HUNTER PARTICIPATION IN QUALITY HUNTING ECOLOGY IN PENNSYLVANIA: BASELINE RESEARCH

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EXECUTIVE SUMMARY

Overabundance of white-tailed deer (*Odocoileus virginianus*) has caused various negative impacts in forested watersheds throughout the eastern United States. Reducing negative impacts by deer requires reducing the deer population more than can apparently be achieved using current management strategies that allow hunters to focus harvest effort on bucks. The Sand County Foundation (SCF) has proposed that 1 testable incentive strategy, whereby hunters earn an opportunity to harvest a buck by first harvesting 1 or more antlerless deer, be evaluated as part of a Quality Hunting Ecology (QHE) effort on demonstration areas.

Effective evaluation of QHE demonstrations requires several phases of research. The first phase was completed in 1999 (Enck and Brown 1999). That study *pre-baseline* identified and analyzed assumptions about hunter and landowner behavior and developed predictions about regulation changes that would have the highest likelihood of achieving desired impacts on the deer population, forest tree regeneration, and water quality. The second, or *baseline* phase, involves collection of data about hunter and landowner behaviors and attitudes prior to implementation of demonstrations. This report provides results and insights from the baseline research conducted with deer hunters in Pennsylvania. The third phase will be a *long-term monitoring and evaluation* effort in which impacts of the demonstration are assessed.

METHODS

Baseline data were collected from deer hunters in Pennsylvania through a self-administered, mail-back questionnaire. A proportional sample of 1,500 deer hunters based on county of residence was obtained from the Pennsylvania Game Commission. The sample was drawn from among the >16,000 respondents to game take survey conducted by the Game Commission in 1999. All persons in the sample had hunted deer at least 1 day somewhere in Pennsylvania during 1998. A telephone follow-up survey was conducted with 100 nonrespondents to the mail survey to assess nonresponse bias and adjust the data to address nonresponse where appropriate.

RESULTS

Baseline Behaviors

The initial sample of 1,500 deer hunters resulted in 24 undeliverable questionnaires, and 963 usable returns (65.2% of the deliverable questionnaires). Respondents were largely male (94%), averaged 30.9 years of deer-hunting experience, and harvested an average of 10.4 antlered bucks and 10.3 antlerless deer during their lifetime. During 1999, respondents reported hunting deer in 66 of the 67 Pennsylvania counties (not in Philadelphia County). A minimum of 85% hunted during the regular firearms season for bucks, and at least 57% hunted during the antlerless season. Most hunted typically either in forested areas (45%) or areas of mixed forest/agriculture (47%). Only 7% typically hunted in agricultural or developed landscapes. Overall, about one-third (35%) of hunters typically hunted on public land.

On average, hunters applied for 0.86 antlerless permits, received 0.83, and filled 0.31 during the 1999 deer-hunting seasons. In 1999, 33% of hunters did not apply for any antlerless permit, compared to only 25% in 2000. Also, only 8.5% of hunters applied for 2 antlerless permits in 1999 whereas 21.6% applied for 2 in 2000. The difference between the 2 years is likely due to changes in regulations that increased opportunities for hunters to apply for multiple antlerless permits in 2000 compared to 1999.

Examination of Research Hypotheses

Hypothesis 1: Hunters have a positive attitude towards the Land Ethic.

This hypothesis was supported. Nearly all hunters (94%) held a positive attitude, and the mean Land Ethic attitude score was 1.04 on a scale from -2.00 to +2.00. However, only 67% agreed that hunters have a responsibility to reduce the deer population when it is out of balance with its habitat; 21% disagreed with this statement.

Hypothesis 2: Hunters recognize that the condition of the Land Community in their hunting area is unacceptable in the context of the Land Ethic.

This hypothesis was not supported. Most hunters reported a positive evaluation of overall habitat conditions in their hunting areas. Most also believed that specific indicators of the Land Community (e.g., forest plant diversity, diversity, and growth; forest wildlife diversity and habitat quality) were in "good" rather than "bad" condition.

Hypothesis 3: Hunters who believe the condition of the Land Community is unacceptable believe that overpopulation by the deer component of the Community is the main reason.

This hypothesis generally was supported although some findings were inconsistent. Most hunters believed that deer have at least a moderate impact on plants in their hunting area, but little or no impact on other wildlife species. A majority of hunters who rated the quality of habitat in their hunting area as being "bad" believed that deer have at least a moderate impact on plants. Hunters who believed overall habitat conditions were "bad" also tended to believe that specific indicators of habitat quality (e.g., plant species survival, growth, diversity) were in "bad" condition. However, 82% of hunters who believed that deer have at least a moderate impact on plants evaluated the overall habitat as "good." Apparently, most hunters did not associate moderate/great deer herbivory with decreased condition of the Land Community.

Hypothesis 4: Hunters who believe that the condition of the Land Community is unacceptable believe that increased harvest of antlerless deer (compared to current harvest levels) will restore the well-being of the ecological community.

This hypothesis was supported. Greater percentages of hunters who believed that deer have at least a moderate impact on forest plants, compared to those who believed that deer have little or no impact on plants, believed that greater antlerless harvest accomplished through QHE would lead to increased forest plant and wildlife growth, abundance, and diversity. Also, higher percentages of respondents who believed that forest plant species survival and diversity were "bad" thought that QHE would improve those conditions, compared to respondents who believed the condition of these components of the Land Community were "good" or who "didn't know."

Hypothesis 5: Hunters' willingness to harvest antlerless deer in the future is greater than hunters' current level of antlerless harvest that is constrained by regulation.

This hypothesis was supported. Hunters applied for an average of 0.9 county-specific antlerless permits in 1999 and 1.0 in 2000. If hunters legally could harvest as many antlerless deer as they wanted, they would take an average of 1.7 antlerless deer per year.

