistic and linear regression techniques separately to test the influence of the independent variables on two different dependent variables. Logistic regression answered the question "What factors determine whether a hunter's reported deer harvest total met/exceeded their harvest threshold?" This question explored the extent to which hunters may be harvesting more deer than they wanted as a way to assist agency efforts at deer herd reduction. Hunters who met or exceeded their harvest threshold (48%) were coded as 1; hunters who failed to achieve their stated harvest threshold (i.e., shot fewer deer than they indicated they were willing to shoot) were coded as 0 (52%). This over/under threshold

classification was the dependent variable for the binary logistic regression. Stepwise linear regression tested the factors that influenced the total number of deer each hunter harvested in the DEZ. For the linear model, “total harvest”—the number of deer taken by each hunter as reported on diary cards—was the dependent variable.

### *Regression Models*

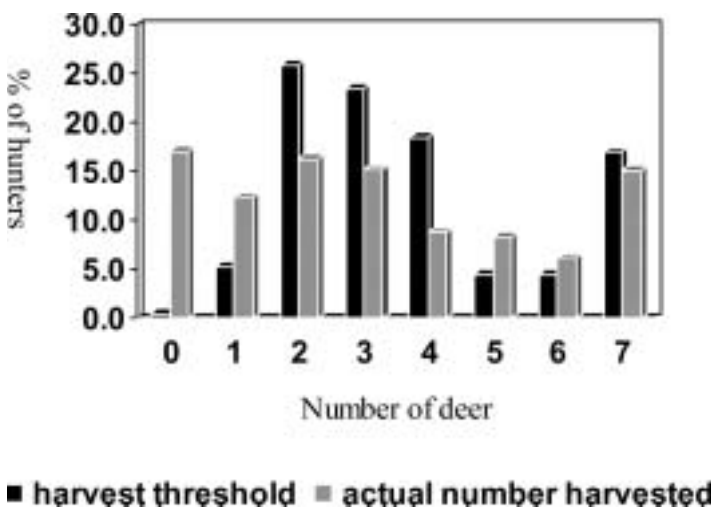
For both the logistic and linear regressions, we generated three separate models to test for the effects of predisposing, enabling, and reinforcing variables, respectively, on harvest behavior. These models were used to identify candidate predictors for use in reduced models for each dependent variable (Hosmer & Lemeshow, 1989). Only the variables that were found to be significant in these exploratory analyses were included in final revised models described in the results. Independent and dependent variables that violated the assumption of normality were transformed using their natural log.

For the linear regression models, stepwise procedures were used to select the most influential variables on total harvest. Model selection was determined by identifying the plateau point for adjusted  $R^2$  values as means of choosing a parsimonious fit. Variables were excluded from models if they were not significantly related to total harvest or if their inclusion resulted in a less than 1% increase in overall explained variance of the model.

## **Results**

### *Univariate Results*

Hunter effort averaged 11.2 days and 50.2 hours for the season. Hunters harvested an average of 3.63 deer, but 52% harvested two deer or less and 17% did not shoot any (Figure 1). About half of the hunters failed to attain their harvest threshold (Figure 1). Among the possible constraints to effort, 26% of respondents said that “lack of time” prevented them from shooting more deer; 13% reported that “access to land” was a barrier.



**Figure 1.** Percent distribution of harvest thresholds reported by hunters compared to number of deer each hunter actually harvested.

Regarding the attitudinal items, 38% of hunters said the DNR was being “too aggressive” with CWD, whereas 31% said it was “about right.” Fifty-four percent of hunters disagreed or strongly disagreed with the deer reduction population goal and only 16% agreed. As for reinforcing factors among hunters who shot at least one deer, 46% listed EAB as the primary reason that they harvested the first deer. Only 19% and 16%, respectively, said that the lottery program and the chance to earn \$200 for shooting a CWD-positive deer motivated them to increase the number of deer harvested. About 77% of hunters were willing to harvest an antlerless deer compared to 23% who considered themselves to be only buck hunters.

