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Effort versus Motivation: Factors Affecting Antlered and Antlerless Deer Harvest Success in Pennsylvania

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Hunting can be an effective tool for managing deer populations, but hunter willingness to harvest deer and their success is critical to management capacity. Moreover, harvest of antlerless deer is crucial to managing deer populations. Previous research has examined the effects of weather, habitats, and hunter access on deer harvest success. However, hunter-related factors leading to harvest success are unknown. This study explored the effects of hunter sociodemographic and background characteristics, field behaviors, and motivations on antlerless and antlered deer harvest success. Findings indicated that hunter characteristics and motivations differentially influence the harvest of a doe or a buck. Successful doe hunters viewed hunting as a management tool, were concerned about maintaining access to hunting areas, and hunted for venison. In contrast, harvesting an antlered deer appeared to be mostly a matter of effort. Those who killed an antlered deer spent more days afield, especially during late season.

Keywords antlered, antlerless, deer, harvest success, wildlife management, Pennsylvania

Introduction

The challenge of managing deer populations in Pennsylvania has shifted from a context of scarcity to overabundance (Brown et al., 2000; Pennsylvania Game Commission [PGC], 2003). This shift represents a challenge for state wildlife management agencies. In 1896, the PGC was formed to increase depleted game stocks, specifically deer (PGC, 2003, 2005a; Witmer & deCalesta, 1992). From 1906 to 1925, the PGC released about 1,200 deer to try to restore the population, and closed antlerless harvest for several seasons (e.g., 1915–1922; 1932–1934). These efforts were successful; by the latter half of the 20th century, the Commonwealth's deer population exceeded its cultural carrying capacity (maximum number of deer that can coexist compatibly with local human populations) in much of the Commonwealth (Witmer & deCalesta, 1992).

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Deer have both positive and negative effects on the Commonwealth's economy, natural resources, and human health. Deer hunting provides recreation and income. Estimates indicate that over 930,000 deer hunters spent nearly 7.5 million hunting days afield in Pennsylvania in 2001 (PGC, 2003). In its 2002 seasons, a total of 517,529 (165,416 antlered and 352,113 antlerless) deer were killed (PGC, 2005c). It has been estimated that deer hunting adds over 245 million dollars annually in retail sales and about 122 million dollars in wages to Pennsylvania's economy (Diefenbach, Palmer, & Shope, 1997).

On the other hand, a high density deer population negatively affects tree species composition and forest biodiversity (Latham et al., 2005). Deer damage field crops and affect humans through deer–vehicle collisions and transmission of Lyme disease (Boyd & Palmer, 1992; Witmer & deCalesta, 1992; Diefenbach et al., 1997; PGC, 2003). The recent spread of Chronic Wasting Disease has exacerbated concerns about high deer populations (Bishop, 2004; Heberlein, 2004; Needham, Vaske, & Manfredo, 2004; Vaske, Timmons, Beaman, & Petchenik, 2004).

As in many other states, PGC management goals have changed from managing deer as a scarce resource to managing the problems associated with abundance (PGC, 2003). Regulated hunting is one of the most effective tools for managing deer population in large areas (Stedman et al., 2004). In 2003, the PGC initiated a five-year, white-tailed deer management plan that emphasized managing for sustainable deer population levels, maintaining and restoring forested ecosystems, and reducing human–deer conflicts (PGC, 2003, 2005b).

Prior wildlife management research has focused on factors that influenced hunter satisfaction (e.g., Gigliotti, 2000; Hammit, McDonald, & Patterson, 1990; Hazel, Langenau, & Levine, 1990; Heberlein & Kuentzel, 2002; Hendee, 1974; Potter, Hendee, & Clark, 1973; Vaske, Fedler, & Graefe, 1986). These studies explored hunting primarily as a recreational activity, rather than as a management tool (Vaske et al., 1986). As a result, few studies have examined factors that predict deer harvest. Although Hansen, Nixon, and Loomis (1986) addressed the effect of weather on daily and annual harvest of white-tailed deer, and Foster, Roseberry, and Woolf (1997) examined the effect of deer and human habitats and hunter access on deer harvest efficiency, studies have not examined the influence of hunter characteristics, field behaviors, or perceptions/motivations on deer harvest success. In a context where wildlife managers seek to control deer populations, a better understanding of hunter-related factors that contribute to *deer harvest* is crucial from a wildlife management perspective.