Hypothesis 6: Hunters who believe that potential changes in their experiences would be both likely and desirable if QHE was implemented will have a higher willingness to harvest antlerless deer in the future, compared to hunters who believe that potential changes would be likely but undesirable.

This hypothesis was largely unsupported. For 8 of 10 QHE-related impacts examined, hunters' future willingness to harvest antlerless deer under a scenario of unlimited opportunity did not differ between those who believed that impacts likely would happen and would be good, and hunters who believed the impacts would be likely but bad. The 2 exceptions were that hunters who believed (1) seeing fewer total deer and (2) seeing less deer sign would be good things and likely to occur under QHE had higher future willingness compared to other hunters. This suggests that hunters with positive evaluative beliefs about QHE impacts are no more likely than those with negative evaluative beliefs to want to harvest more antlerless deer in the future.

H7: Changing the characteristics of the hunting system to put primary emphasis on antlerless deer harvest rather than antlered buck harvest will have a grater influence on hunters' aggregate willingness than liberalizing regulations within the current hunting system.

This hypothesis was supported. Future willingness to harvest antlerless deer was highest for those hunters supporting regulatory changes that would shift primary harvest emphasis to antlerless deer, followed by those who supporting regulatory changes that would maintain primary harvest emphasis on bucks while allowing increased antlerless opportunity. Future willingness to harvest antlerless deer was lowest for hunters opposing either type of regulatory change. This suggests that hunters who are supportive of any kind of change that would result in additional antlerless harvest have higher willingness compared to those who oppose additional antlerless harvest in general.

DISCUSSION AND CONCLUSIONS

Most Pennsylvania deer hunters have a positive attitude towards the Land Ethic and do not need to be convinced of its merits. An overwhelming majority of hunters agree that they and deer are parts of a larger Land Community in which all components interact with and affect other components. If education about the Land Ethic is integrated into QHE demonstrations, the greatest benefit can be gained by focussing on hunters' "responsibility to restore balance in the Land Community" if deer overabundance is causing unacceptable negative impacts on other components. Our identification of this potential educational need for Pennsylvania hunters confirms earlier research from New York and is consistent with the idea that hunters need to be reminded of their "civic responsibility" to harvest more antlerless deer.

One of the greatest challenges to overcome may be that most Pennsylvania hunters seem not to believe that habitat quality is compromised by deer in areas where they hunt. It may be difficult for hunters to believe that other components of the Land Community are being adversely impacted when deer are considered by managers and some other stakeholders as thriving or "overabundant." Most hunters seem not to make a connection between the effects of deer browsing and the condition of the Land Community. Further, even hunters who believed that deer have negative effects on forest vegetation tend not to believe that habitat for other forest wildlife is adversely impacted.

Nonetheless, QHE does hold promise as a mechanism for reducing the negative effects of deer browsing in forested watersheds. Those hunters who believed that deer are adversely impacting the Land Community were most likely to believe that QHE will improve the condition of the Land Community. In particular, they believed that lowering the total deer population by increasing the harvest of antlerless deer would result in better vegetation survival, growth, and species diversity. QHE also holds promise because most Pennsylvania hunters are willing to harvest more antlerless deer than they can under current regulations.

One of the most important aspects of QHE to test on demonstration areas is the concept whereby hunters "earn-a-buck" by first harvesting $\geq$1 antlerless deer. Current statewide regulations allow any deer hunter to hunt for a buck without linking that opportunity to harvest of antlerless deer. Indeed, any hunter who wants an opportunity to hunt for antlerless deer must first purchase a buck license, and buck season for hunters using modern firearms traditionally has occurred prior to antlerless season. Thus, for hunters who want to harvest only 1 deer, the first opportunity to harvest a deer comes during buck season. Implementing an "earn-a-buck" approach would shift primary harvest emphasis to antlerless deer instead of bucks. Most importantly, this would allow hunters who want to shoot few total deer to contribute their maximum potential for antlerless deer harvest.

Several important questions remain unanswered and should be examined as demonstration areas are implemented.

1. What role does site fidelity play in hunters' willingness to take advantage of hunting opportunities in places other than their traditional hunting sites?

2. If QHE reduces the overall deer population on demonstration areas, how will hunter retention be affected?

3. Given that hunters 48 years of age and older (median age) have a lower future willingness to harvest antlerless deer compared to younger hunters (1.4 vs. 2.0), what will be the impact on hunter willingness and capacity to harvest antlerless deer if the trend towards an older hunter population continues?

4. How many total deer would Pennsylvania hunters like to harvest in any year?

5. To what extent do Pennsylvania hunters have a preference to shoot bucks over antlerless deer, and what effect will this have on antlerless harvest under various regulatory scenarios?

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INTRODUCTION

Background

Overabundance of white-tailed deer (*Odocoileus virginianus*) is a documented problem for wildlife managers throughout the eastern United States (Warren 1997). High deer populations alter forest tree species composition (Tilghman 1989), impede tree regeneration (Waller and Alverson 1997, Healy 1997), decrease diversity of nonwoody plants (Miller et al. 1992), reduce songbird abundance and diversity (DeCalesta 1994), cause unacceptable numbers of automobile collisions (Stout et al. 1993), raise concerns about the spread of Lyme disease (Ostfield et al. 1996) and damage to agricultural crops (Boyd and Palmer 1992). Addressing these negative impacts has become a major challenge of wildlife managers throughout the region.

Reducing negative impacts requires reducing the deer population (Waller and Alverson 1997). Traditionally, state deer managers have relied on voluntary harvest of adult antlerless deer through recreational hunting opportunities to keep populations within acceptable levels (Decker and Connelly 1990). This system works well when deer populations are relatively low and hunters are willing to harvest enough antlerless deer within the context of recreational hunting opportunities (Enck and Brown 1999). However, overabundant deer populations imply, by definition, that recent antlerless harvests have been lower than the harvests needed to prevent negative ecological and public safety impacts. Given that recent, *existing antlerless harvests* have been lower by definition than *needed antlerless harvests* in areas with overabundant deer populations, managers can benefit from understanding factors affecting the level of *potential antlerless harvests* that are possible under a scenario that ensures continued recreational hunting.