### ***Logistic Model Results***

The final logistic model suggested that hunters who exceeded their harvest threshold were those who were most efficient (or were least selective) in shooting deer, hunted more days, saw more deer, had a higher harvest threshold, described themselves as more willing to shoot antlerless deer, and were motivated by EAB to shoot their initial deer. Results indicated that all but one of the variables in the model was significantly ( $p < .05$ ) related to whether hunters attained their stated harvest threshold (Table 2). The only variable that failed to reach statistical significance when controlling for the other factors was the motivation to receive a \$20 lottery payment. All of the significant predictor variables were positively related except for harvest threshold, which had a negative association. This result can be interpreted as the more deer a hunter says that he or she is willing to kill for his or her own use, the less likely or harder it will be to achieve that number of deer. Variables with the strongest association in predicting whether hunters attained their harvest threshold were hunters’ motivations to comply with EAB and their orientation toward harvesting antlerless deer. Based on odds ratios, hunters who were motivated by EAB and those who did not consider themselves to be buck hunters were each about twice as likely as other hunters to meet or exceed their harvest threshold. The overall fit of the model was significant and correctly classified 77% of the cases,  $\chi^2(7) = 154.40$ ,  $p < 0.001$ .

### ***Linear Model***

Stepwise linear regression identified significant variables that affected the overall number of deer harvested by each hunter. Results produced a relatively parsimonious explanation

**Table 2**  
Revised logistic regression model predicting whether hunters achieved their harvest thresholds in the DEZ during the 2004 season

Variable	B	Wald	<i>p</i> -value	Odds ratio
Effort (days)	.051	5.90	.01	1.05
Number of deer seen	.057	36.0	.001	1.06
Harvest threshold amount	-.593	41.3	.001	0.55
Harvest efficiency	.065	50.1	.001	1.07
Hunter type (buck vs. antlerless)	.733	4.7	.05	2.08
EAB as a motivator	.820	9.0	.001	2.27
Lottery as motivator	.717	3.2	.07	2.05

**Table 3**  
Stepwise linear regression results for significant factors influencing hunters' harvest levels in the DEZ during the 2004 season

	Dependent variable: number of deer harvested			
	Preliminary models		Final model <sup>3</sup>	
	$\beta$	<i>p</i> -value	$\beta$	<i>p</i> -value.
Predisposing variables <sup>1</sup>				
Harvest threshold	.31	.001	.22	.001
Harvest efficiency	.46	.001	.53	.001
	$R_{adj}^2 = 0.39, F = 113.4, p < .001, df = 2$			
Enabling variables <sup>2</sup>				
Effort (days hunted)	.33	.001	Excluded	
	$R_{adj}^2 = 0.20, F = 47.5, p < .001, df = 1$			
Reinforcing variables				
Number of deer seen	.45	.001	.47	.001
Motivation to comply with EAB	.26	.001	Excluded	
Motivation to win \$20 drawing for harvesting deer	.20	.001	Excluded	
	$R_{adj}^2 = 0.55, F = 55.1, p < .001, df = 3$			
	Final model: $R_{adj}^2 = 0.59, F = 183.7, p < .001, df = 3$			

<sup>1</sup>Variables removed at step 2: hunter type, attitude toward CWD eradication plan, attitude toward population reduction goal, perceived risk of eating deer from CWD.

<sup>2</sup>Variables removed at step 1: time available to hunt, access to land.

<sup>3</sup>Variables removed at step 3: effort, motivation to comply with EAB, motivation to win \$20 drawing for harvesting deer.

of why some deer hunters harvested more deer than others in the DEZ (Table 3). Three-predictor model explained 59% of the variance in hunter harvest levels. Harvest efficiency, number of deer seen, and maximum harvest threshold were significantly related to the number of deer harvested per hunter. Harvest efficiency was the strongest predictor ( $\beta = .53$ ) of the number of deer harvested when controlling for the influence of other variables in the model. Hunters who were least selective (i.e., those who optimally convert deer sightings into deer harvests) shot more deer than hunters who passed up shot opportunities. The more deer seen and the higher one's willingness to harvest deer, the more deer were harvested per hunter.

## Discussion

Different variables predicted hunters who met or exceeded their harvest threshold than predicted overall harvest levels. The logistic model found seven variables associated with classification of being over/under one's harvest threshold. Attainment of harvest threshold was greatest for hunters motivated by EAB, those who did not consider themselves "buck hunters," and those most likely to shoot more deer than they wanted for their own personal use. Moreover, hunting more days, seeing more deer, converting more chances, and desiring

fewer deer for personal use also contributed to hunters' likelihood of meeting or exceeding their stated threshold.