The PGC (2005a) reported that does are traditionally under harvested and bucks over harvested in the Commonwealth. As a result, its new deer management program sought to decrease the yearling buck harvest and, as a result, adjust the buck to doe ratio to attain a more natural breeding ecology (Luloff et al., 2002). This suggests the need to differentiate the factors contributing to deer harvest success by *type* of deer—antlered or antlerless. We seek this understanding in our study.

Methods

Data and Study Site

Data were collected from hunters on the Sproul State Forest, located in north-central Pennsylvania on the Allegheny Plateau. This forest is managed by the Pennsylvania Department of Conservation and Natural Resources (DCNR), Bureau of Forestry (BOF). It represents a large tract of contiguous forested public land that has historic associations

with deer hunting. Both local and non-local hunters regularly come to this region, hunt, and use camps.

The data were collected early in 2003 following the 2002 deer seasons (Luloff et al., 2004; Stedman et al., 2004). Our sampling frame consisted of a random sample of hunters we encountered at check stations (hunters were requested to stop at these stations prior to their hunt) and in camps (Stedman et al., 2004). The survey addressed hunters' experiences, sociodemographic characteristics, attitudes, beliefs, and behaviors. Two data collection techniques were used, mail and telephone surveys. We mailed survey instruments to 427 hunters; 287 hunters were contacted via phone. The mail survey used a three-step Dillman (1978) technique including an initial mailing, a second follow-up reminder postcard, and a second mailing of a survey instrument and reminder letter. The mailed surveys yielded 208 responses (response rate of 50%). We received a higher response rate (59%, $n=170$) by phone. No statistically significant differences between the mail survey data and telephone survey data existed (Luloff et al., 2004). Therefore, the two data sets were merged for analysis.

Variables

The dependent variable, harvest success, was dichotomously measured by whether a hunter self-reported killing (a) an antlerless and (b) an antlered deer in the 2002 hunting seasons (Table 1).

Explanatory variables included hunters' sociodemographic and background characteristics, field behaviors, and attitudes. Sociodemographic measures included age, self-described health status, education, income, and place of residence. Field behaviors included whether a hunter used a camp on the Sproul or drove into the forest to hunt for the day, the topography they hunted most often, their hunting style, their use of hunting aids, and days spent afield during various seasons. Hunter perceptions/motivations addressed a range of hunting related issues that were measured using a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). These data were factor analyzed and two major dimensions were found (Table 2). The first (8 items) measured hunting as a deer management tool (Cronbach's alpha=0.72) and the second (5 items) measured maintaining adequate access to hunting lands (Cronbach's alpha=0.62). Items that did not load (factor loadings less than 0.40) into either of these two dimensions were excluded from the analysis. Two other attitudinal variables, importance of hunting (very unimportant=1 to very important=7), and perceived crowding (not at all crowded=1 to extremely crowded=9) were also examined.

Reasons for hunting were assessed using a series of 5-point Likert scale items that ranged from very unimportant (1) to very important (5). These data were factor analyzed to explore its unidimensionality. Eight items loaded on one factor labeled "recreation" (Cronbach's alpha=0.74, Table 3). Two achievement-based reasons, to obtain venison and to get a large antlered deer, failed to load on this factor and were retained as separate items because they represented different types of motivations especially germane to our study contrasting antlerless and antlered deer harvest.

Data Analysis

We examined the factors affecting hunter success via bivariate correlations and multivariate modeling. Our intent was to identify all hunter-related factors associated with harvest. Bivariate associations were examined using Pearson correlations. Logistic regression was