An opportunity for developing this understanding is provided through research sponsored by the Sand County Foundation (SCF). SCF is a private, non-profit conservation organization that brings together ecologists, private and public agencies, businesses, and landowners to improve natural habitats following the principles of Leopold's Land Ethic. In the 1990's SCF initiated a Quality Hunting Ecology (QHE) program on the Leopold Reserve in Wisconsin as an experimental effort to reduce deer damage in forested watersheds. In the last several years, SCF has worked in Pennsylvania and other Great Lakes States to develop QHE demonstration areas on which various incentives for increasing antlerless deer harvests would be tried experimentally. On these demonstration areas, ecological responses (e.g., forest tree regeneration, abundance, and diversity; deer population characteristics, and other ecosystem-level attributes that affect water quality) and human responses (e.g., hunter and landowner behaviors and attitudes) will be evaluated.

Effective evaluation of experimental changes will require several phases of research. The first phase has been completed (Enck and Brown 1999). Our pre-baseline study identified and analyzed assumptions about hunter and landowner behavior and developed predictions about regulation changes that have the highest likelihood of achieving desired impacts on the deer population, forest tree regeneration, and water quality. The second, or baseline phase, involves

collection of data about hunter and landowner behaviors and attitudes prior to implementation of demonstrations. The third is a long-term monitoring and evaluation phase in which impacts of the demonstration are assessed.

Pertinent Prebaseline Findings:

The prebaseline research (Enck and Brown 1999) and additional work by Curtis et al. (2000) and Brown et al. (2000) used a case study from New York State to examine assumptions about whether deer populations at landscape scales can be stabilized using a hunting system that typically places primary hunting opportunity on buck harvest (i.e., licensed buck hunters voluntarily applying for ≥1 antlerless permits). Those research efforts found that hunters' rates of applying for and filling antlerless deer permits differ among geographic regions in New York State, and affect whether a traditional hunting system can stabilize deer populations, even when hunters are offered opportunities to voluntarily harvest an unlimited number of antlerless deer. The New York case study supported earlier evidence from Pennsylvania that deer hunters generally oppose reducing the deer population (Diefenbach et al. 1997) and are unlikely to participate sufficiently in the current hunting system to reduce the deer population without additional educational efforts or regulatory changes by the Pennsylvania Game Commission (Diefenbach and Palmer 1997).

The pre-baseline phase research (Enck and Brown 1999) also identified and examined several important assumptions associated with a traditional hunting system commonly used by state management agencies. Assumptions that hunter numbers and participation rates (i.e., number of antlerless permits they apply for and fill) will be high enough to manage deer populations do not seem to be valid when deer populations are overabundant. Thus, increasing the number of antlerless permits available in a given unit, while maintaining primary emphasis on buck harvest opportunities, likely will not stabilize or reduce deer populations. This research suggested that fundamental changes are needed in the hunting system used to manage deer. SCF has proposed that 1 testable incentive strategy, whereby hunters earn an opportunity to harvest a buck by first harvesting an antlerless deer, be evaluated on QHE demonstration areas.

Quality Hunting Ecology (QHE)

QHE is operationalized through a hunting system that places primary emphasis on antlerless harvest, and which is aimed at producing ecosystem effects consistent with the philosophy of Leopold's Land Ethic (Leopold 1949:221):

> A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity.

We summarize the main premises of the Land Ethic as:

1. Humans are 1 of several equal, interacting components of a broader Land Community that also includes soil, plants, and animals.

2. The well-being of the Land Community depends on whether all the components continue to exist and thrive.

3. Humans have a responsibility to maintain the well-being of the Land Community, even if that involves individual sacrifice on their part.

Two conditions are necessary for human attitudes and behaviors to be consistent with the premises of the Land Ethic. First, people should consciously avoid engaging in actions that negatively affect the Land Community. Second, people also should be able to recognize the need for and be willing to take actions to address negative impacts on the Land Community that are caused by themselves or other components of the Community.

In a deer management context, the Land Ethic is embodied by the desire to manage deer to reduce negative impacts of deer on the Land Community (and its component plant, animal, and human parts) and to ensure that positive impacts of having deer in the ecosystem can be experienced. As noted previously, management of deer typically depends on voluntary participation by hunters, especially in the harvest of antlerless deer (Decker and Connelly 1990). This is true for all Great Lakes States.

SCF has been particularly interested in understanding and ameliorating deer impacts on the Land Community in Pennsylvania, an important deer-hunting state in the Great Lakes region. Particularly in the northern, forested areas of Pennsylvania, deer-related impacts on the Land Community and habitat quality are unacceptable to a variety of stakeholders and need to be decreased (Diefenbach and Palmer 1997). In those areas, the well-being of the Land Community is recognized as being compromised by at least some important stakeholder groups (i.e., commercial forest products producers, private and public agency forest managers, some birding organizations, public agency wildlife managers). For hunters to consciously manifest the Land Ethic in this context, they must be willing to harvest more antlerless deer than they currently do to reduce negative impacts of deer on the ecosystem can be reduced, and to restore the well-being of the Land Community.

QHE has been proposed as a mechanism through which restoration and balancing of the Land Community can be accomplished. SCF and its various partners in Pennsylvania[1] desire to implement QHE on demonstration areas, and to monitor any resulting changes in components of the Land Community. Insights gained through this effort can be used to ensure that the best

[1] Between 1998 and 2000, these partners included the Pennsylvania Game Commission, Bureau of Forestry within the Pennsylvania Department of Conservation and Natural Resources, U.S. Forest Service Northeastern Experiment Station in Irving, the Western Pennsylvania Conservancy, Kane Hardwoods, and the Bradford Water District.

possible management decisions and policies can be enacted. Of greatest interest in this study are 4 interacting components: forest plant communities, deer populations (as the major herbivore), hunters (as the major predator), and landowners (who control hunter access). Baseline research is aimed at documenting the current conditions and levels of these components. The study reported herein focuses specifically on the hunter component. Subsequent research will provide opportunities to monitor changes in all components and to document how changes in any single component may affect changes in the others.