The array of factors and their relative importance changed substantially when the number of deer each hunter actually harvested was considered as the dependent variable. Findings suggested that high harvest was a function of willing antlerless hunters who were in quality spots, saw a large number of deer, and optimized their chances. These variables included effort and the effects of external motivators such as EAB or incentive programs. Consistent with Heberlein and Kuentzel (2002), our findings indicated that hunters who preferred to hunt for bucks passed up more shot opportunities than other hunters.

Results also suggested that hunter effort, by itself, was not a significant determinant of deer harvest. Increases in hunter effort may not be contributing to the agency's goal of deer reduction. Perhaps DEZ hunters who spent more time afield may also be hunters who were more selective in their harvest opportunities such as trophy buck hunters who spend many hours trying to harvest a buck of a particular size. Alternatively, the lack of statistical significance of hunting effort when controlling for other factors suggests that extra time in the woods does not necessarily overcome a poor hunting location (i.e., time afield matters less than maximization of opportunity). One can envision two hunters, one in an area of high deer density and the other in an area of low deer density. As long as there is a willingness to shoot what is seen, the hunter in the high density area will not have to wait as long for a chance to get a deer, whereas the second hunter may have to expend more effort to fill a tag.

Both harvest efficiency and harvest thresholds emerged as important considerations for research and management. "Harvest efficiency," however, may have a number of underlying factors influencing why some hunters chose to convert most of their chances, whereas others were "less efficient." First, from an ethical perspective, hunters may pass up shots at deer including opportunities that are perceived to be out of range or presented at a poor angle. Even though the existing deer population reduction goal encourages hunters to be aggressive and take all chances presented to them, at least some and perhaps many hunters were not taking every chance.

Second, deer hunters may selectively wait for a large buck or even a large doe. The importance of EAB as a motivator suggests that almost half of the hunters surveyed may not have shot their first antlerless deer if they were not required to do so to also hunt bucks. Clearly, hunters prefer to be selective in their choice of harvest.

Third, hunters who were less efficient may simply be those who, like Higgins-Inman and Vaughan's (2002) bear hunters, derive satisfactions from the chase and pass opportunities to extend their experience. In the DEZ where tags were unlimited, this seems less plausible.

Fourth, some hunters may self-regulate their harvest based on disagreement with deer management goals of herd reduction. Although this is possible, we did not find supportive evidence. Neither attitudes toward the eradication plan nor the deer reduction goal were significant in our preliminary model. Those opposed to the deer reduction goal were just as likely to be among the highest harvesters as those who agreed with the goal. Conversely, hunters who supported the goal were just as likely to not shoot any deer as those who opposed it.

Perceived risk regarding consuming venison from the DEZ did not influence harvest behavior. This supports CWD studies showing concern over meat safety has not yet had a significant impact on hunting participation (Gigliotti, 2003; Miller, 2003). Hunters' growing experience with CWD, most notably the lack of any human illnesses from the disease, may have reduced fears typically associated with unknown or dreadful risks (Slovic, 1987).

These findings are another example of the growing body of research that has found weak or no relationships between general attitudes and specific behaviors (e.g., Azjen & Fishbein, 1980; Marcinkowski, 1998; Tarrant & Green, 1999). This is a mixed blessing for deer managers who can take comfort in knowing that just because hunters may complain about specific policies, it does not necessarily mean that they will not comply with the desired goals. It also means that the most ardent supporters may not be doing their part to “help the cause.”

The importance of deer sightings in predicting harvest levels was not surprising. Hunters who saw more deer were more likely to be presented with opportunities perceived as both desirable and within their skill sets. Seeing more deer may also have a psychological and pragmatic effect on harvest behavior. Seeing many deer serves to reinforce hunter perceptions that their individual harvest actions are not significantly affecting overall deer abundance and, therefore, not mortgaging their future opportunities. This perception may serve to increase their harvest threshold more than someone who hunts in an area with lower deer density who becomes less willing to harvest additional deer. More research is needed to identify additional factors that influence hunter harvest threshold.

### ***Management Implications***

Findings partially support the use of EAB in the DEZ as a strategy for increasing deer harvest. Motivation to earn a buck was related to a greater likelihood of achieving harvest threshold, but was unrelated to total deer harvested. Although EAB works to increase the number of hunters who shoot more deer than they desire for their own use (i.e., harvest threshold), this program’s effectiveness appears limited to the lower end of the harvest distribution. The motivation to comply with EAB was present in many hunters and we assumed that the number of antlerless deer harvested would decrease in its absence. Hunters may shoot an antlerless deer to get to the buck once, but few hunters are shooting multiple antlerless deer in an attempt to secure multiple buck tags.