Table 1
Measures

Variables	Measurements	Descriptives N	% or Mean	SD
Dependent variables—harvest success				
Antlered deer				
Not killed	0	216	73.2	
Killed	1	79	26.8	
Antlerless deer				
Not killed	0	195	66.1	
Killed	1	100	33.9	
Explanatory variables				
Sociodemographic characteristics				
Age	Years	295	48.7	13.9
Education				
High school or less	0	133	45.1	
Some college or vocational training	1	77	26.1	
Completed college or more	1	85	28.8	
Income				
Less than or equal to $45,000	0	113	38.3	
More than $45,000	1	182	61.7	
Self-reported health status				
Else	0	176	59.7	
Excellent	1	119	40.3	
Residence				
Country/rural area	0	74	25.1	
City	1	58	19.7	
Suburban	1	59	20.0	
Rural town/village	1	104	35.3	
Hunting background				
Hunting experience	Years	295	32.4	12.9
Instruction on hunting				
Parents	0	200	67.8	
Other than parents	1	95	32.2	
Information sources				
Informal (talking to others)	0	44	14.9	
Formal (e.g., newspapers)	1	251	85.1	
Field behaviors				
Camping status				
Drove to forest or else	0	58	19.7	
Used a camp	1	237	80.3	

Continued

Table 1
Continued

Variables	Measurements	Descriptives N	Descriptives % or Mean	Descriptives SD
Topography most hunted				
Upper plateau	0	67	22.7	
Mixed	1	173	58.6	
Side hills	1	55	18.6	
Hunting style				
Hunted in group or else	0	135	45.8	
Hunted alone	1	160	54.2	
Used hunting aids (Index 0–4)	Interval	295	1.6	1.1
Days afield during				
Early season	Days	295	4.2	6.4
Early Jr/Sr season	Days	295	1.1	2.8
Firearm season	Days	295	6.1	3.2
Late season	Days	295	2.0	2.8
Perceptions/motivations about hunting				
As deer management tool (Factor score)	Interval	295	0.0	1.0
Maintaining access to hunting lands (Factor score)	Interval	295	0.0	1.0
How important hunting is (Very unimp.=1 to very imp.=7)	Ordinal	295	6.5	0.9
How crowded do you feel (Not at all=1 to extremely=9)	Ordinal	295	3.4	2.1
Reasons for participation				
Recreation (Factor score)	Interval	295	0.0	1.0
To obtain venison (Very unimp.=1 to very imp.=5)	Ordinal	295	2.9	1.0
To get antlered deer (Very unimp.=1 to very imp.=5)	Ordinal	295	2.9	1.2

used as a multivariate tool to examine the effects of the explanatory variables on antlered and antlerless deer harvest success. We present these results in two models: one for antlerless and one for antlered harvest. The full model (containing all of the independent measures) included hunters' sociodemographic and background characteristics, field behaviors, and their perceptions/motivations about a range of hunting issues.

The results of the logistic regression analysis are presented as odds ratios. For the independent variables, odds ratios greater than 1 indicate the odds of harvest success increases when the independent variables increase, whereas odds ratios of less than 1 indicate the odds of harvest success decreases when the independent variables increase (Menard, 1995). For categorical independent variables, an odds ratio greater than 1 indicates an increased chance of harvest success, and an odds ratio less than 1 indicates a decreased chance of harvest success (Liao, 1994).

Table 2
Hunter perceptions/motivations about hunting

Dimensions and items (strongly disagree=1 to strongly agree=5)	Factor loadings		Descriptives	
	Factor 1	Factor 2	Mean	Agree[1] (%)
Hunting as a deer management tool				
I hunt with the goal of harvesting an antlered deer only.	–0.59		2.95	42.0
The number of deer has no effect on plant and animal communities.	–0.57		1.99	12.2
Deer damage to forests in Pennsylvania is a problem.	0.69		3.17	35.1
Keeping deer population in balance with natural food supplies is necessary.	0.54		4.07	87.1
I don't really care if I shoot an antlered/antlerless deer as long as I get a deer.	0.45		2.72	31.8
Deer cause serious conflicts with other land uses, such as forestry, farming, highways, and other development.	0.55		3.40	58.7
I would rather harvest a doe than no deer at all.	0.64		3.06	50.9
The number of deer has no effect on forest regeneration.	–0.58		2.12	9.2
Cronbach's Alpha	0.72			
Variance explained (%)	21.20			
Maintaining adequate access to hunting lands				
There is enough public hunting land in PA to provide access to anyone who wants to hunt.		–0.48	3.58	67.4
The quality of the hunting experience is higher on private lands than it is on public lands.		0.42	3.03	37.0
Posting of private land has made it more difficult for me to find a place to hunt.		0.76	3.37	57.3
It has become increasingly difficult for me to find a good place to hunt deer.		0.69	2.90	37.3
Posting has restricted my access to hunting on private lands.		0.55	3.60	64.0
Cronbach's Alpha		0.62		
Variance explained (%)		17.00		
Cumulative variance explained (%)		38.20		

[1]Agree includes agree and strongly agree.
[2]Loadings of <.30 have been excluded from the display.