Implementing QHE is challenging because human predators are different from other components of the Land community. On 1 hand, hunters are a component of the Land Community that can be "managed" to a certain degree like the plant and deer components. On the other hand, hunters may respond to management in ways that are less predictable or desirable than responses by other components. If hunters are "managed" in a way unsatisfactory to them, they may choose to respond less than expected (e.g., applying for fewer antlerless permits than the number available) or they can simply become part of a Land Community somewhere else (e.g., hunt elsewhere or quit altogether). To reduce uncertainty associated with this unpredictability, more information is needed about the kinds of regulations and/or incentives needed to change hunter harvest behavior so management goals can be achieved.

Because human predators are different from other components of the Land Community in this way, successful implementation of QHE depends on an important assumption. Hunters' attitudes and behaviors are consistent with the Land Ethic. That is, hunters must recognize that deer are harming the Land Community and hunters must take some responsibility for restoring the well-being of that community. If this first assumption is not valid, QHE can only be successfully implemented if the hunting system through which it is operationalized can ensure that hunters' responses to management are more predictable and result in management goals being met. That is, QHE must ensure that hunters harvest the number of antlerless deer necessary to restore the well-being of the Land Community because they are unlikely to harvest enough antlerless deer voluntarily under the current hunting system.

Given the current deer management situation in Pennsylvania (i.e., deer populations are above goals in many units and are having unacceptable negative impacts on other components of the Land Community [Diefenbach and Palmer 1997]), management can benefit from close scrutiny of the assumption stated above. This study is aimed, in part, at providing that scrutiny. It assesses hunters' attitudes about and level of participation in opportunities to harvest antlerless deer, which is the mechanism through which deer populations can be influenced. Our study also determines the degree to which hunters' attitudes and behaviors are consistent with the Land Ethic. Further, this research can be used to examine the predictability of hunters' responses to management actions (i.e., QHE interventions) by identifying factors that affect hunters' willingness to harvest antlerless deer.

To examine the degree to which hunters' attitudes and behaviors are consistent with the Land Ethic, both social-psychological and behavioral indicators are necessary. Information is

needed about hunters' attitudes towards the Land Ethic, their beliefs about whether conditions in their hunting areas are consistent with the Land Ethic, and their willingness to address imbalances if they recognize them. Of particular importance is identifying particular imbalances that hunters perceive.

Despite the controversy surrounding allocation of antlerless permits in Pennsylvania (Diefenbach and Palmer 1997), we cannot assume that hunters oppose the Land Ethic and need to be convinced of its merits. Indeed, Diefenbach et al. (1997) found that most Pennsylvania deer hunters believe that deer populations should be kept in balance with their habitat, and that deer *can* negatively impact the forest ecosystem. However, Diefenbach et al. also reported that most hunters fail to recognize how much of an impact deer have already had and that conditions in many forested areas are inconsistent with the Land Ethic. A complicating factor is that many hunters perceive deer to be "scarce" (i.e., populations lower than desired) in their hunting areas (Diefenbach et al. 1997). Thus, they may believe that decreased antlerless harvests would be consistent with the Land Ethic if they also believed that available habitat could support higher deer populations (we do not know the degree to which hunters believe the habitat can support more deer).

On the other hand, hunters could have a negative attitude towards the Land Ethic. They might believe that hunter satisfaction resulting from high deer populations is more important than abundance and diversity of forest flora and fauna. If that is found to be true, regulatory and/or educational interventions will be necessary to increase hunters' willingness to harvest antlerless deer.

Theoretical Foundation

The deer management situation in Pennsylvania calls for research that allows managers to understand the social-psychological influences on hunters' behaviors. Of special interest is the ability to predict future behaviors based on hunters' basic attitudes and beliefs about deer management and the harvest of antlerless deer, and if possible, to develop incentives/restrictions to change those behaviors. Ajzen and Fishbein's (1980) theory of reasoned action (TRA) is an appropriate foundation for conducting this research.

A main premise of TRA is that *intended behavior* (e.g., number of antlerless deer that a hunter is willing to harvest if an unlimited supply of antlerless deer was available) is directly related to *attitude towards the behavior* (e.g., harvest of antlerless deer). Another premise is that attitude towards the behavior is influenced by a *set of antecedent beliefs* (e.g., about the condition of the Land Community in their hunting areas, about possible effects of increased antlerless deer harvest on the Land Community) and *antecedent attitudes* (e.g., towards the principles of the Land Ethic). *Past behavior* (e.g., previous antlerless harvest) also may influence intended behavior indirectly through effects on the antecedent beliefs and attitudes. Further, various social and demographic characteristics may have *moderating influences* on the attitude-behavioral intention relationship.

Our research will increase our understanding of the relationship between hunters' intended future behavior, and current attitudes and beliefs (Figure 1). Then, we can explore how intended future behavior might change under different management scenarios based on how outcomes of those scenarios relate to hunters' antecedent beliefs and attitudes. This research thus provides both a baseline data set of behaviors, attitudes, and beliefs given the current deer management situation as well as an evaluation of some potential effects of QHE on antlerless harvest.