Other reinforcing factors that seek to reward hunters for shooting more deer appear largely ineffective. The WDNR’s monetary incentive program was not effective in substantially increasing the number of deer killed. Few hunters reported that the chance to earn \$200 for a CWD-positive deer or win a \$20 lottery drawing motivated them to harvest additional deer. Neither variable was significantly related to hunter harvest behavior when controlling for other factors. Given these and similar findings among DEZ landowners (Petchenik, 2006), the agency has discontinued its use of the \$20 lottery program. After careful consideration, the WDNR has retained the cash reward for testing CWD-positive deer in an effort to maintain a consistent message about the need to remove diseased animals (Petchenik, 2006).

Overall, hunter harvest decisions depend most heavily on intrinsic harvest thresholds that seem somewhat immune to agency attempts to increase them. Managers may be best served to manage the segment of hunters most willing to harvest deer rather than taking its current broad approach of providing a longer season as a means of increasing effort. One emerging strategy supported by our findings is an agency effort to register hunters under private landowner permits to hunt in “sparks” areas where CWD incidence is high or other priority locations such as refuges created where hunter density is low because of limited access. This is one example of a focused effort to put willing hunters in places where they can reduce deer numbers most efficiently. This strategy is likely to be more effective than trying to promote overall hunter effort, especially since time in the field appears to matter less than location.

Our sampling design that draws on successful hunters in the past as a basis for measuring hunter effort and harvest is a potential limitation. Given the available funding and database options for generating a hunter sample from the DEZ, however, we believe this to be the optimal approach. Currently, there is no way to capture deer hunters who hunt in specific areas such as the DEZ without utilizing past information about where they registered deer. Results here may differ from a random sample of all hunters in the area if successful hunters differ in their attitudes and behaviors than hunters who did not harvest a deer the previous year. Findings, especially related to hunter behavior (i.e., harvest, effort), may overstate the amount of deer hunting currently in the DEZ.

Finally, our models fall short of explaining all factors that influence harvest decisions, but provide a starting point for research on harvest behavior. Managers need to consider the rate of deer herd reduction in light of overall hunter demand for venison to determine if recreational hunting alone or in conjunction with other measures (e.g., sharpshooters) can realistically achieve the desired herd reduction to manage CWD.

## References

- Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.
- Brown, T. L., Decker, D. J., Riley, S. J., Enck, J. W., Lauber, T. B., Curtis, P. D., & Mattfield, G. E. (2000). The future of hunting as a mechanism to control white-tailed deer populations. *Wildlife Society Bulletin*, 28, 797–807.
- Bull, P. A., Lupi, F., & Peyton, R. B. (2004). The effect of disease management policies and outcomes on deer hunting location: The mobility of Michigan deer hunters. *65th Annual Midwest Fish and Wildlife Conference*, Indianapolis, IN.
- Carpenter, L. H. (2000). Harvest management goals. In S. Demairis & P. R. Krausman (Eds.) *Ecology and management of large mammals in North America* (pp. 192–213). Upper Saddle River, NJ: Prentice Hall.
- Decker, D. J., & Connelly, N. A. (1989). Motivations for deer hunting: Implications for antlerless deer harvest as a management tool. *Wildlife Society Bulletin*, 17, 455–463.
- Eliason, S. L. (1999). The illegal taking of wildlife: Toward a theoretical understanding of poaching. *Human Dimensions of Wildlife*, 4, 27–39.
- Eliason, S. L. (2004). Accounts of wildlife law violators: Motivations and rationalizations. *Human Dimensions of Wildlife*, 9, 119–131.
- Finn, K. L., & Loomis, D. K. (2001). The importance of catch motives to the recreational anglers: The effects of catch satiation and deprivation. *Human Dimensions of Wildlife*, 6, 173–187.
- Frawley, B. J. (2002). *Factors affecting the sale of antlerless deer hunting licenses in the north-east lower peninsula*. Report No. 3372, Lansing: Michigan Department of Natural Resources Wildlife Division.
- Frey, S. N., Conover, M. R., Borgo, J. S., & Messmer, T. A. (2003). Factors influencing pheasant hunter harvest and satisfaction. *Human Dimensions of Wildlife*, 8, 277–286.
- Gigliotti, L. M. (2000). A classification scheme to better understand satisfaction the satisfaction of Black Hills deer hunters: The role of harvest success. *Human Dimensions of Wildlife*, 5, 32–51.
- Gigliotti, L. M. (2004). Hunters' concern about chronic wasting disease in South Dakota. *Human Dimensions of Wildlife*, 9, 233–235.
- Heberlein, T. A. (2004). "Fire in the Sistine Chapel": How Wisconsin responded to chronic wasting disease. *Human Dimensions of Wildlife*, 9, 165–179.
- Heberlein, T. A., & Kuentzel, W. F. (2002). Too many hunters or not enough deer? Human and biological determinants of hunter satisfaction and quality. *Human Dimensions of Wildlife*, 7, 229–250.
- Higgins-Inman, K., & Vaughan, M. R. (2002). Hunter effort and success rates of hunting bears with hounds in Virginia. *Ursus*, 13, 223–230.