Table 3
Reasons for hunting

Dimension and items (very unimportant=1 to very important=5)	Factor loadings	Descriptives	
	Factor	Mean	Important[1] (%)
Recreation (non-achievement based)			
To get outdoors	0.70	4.61	96.9
To get away from everyday routine	0.60	4.52	95.2
To be with my friends	0.59	4.25	87.4
To be with my family	0.59	4.07	78.3
To return to traditional sports	0.51	4.10	79.3
The challenge of hunting deer	0.68	4.24	88.5
To test my outdoor skills	0.70	3.94	74.9
To help manage deer population	0.43	3.75	66.1
Total variance explained	36.50		
Cronbach's Alpha	0.74		

[1]Important includes important and very important.

Results

The proportion of responding hunters who killed an antlerless deer was slightly but significantly greater than those who killed an antlered deer. About one in four (27%) and one in three (34%) hunters killed at least one antlered or one antlerless deer, respectively. About 12% reported killing both an antlered and an antlerless deer. The average hunter was about 49 years old with an average hunting experience of 32 years. Many (45%) had no more than a high school education. About one in four (26%) had some college or vocational training, and 29% had at least a baccalaureate degree. Sixty-two percent had income over $45,000 per year and lived in the country or in a rural town or village. Four in ten (40%) hunters self-reported their health as excellent. About 60% of the hunters either lived in the rural countryside (25%) or in a small town/village (35%). The remainders were from city or urban areas.

Whereas one in five hunters drove in to the study area to hunt for the day, the remainder owned, belonged to, or used a hunting camp. With respect to field practices, slightly over half (54%) hunted alone. Hunters, on average, hunted about six days during regular firearm (rifle/pistol/shotgun) deer season followed by four days in the early season, two days in the late season, and one day in the early junior/senior season.

Variations were also observed among hunters regarding their perceptions and motivations for hunting. Hunters generally recognized the role that deer play in the ecosystem: a large majority (91%) disagreed that the number of deer has no effect on forest regeneration, 88% recognized that the number of deer can affect plant and animal communities, and 87% agreed with the need to keep deer populations in balance with natural food supply. About half (51%) of the hunters indicated that they would rather harvest a doe than no deer at all, whereas 42% mentioned that they hunted with the goal of harvesting an antlered deer only. Issues pertaining to maintaining access to hunting lands were also important. For instance, 64% hunters reported that posting of private lands has constrained their access to hunting lands, and 37% believed that they are facing difficulty to find a good

place to hunt. Two thirds (67%), however, still believed that there is enough public land in Pennsylvania to provide opportunities to hunters.

Almost all the hunters (97%) described hunting as either important or very important to them. Most hunters believed that hunting was important because it helped them get outdoors; get away from everyday routines, to be with their families, and friends. About two in three hunters (66%) mentioned that their participation was important for managing deer population. Of the two achievement-based reasons, hunting for venison (38%) and large antlered deer (43%) was important.

Factors Affecting Antlerless Deer Harvest Success

As indicated by the bivariate correlations, hunters that were more likely to harvest an antlerless deer were characterized by excellent self-reported health status, rural residence, reliance on formal sources of information such as newspapers, hunting magazines, and the Internet, and use of hunting aids in the field (i.e., map, compass, walkie-talkie, and GPS unit). Successful antlerless hunters also spent a greater number of days afield during early and late seasons (Table 4). Attitudinal and motivational factors were also important. Hunters that saw hunting as a deer management tool were concerned about maintaining access to hunting lands, and hunted for venison were more likely to harvest antlerless deer. Older hunters who lived in city or urban areas were less likely to harvest an antlerless deer, as were hunters with more years of hunting experience.

Many of these bivariate relationships also were significant in the multivariate analysis. Rural hunters and those reporting excellent health were more likely to harvest an antlerless deer, net of other factors. Hunters who lived in a city (odds ratio = 0.33; $p < .05$), a suburban area (odds ratio = 0.29; $p < .05$) and a small town or village (odds ratio = 0.33; $p < .01$) were significantly less likely to kill an antlerless deer compared to those who lived in a rural area. Those who self-reported excellent health were over two times more likely (odds ratio = 2.02; $p < .05$) to kill an antlerless deer than those who listed their health status otherwise.