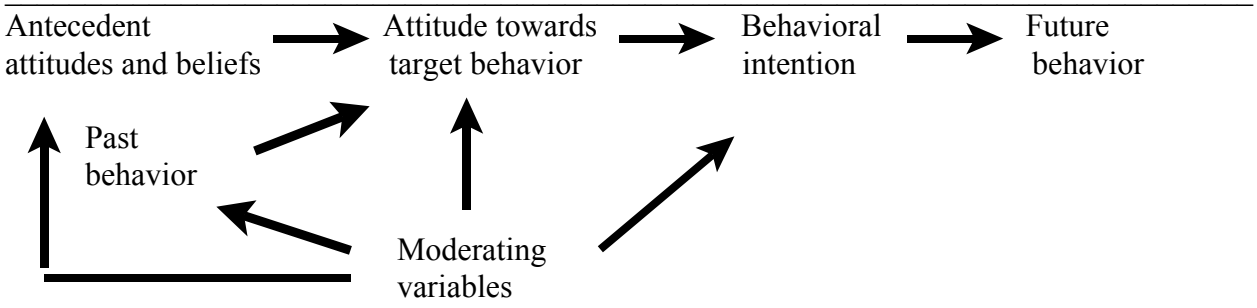

Figure 1. Theoretical relationship between hunters' future willingness to harvest antlerless deer (future behavior) and several independent variables representing intentions, attitudes, beliefs, and past behaviors.

Research Hypotheses

We developed several hypotheses pertaining to the baseline research phase. The first of these pertain to the Land Ethic. The degree to which these are supported will determine whether education/communication aspects of QHE should be emphasized within the current hunting system, or whether a change in the hunting system also will be needed.

H1. Hunters have a positive attitude towards the Land Ethic.

H2. Hunters recognize that the condition of the Land Community in their hunting area is unacceptable in the context of the Land Ethic.

H3. Hunters who believe the condition of the Land Community is unacceptable believe that overpopulation by the deer component of the Community is the main reason.

H4. Hunters who believe that the condition of the Land Community is unacceptable believe that increased harvest of antlerless deer (compared to current harvest levels) will restore the well-being of the ecological community.

If H1 is not supported by baseline research, a different hunting system may be necessary to increase harvest of antlerless deer. If H1 is supported, but the others are not, an educational

component to QHE may be necessary to increase hunters' willingness to harvest antlerless deer within the current hunting system. However, support for hypotheses 2-4 will not guarantee that education-based elements of QHE will be successful by themselves because factors other than support for the Land Ethic may be more important influences on hunters' willingness to harvest antlerless deer.

Thus, baseline information is needed about hunters' current willingness to harvest antlerless deer, and about factors that affect their level of willingness. Of particular importance is identification of hunting-related impacts that hunters both desire and think are likely to occur in their hunting areas if harvest of antlerless deer is increased and more bucks reach maturity. Predictions then can be made about how hunters might respond to management actions (i.e., interventions) on the demonstration areas.

Subsequent research beyond this study can monitor whether willingness (as a dependent variable) changes as hunters' experiences (as independent variables) change over time due to ecological community responses to management. To have the greatest benefit, types of experiences examined in the baseline research should be linked to the characteristics of the hunting system used to operationalize QHE. For example, some kinds of experiences (e.g., seeing a balanced deer sex ratio, seeing fewer total deer but more bucks, seeing bucks with larger antlers) only are possible if the hunting system is modified from its present form. The new hunting system would have to restrict buck harvest to some degree while increasing harvest of antlerless deer.

We have developed several additional hypotheses pertaining to hunters' willingness to harvest antlerless deer.

H5. Hunters' willingness to harvest antlerless deer in the future is greater than hunters' current level of antlerless harvest that is constrained by regulation.

H6. Hunters who believe that potential changes in their experiences would be both likely and desirable if QHE was implemented will have a higher willingness to harvest antlerless deer in the future compared to hunters who believe that potential changes would be likely but undesirable.

H7. Changing the characteristics of the hunting system to put primary emphasis on harvest of antlerless deer rather than on antlered bucks will have a greater influence on hunters' aggregate willingness than liberalizing regulations within the current hunting system.

Goals and Objectives of the Baseline Phase of Research

We have 2 goals for this baseline research.

1. Collect behavioral and attitudinal information from hunters that can be used in

subsequent years to evaluate 1 measure of success of the QHE intervention.

2. Predict impacts of implementing a QHE on hunters' behaviors and attitudes.

We have 7 research objectives.

1. Describe baseline levels of hunter participation and harvest.

2. Determine behavioral intention of hunters (i.e., willingness) to harvest antlerless deer.

3. Determine baseline attitudes of hunters towards: (a) harvesting antlerless deer and antlered bucks, (b) principles of the Land Ethic, and (c) use of incentives/regulations to increase harvest of antlerless deer.

4. Determine baseline beliefs of hunters about: (a) current condition of the ecological community in hunters' usual hunting areas, (b) possible impacts on their future hunting experiences that might be associated with a QHE program that emphasizes harvest of antlerless harvest instead of antlered bucks, and (c) desirability of possible impacts from a QHE program.

5. Assess influence of past hunting behavior on the attitude-behavioral intention relationship.

6. Assess the degree to which social and demographic characteristics of hunters have a mediating influence on the attitude-behavioral intention relationship.

7. Develop insights about communication and education components that are likely to increase hunters' positive assessment of, and participation in, QHE opportunities.

METHODS

Baseline data were collected from deer hunters in Pennsylvania through a self-administered, mail-back questionnaire. A proportional sample of 1,500 deer hunters based on county of residence was obtained from the Pennsylvania Game Commission. The sample was drawn from among the >16,000 respondents to game take survey conducted by the Game Commission in 1999. All persons in the sample had hunted deer at least 1 day somewhere in Pennsylvania during 1998.

Studies of human behavioral characteristics and attitudes that involve sampling from a large population have a margin of error associated with them. This margin of error varies according to sample size, and the percentage of respondents giving a particular answer to each

question (Cochran 1977). Given that 963 hunters returned usable questionnaires (see response rate below), the maximum expected margin of error at the 95% confidence level for any question with dichotomous responses was ±3.2% (Table 1). That is, if 100 different samples of the same size were taken from the population of deer hunters, 95 times out of 100 the results obtained would vary no more than ±3.2 percentage points from the results that would be obtained if the entire population of deer hunters answered the question.