- Holsman, R. H., & Meinerz, R. D. (2004). *A preliminary report on hunter effort and attitudes in Wisconsin's chronic wasting disease eradication zone: Results from the 2003 extended deer season*. Stevens Point: University of Wisconsin-Stevens Point College of Natural Resources.
- Hosmer, D. W., & Lemeshow, S. (1989) *Applied logistic regression*. New York: Wiley.
- Kellert, S. R. (1978). Attitudes and characteristics of hunters and anti-hunters. *Transactions of the North American Wildlife and Natural Resources Conference*, 43, 412–423.
- Lynch, J. A. (2000). *Factors influencing snowmobilers' aberrant behaviors: A comparison of the 1996–97 convicted snowmobile law violators and other snowmobilers*. Unpublished doctoral dissertation. East Lansing: Michigan State University.
- Marcinkowski, T. (1998). Predictors of environmental behavior: A review of three dissertation studies. In H. R. Hungerford, W. J. Bluhm, T. L. Volk, & J. M. Ramsey (Eds.), *Essential readings in environmental education* (pp. 227–236). Champaign, IL: Stipes.
- Miller, C. A. (2003). Hunter perceptions and behaviors related to chronic wasting disease in northern Illinois. *Human Dimensions of Wildlife*, 8, 229–230.
- Miller, C. A., & Vaske, J. J. (2003). Individual and situational influences on declining hunter effort in Illinois. *Human Dimensions of Wildlife*, 8, 263–276.
- Mullen, P. D., Hersey, J. C., & Iverson, D. C. (1987). Health behavior models compared. *Social Science Medicine*, 24, 973–981.
- Muth, R. M., & Bowe, Jr., J. F. (1998). Illegal harvest of nonrenewable resources in North America: Toward a typology of the motivations of poaching. *Society and Natural Resources*, 11, 9–16.
- Needham, M. D., Vaske, J. J., & Manfredi, M. J. (2004). Hunters' behavior and acceptance of management actions related to chronic wasting disease in eight states. *Human Dimensions of Wildlife*, 9, 211–231.
- Petchenik, J. (2003). *Chronic wasting disease in Wisconsin: Gun deer hunters' first response*. Madison: Wisconsin Department of Natural Resources.
- Petchenik, J. (2006). Landowner responses to harvest incentives in Wisconsin's southwest chronic wasting disease eradication zone. *Human Dimensions of Wildlife*, this issue.
- Riley, S. J., Decker, D. J., Enck, J. W., Curtis, P. D., & Lauber, B. (2003). Deer populations up, hunter populations down: Implications of interdependence of deer and hunter population dynamics on management. *Ecoscience*, 10(4), 455–461.
- Rolley, R. E. (2005). *Controlling chronic wasting disease in Wisconsin: A progress report and a look toward the future*. Madison: Wisconsin Department of Natural Resources, Bureau of Integrated Science Services.
- Slovic, P. (1987). Perception of risk. *Science*, 236, 280–285.
- Sutton, S. G. (2003). Freshwater and situational determinants of catch-and-release choice of freshwater anglers. *Human Dimensions of Wildlife*, 8, 109–126.
- Sutton, S. G., & Ditton, R. B. (2001). Understanding the catch and release behavior among U.S. Atlantic bluefin tuna anglers. *Human Dimensions of Wildlife*, 6, 49–66.
- Tarrant, M. A., & Green, G. T. (1999). Outdoor recreation and the predictive validity of environmental attitudes. *Leisure Sciences*, 21, 17–30.
- Van Deelen, T. R., & Etter, D. R. (2003). Effort and functional response of deer hunters. *Human Dimensions of Wildlife*, 8, 97–108.