Among field behaviors, only the effect of days spent afield during early season was significant, when all other variables were included in the full model. Net of other factors, every additional day spent afield during early season increased the odds of killing an antlerless deer by 8% (odds ratio = 1.08; $p < .01$).

Attitudinal factors remained significant when controlling for other variables: perhaps most importantly, hunters' view of themselves as wildlife managers affects their hunting outcome. Hunters who viewed hunting as a deer management tool (e.g., believed that deer damage is a problem, that balancing the deer population and natural food supplies is necessary, and that the number of deer has a negative effect on plant and animal communities) were more likely to harvest an antlerless deer. Outcome-oriented motivations such as "hunting to obtaining meat" also positively contributed to antlerless deer harvest success. Finally, those who did not hunt with the goal of harvesting an antlered deer were significantly more likely to kill an antlerless deer. These results suggest that hunters who perceive hunting as a deer management tool are motivated to control the antlerless deer population. Hunters who were more concerned about maintaining access to hunting lands (a composite factor that included variables such as "posting of private lands has made it more difficult for me to find a place to hunt") also were more likely to harvest an antlerless deer. Simultaneous inclusion of all measures accounted for about 27% of the variation in hunter success and correctly classified about 77% of the cases.

Table 4
Factors affecting antlerless and antlered deer harvest success

Variables	Antlerless deer		Antlered deer	
	Bivariate correlation	Multivariate Model	Bivariate correlation	Multivariate Model
Sociodemographic characteristics				
Age (years)	–0.12*	1.01	–0.10+	1.00
Education (Ref=High school or less)				
Some college or vocational training	–0.08	0.59	–0.08	0.71
Completed college or more	0.02	0.97	–0.05	0.68
Income (Ref=Less than or equal to $45,000)				
More than $45,000	0.00	1.00	–0.06	0.77
Self-reported health status (Ref=Else)				
Excellent	0.11+	2.02*	0.11+	1.35
Residence (Ref=Country/rural area)	0.25***		0.09	
City	–0.10+	0.33*	–0.05	0.74
Suburban	–0.09	0.29*	–0.09	0.65
Rural town/village	–0.06	0.33**	–0.03	0.99
Hunting background				
Hunting experience (years)	–0.12*	0.99	–0.10+	0.98
Instruction on hunting (Ref=Parents)				
Other than parents	0.03	1.37	–0.11	0.69
Information sources (Ref=Informal, e.g. talking to others)				
Formal (e.g., newspapers=1)	0.14*	1.78	0.04	0.99
Field behaviors				
Camping status (Ref=None)				

Continued

Table 4
Continued

Variables	Antlerless deer		Antlered deer	
	Bivariate correlation	Multivariate Model	Bivariate correlation	Multivariate Model
Used a camp	0.03	1.29	0.07	0.63
Topography most hunted (Ref=Upper plateau)	0.01		–0.02	
Mixed	0.01	1.05	–0.08	0.88
Side hills	–0.01	0.76	0.12*	1.48
Hunting style (Ref=Hunted in group)				
Hunted alone	–0.08	0.79	–0.01	1.05
Used hunting aids (Index 0–4)	0.14*	1.26	–0.04	0.89
Days afield during				
Early season	0.26***	1.08**	0.14*	1.03
Early Jr/Sr season	0.01	0.92	–0.02	0.96
Firearm season	0.09	1.01	0.06	0.99
Late season	0.28***	1.09	0.17**	1.11+
Perceptions/motivations about hunting				
As deer management tool (Factor score)	0.32***	2.31***	0.06	0.97
Maintaining access to hunting lands (Factor score)	0.19***	1.78**	–0.04	0.89