Table 1. Margin of error associated with dichotomous variables given that 963 persons responded to a mail questionnaire sent to a sample selected from a population of >1,000,000 persons who hunted deer in Pennsylvania in 1999.

Response percentage[a]	Margin of Error
10% or 90%	± 1.9%
20% or 80%	± 2.6%
30% or 70%	± 3.0%
40% or 60%	± 3.1%
50% or 50%	± 3.2%

[a]Example: If 93.2% of respondents said they hunted deer during the 1999 firearms season for antlered bucks, the margin of error is 1.6% (i.e., the estimate is that 91.6% to 94.8% of hunters went afield during that season).

Survey Implementation

A 4-wave mailing procedure was followed similar to that suggested by Dillman (2000). Questionnaires were mailed with cover letters about the study on 8 September 2000. A reminder letter was mailed to nonrespondents on 18 September. A second reminder letter and a duplicate copy of the questionnaire were mailed to nonrespondents on 2 October. A final reminder letter was mailed to nonrespondents on 11 October.

Each questionnaire was assigned a unique identification number to facilitate recording of returns. As completed questionnaires were received, a response code was entered for that identification number into a computerized mailing database. This prevented respondents from receiving further reminder letters.

Nonrespondent Follow-up

Any survey for which some persons do not respond has the potential for response bias associated with it. Even if the sample is representative of the population being studied, it is unlikely that self-selected respondents will be representative of the entire sample (Filion 1980).

Misleading and inaccurate inferences may result when nonrespondents differ from respondents (Cochran 1977). For this inquiry, we assessed whether nonresponse bias existed by conducting telephone interviews with a random sample of 100 nonrespondents to the mail questionnaires. Telephone interviews were conducted from 30 October through 11 November 2000.

It was not feasible to ask nonrespondents every question in the mail-back questionnaire. We obtained the following data through telephone interviews. (1) Number of days hunted and deer harvest during 1999 hunting seasons. (2) Application for and use of antlerless permits in 1999. (3) Total number of antlerless deer that hunters are willing to harvest. (4) Attitude towards harvest of antlerless deer and antlered bucks. (5) Attitude towards possible incentives and regulations that could be built into QHE. (6) Beliefs about the impacts of deer on other forest fauna and flora. (7) Hunter demographic information.

The nonrespondent follow-up allowed 3 important steps to be taken. First, we are able to describe nonrespondents as a group separate from respondents. Second, we determined the degree to which nonresponse bias existed for specific variables by using Chi-square tests (for variables with multiple response categories) or t-tests (for means). Third, for questions asked in both the mail survey and nonrespondent telephone follow-up and for which nonresponse bias existed, we adjusted results to address nonresponse bias.

Data Analysis

We entered data from returned questionnaires and telephone interviews with nonrespondents into separate computer databases and analyzed the data using SPSS-X (SPSS Inc. 1994). Specific analyses conducted to examine each of the 7 hypotheses developed for the study are presented below.

Identifying Factors that Influence Hunters' Willingness to Harvest Antlerless Deer:

Application of the Theory of Reasoned Action required development of several indicator variables representing the factors in the model (see Figure 1 on page 6). Relationships among variables in the model were identified using stepwise multiple regression, which is used commonly in exploratory studies. Significance level for factors entering the model (P-in) was set *a priori* to P = 0.05. A listing and brief description of indicator variables follows.

Behavioral Intention (i.e., future willingness to harvest antlerless deer). We used a single, open-ended question: how many antlerless deer would you be willing to harvest if you could harvest as many antlerless deer as you wanted?

Attitude towards the target behavior of harvesting antlerless deer. We developed a mean attitude index (DOEATT) using the average of hunters' responses to 3 questions. (1) How do you feel about personally harvesting antlerless deer? (2) Would you say that you like or dislike harvesting antlerless deer? (3) Would you say it is enjoyable or unenjoyable to harvest antlerless

deer? Hunters could respond to each of these questions on a 7-point scale, with strongly positive / greatly like / very enjoyable at 1 end of the scale to strongly negative / greatly dislike / very unenjoyable at the other.

We used the mean of hunters' responses to multiple statements to develop the DOEATT index (and other attitudinal indices for this study) because average indices tend to have higher validity than single question indicators (Azjen and Fishbein 1980). Our decision to do this for DOEATT was supported by our examination of index reliability based on internal consistency (Carmines and Zeller 1979). Chronbach's alpha, a measure of reliability, for the 3-question DOEATT index was 0.77. Reliability decreased if any of the 3 questions were dropped from the index.

Antecedent Attitudes and Beliefs**.** We used a single variable to assess hunters' *attitudes towards harvest of antlered bucks* (BUCKATT). "How do you feel about personally harvesting antlered bucks? Although we initially expected to use responses to 3 questions similar to those used to create DOEATT (e.g., feel positive/negative, enjoyable/unenjoyable, like/dislike), the feel positive/negative single indicator was a better choice for several reasons. First, responses to this variable were significantly correlated with willingness ($r = 0.07$, $P = 0.04$) whereas responses to neither of the other 2 variables were. Second, neither the 3-question mean index nor a 2-question mean index using enjoyable/unenjoyable and like/dislike were significantly correlated with willingness. Third, our reliability analysis of BUCKATT found that the mean 2-variable index had a substantially higher Chronbach's alpha (0.65) compared to the reliability of a mean index using all 3 variables (0.30). However, several exploratory regression analyses showed that feel positive/negative was a significant variable helping to explain variation in willingness, whereas the 2-variable mean index had no influence on willingness.

We developed a mean index of hunters' *attitudes towards the Land Ethic* (LANDETH) using the average of responses to the 3 statements pertaining to the main premises of Leopold's Land Ethic (see page 4). Hunters were asked to respond to each statement along a 5-point scale from strongly disagree (-2) to neither agree nor disagree (0) to strongly agree (+2). Chronbach's alpha for the 3-statement index was 0.63. Reliability decreased if responses to any of the 3 statements were eliminated from the index.

We assessed hunters' *beliefs about the condition of the Land Community* in their hunting areas in 2 ways. First, we developed a mean index to hunters' assessment of overall habitat quality (HABQUAL) by averaging responses to 6 statements about plant and animal abundance and diversity. (1) Many different kinds of plants other than trees grow there. (2) Not very many kinds of birds or other kinds of wildlife live there. (3) Deer numbers are in balance with their habitat. (4) Only a few types of young trees grow in the forest understory. (5) Good habitat exists for many kinds of nongame animals. (6) Few tree seedlings seem to survive past 2 or 3 years old. Possible responses ranged along a 5-point scale from strongly disagree (-2) to neither agree nor disagree (0) to strongly agree (+2). Our HABQUAL index was based on the assumption that agreement with statements 1, 3, and 5 indicated "good" habitat. Thus, responses

to statements 2, 4, and 6 were reversed prior to creation of the HABQUAL index because agreement with those statements was similar to disagreement with the other 3 statements. Chronbach's alpha for the 6-statement index was 0.65. Reliability decreased if any of the 6 statements were eliminated from the scale.

Second, we determined hunters' beliefs about the level of impact deer have on the Land Community in their hunting areas through 2 questions. (1) How much of an impact do deer have on the kinds and numbers of forest plants in your hunting area (P-IMPACT)? (2) How much of an impact do deer have on the kinds and numbers of forest wildlife in your hunting area (W-IMPACT)? Hunters could respond to both these questions along a 4-point scale from "no impact" to "great impact."

We assessed hunters' *evaluative beliefs about possible impacts of implementing QHE* through a set of 10 statements. (1) You will see a bigger variety of nongame animals while hunting deer. (2) You will see fewer total deer. (3) You will see more bucks. (4) You will see a more equal ratio of bucks and does. (5) You will see a bigger variety of trees and other plants. (6) You will see a shorter distance in the forest because of more plant growth. (7) You will see additional older, mature bucks. (8) You will have a better chance of harvesting a mature buck. (9) You will see more buck sign (more rubs and scrapes). (10) You will see less overall deer sign (fewer heavily used trails, droppings).

For each possible impact, we asked hunters to indicate how likely or unlikely they thought the impact would be to occur if QHE was implemented (belief strength). Then we asked them to consider the degree (extremely, moderately, or slightly) to which each impact would be good or bad for their hunting area (i.e., outcome evaluation). We multiplied belief strength by outcome evaluation for each impact to create an evaluative belief index for each possible impact. For any hunter, this index could be either positive or negative for each impact. A positive index resulted if the respondent agreed the impact is likely to happen and it would be good, or if the impact would be bad but the impact is unlikely to happen. A negative index resulted if the respondent believed the impact would be bad and that it is likely to happen, or if it is unlikely that a good impact would happen. We developed a summative index to evaluative beliefs associated with QHE by adding the 10 belief indices for each hunter.

Past hunting behavior. We used a series of questions to obtain baseline data about past hunting behaviors. How many years have you hunted deer in Pennsylvania or other places? How many antlered bucks have you harvested since you started hunting? How many antlerless deer have you harvested since you started hunting? How many antlerless hunting permits did you apply for, receive, and fill in 1999, and how many did you apply for in 2000. In which counties, and for how many days, did you hunt for deer during early archery season, regular firearms season for antlered bucks, 3-day statewide season for antlerless deer, and winter flintlock muzzleloader season? What deer (antlered bucks, antlerless deer or both) did you harvest during any of these seasons? We also collected information about the proportion of forestland to other land types in the township in which respondents hunted most often, and the type of land (public

vs. private) on which they hunted. In addition, we asked hunters a variety of economic and demographic questions.

Examination of Hypotheses:

Hypothesis 1. We examined the proportion of positive and negative LANDETH index scores to determine whether hunters supported the Land Ethic. Because support for the Land Ethic depends not only on a positive mean index, but also on agreement with each of the premises of the Land Ethic, we also examined the proportion of positive and negative responses to each of the 3 statements used to create the mean index. Thus, this hypothesis will be supported if a majority of hunters had a positive LANDETH score, and positive responses to each of the 3 statements.

Hypothesis 2. We examined the proportion of positive and negative HABQUAL index scores to determine hunters' assessment of the overall condition of the Land Community in their hunting areas. This hypothesis will be supported if a majority of hunters have a negative index. To further understand hunters' assessment of HABQUAL, we also examined hunters' responses to each of the 6 variables used to create the index. Specifically, we wanted to know whether hunters consistently evaluated any of the specific indicators of the Land Community condition as being negative, even if the overall condition was positive. If the data show such consistency, H2 will be partially supported.

Finally, we examined the inter-item correlation coefficients for each of the 6 statements used to create HABQUAL to ascertain whether hunters linked the condition of any habitat characteristics with the condition of any other habitat characteristics. We first identified respondents with a negative HABQUAL index. Then we further identified those respondents who assessed the first Land Community variable as being in "bad" condition. We examined correlation coefficients between this variable and the other 5 used in the HABQUAL index. High positive coefficients indicated additional support for H2. We repeated this process for each variable used to create HABQUAL. Then we repeated the process for respondents with a positive HABQUAL index to look for similar relationships. In all cases, relationships were considered significant for $P \leq 0.05$.

Hypothesis 3. We collapsed HABQUAL scores into 2 categories (negative, neutral/positive) and P-IMPACT into 2 categories ($\leq$slight, $\geq$moderate). Then we used a crosstabulation procedure to look for relationships between the 2 variables. This hypothesis will be supported if a majority of hunters who believe that HABQUAL is negative also believe that deer have $\geq$moderate impact on forest plant abundance and diversity in their hunting areas. We also compared the percentages of respondents who believed that any of the 6 Land Community variables were in "bad" condition, for those with negative and positive HABQUAL indices.