How important hunting is (Very unimp. = 1 to very imp. = 7)	0.10+	1.05	0.07	1.05
How crowded do you feel (Not at all = 1 to extremely = 9)	0.06	0.98	–0.06	0.90
Reasons for participation				
Recreation (Factor score)	0.05	0.83	0.05	1.08
To obtain venison (Very unimp. = 1 to very imp. = 5)	0.18**	1.41*	0.08	1.13
To get antlered deer (Very unimp. = 1 to very imp. = 5)	–0.06	1.03	–0.02	0.96
Hunting behavior				
Antlered/antlerless deer (Ref = Did not kill)				
Killed	0.13*	1.45	0.13*	1.33
Intercept		0.04+		0.74
Model Chi-square		101.78***		34.03
Model degrees of freedom		28		28
–2 Log likelihood		276.03		308.79
Pseudo R^2 (%)		27.0		10.0
Correctly classified (%)		76.7		75.3
N		295		295

t-statistic *** = $p < 0.001$; **=$p < 0.01$; *=$p < 0.05$; +=< 0.10.
Ref = Reference category.

Factors Affecting Antlered Deer Harvest Success

In contrast to our findings for antlerless deer, attitudes and motivations have no apparent effect on the harvest of antlered deer. Bivariate results suggest that self-reported health status (r=.11; $p < .10$), hunting on side hills (r=.12; $p < .05$), and time spent afield during early (r=.14; $p < .05$) and late (r=.17; $p < .01$) seasons were positively associated with buck harvest (Table 4). Older hunters (r=–.10; $p < .10$) with more hunting experience (r=–.10; $p < .10$), however, were less likely to harvest an antlered deer.

The results of multivariate logistic regression analysis revealed that the hunter-related factors associated with buck harvest remain more elusive than those associated with antlerless harvest. Given the number of variables, the explanatory power of the model was not good (pseudo R^2=10%). The number of days afield during late season was the only factor that significantly increased buck harvest success. Net of other factors, every additional day spent afield during late season increased the odds of killing an antlered deer by 11% (odds ratio=1.11; $p < .10$).

Discussion and Implications

In the context of increasing recognition of the importance of hunting as a wildlife management tool, we sought to understand the hunter-related factors associated with harvest. Given the crucial importance of antlerless harvest in particular, we compared the predictors of antlerless harvest success with those of antlered deer harvest: What kinds of hunters harvest each type of deer?

We found differences between predictors of antlerless and antlered harvest. Our bivariate and multivariate findings indicated that self-reported health status, rural residence, and investing greater numbers of days afield during various seasons were associated with antlerless deer harvest success. Motivations and attitudes mattered: hunters' attitudes about their manager role, and recognition of damage to forests caused by abundant deer population were related to the successful harvest of an antlerless deer, as were their motivations to hunt for meat. From a wildlife management perspective, these findings emphasize the role of hunting as a deer management tool (Decker & Connelly, 1990) rather than simply a recreational activity. In contrast, harvesting an antlered deer was more a matter of effort than motive. Only one effort-based variable was significantly associated with antlered deer harvest—spending more days afield during late hunting season.

These findings are relevant to policy prescriptions for controlling abundant deer populations in the context of declining number of hunters, declining access, and/or limited willingness of hunters to kill does. Wildlife management agencies could manipulate factors such as days spent afield during various seasons to increase or decrease harvest success of a deer of either sex. For example, by adjusting deer season parameters (e.g., length of season, time of year, bag limits), wildlife management agencies could potentially increase antlerless deer harvest among those hunters willing to harvest additional antlerless deer.

Finally, because hunter motivations matter in antlerless deer harvest success—and adoption of the "hunter as wildlife manager" mantle appears especially crucial—providing more focused information to hunters about the role of hunting as a wildlife management tool may motivate them to increase their harvest success, particularly of does. Sport hunting has been touted as the only practical option for managing wildlife populations over large areas, despite concerns that declining hunter numbers and restricted access may

severely limit their ability to do so. These constraints suggest an increasing need to understand the factors associated with hunter success. Hunters have begun to articulate a management-based defense of hunting, a defense that increasingly resonates among those who are potentially impacted by over-abundant populations. In the case of deer, harvesting females is crucial to keeping populations in check. We therefore view with optimism our findings that hunters who see hunting as fulfilling important management obligations are more likely to actually behave accordingly (i.e., to harvest an antlerless animal). Although we do not naively view the process of changing attitudes as easily accomplished, our findings seem to point to an opportunity in this area—the articulation of the view of hunting that emphasizes its management role is more likely to be accepted by the public. When embraced by the hunting populace, such a view will contribute to behaviors consistent with principles of managing wildlife populations.

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