Hypothesis 4. In the questionnaire, an increase in antlerless harvest was tied explicitly to QHE. Hunters were informed that implementation of QHE was a way of managing for quality

deer. They also were informed that "managing for 'quality deer' means (a) reducing the deer population by increasing antlerless harvest and (b) making sure some bucks live to maturity."

We used hunters' assessment of at least a moderate "level of impact by deer on forest plants" in their hunting areas as an indicator of whether the well-being of the Land Community needed to be restored. We believed "level of impact by deer" was a better indicator of the need for restoration of the ecological community than a negative HABQUAL score because "level of impact by deer" directly links habitat conditions to deer. We believed that "level of impact by deer" also was a better indicator of the need for restoration than disagreement with the HABQUAL statement "deer numbers are in balance with their habitat." "Level of impact by deer" had higher correlation coefficients with hunters' beliefs about whether decreasing the deer population would increase forest plant and wildlife abundance and diversity, compared to the correlation coefficients between these beliefs and the statement about deer numbers in balance with habitat. The higher correlation coefficients suggest a stronger link between deer and condition of the Land Community than is indicated through the HABQUAL statement "deer populations are in balance with their habitat."

This hypothesis will be supported if higher percentages of hunters who believe deer have a $\geq$ moderate P-IMPACT, compared to those who believe deer have a $\leq$ slight P-IMPACT, think that decreasing the deer population through QHE will lead to improvements in specific Land Community variables.

Hypothesis 5. We used t-tests to compare the mean number of antlerless permits applied for in 1999 and 2000 with the number of antlerless deer that hunters would harvest if they could take as many antlerless deer as they wanted. We also used Chi-square tests to ascertain differences in the percentage of hunters who applied for $\geq$1 antlerless permit under the current system of county-specific permits, and the percentage of hunters who would take $\geq$1 antlerless deer under a scenario of unlimited opportunity. This hypothesis will be supported if mean future willingness is higher than current (1999 and 2000) willingness. Additional support for this hypothesis will exist if a greater proportion of hunters are willing to harvest at least 1 antlerless deer in the future compared to the current situation.

Hypothesis 6. As noted above with hypothesis 4, subjects were informed that management actions associated with QHE would be aimed at decreasing the overall deer population by increasing antlerless deer harvest and would ensure that some bucks would live to maturity. Following this information, we asked hunters about 10 possible impacts to their hunting experiences. (1) You will see a bigger variety of nongame animals while hunting deer. (2) You will see fewer total deer. (3) You will see more bucks. (4) You will see a more equal ratio of bucks and does. (5) You will see a bigger variety of trees and other plants. (6) You will see a shorter distance in the forest because of more plant growth. (7) You will see older, more mature bucks. (8) You will have a better chance of harvesting a mature buck. (9) You will see more buck sign (more rubs and scrapes). (10) You will see less overall deer sign (fewer heavily used trails, droppings).

For each possible impact, we asked hunters to indicate how likely or unlikely they thought the impact would be to occur if QHE was implemented. Then we asked them to consider whether each impact would be extremely, moderately, slightly, or neither good nor bad for their hunting area. For each of the 10 impacts, we separated those hunters who believed the impact would occur if QHE was implemented and that the impact would be good for their hunting area from those who believed otherwise. Then we used a t-test to compare the mean number of antlerless deer that hunters in each group would harvest under a scenario of unlimited antlerless opportunity. This hypothesis will be supported if mean willingness to harvest antlerless deer is higher for those who believe QHE will result in impacts that are good for their hunting areas.

Hypothesis 7. Enck and Brown (1999) described how the current hunting system places primary emphasis on harvest of bucks rather than antlerless harvest. Anyone who wants to hunt deer must first purchase a statewide license valid for a buck, and those persons interested in hunting antlerless deer must go through the extra step of applying for $\geq$1 county-specific permit. In addition, the 2-week firearms season for antlered bucks has traditionally been held prior to the 2 or 3-day firearms season for antlerless deer in Pennsylvania. Thus, anyone who wants to harvest only 1 deer per year would be less likely to harvest an antlerless deer, especially if they harvested a buck.

We developed 5 statements about possible changes in antlerless deer hunting regulations that could be made but still place primary emphasis on buck harvest. (1) Double the length of the antlerless season from 3 to 6 days. (2) Let hunters donate to a local food bank any extra venison they could not use. (3) Let hunters earn 1 day of free access to hunt bucks on posted private land next year for every antlerless deer they harvest this year. (4) Let hunters earn a $50 state tax credit for every antlerless deer they harvest. (5) Combine buck and antlerless deer seasons, and let hunters fill their antlerless license while hunting for a buck. We then developed a mean index to hunters' attitudes towards these kinds of changes in the existing hunting system (KEEPSYS) by averaging hunters' responses to the 5 questions.

We developed 3 statements about possible changes in hunting regulations to indicate primary regulatory emphasis on antlerless harvest. (1) Make the regular deer license valid for an antlerless deer. (2) Combine buck and antlerless deer seasons, and require every hunter to harvest and take an antlerless deer to a check station before they can get a buck tag. (3) Have antlerless deer season before buck season, and require every hunter to harvest and take an antlerless deer to a check station to get a buck tag. We then developed a mean index to hunters' attitudes towards these kinds of changes that would shift primary harvest emphasis to antlerless deer (NEWSYS) by averaging hunters' responses to the 3 questions.

We conducted 3 separate ANOVA analyses to compare (1) the mean number antlerless permits applied for in 1999, (2) the mean number of antlerless permits applied for in 2000, and (3) mean future willingness to harvest antlerless deer, for those hunters who supported vs. those who opposed KEEPSYS and NEWSYS. We also used t-tests to examine each of the 8 possible regulation changes individually, comparing means for those who support vs. oppose each possible

change. We did this for the mean number of permits applied for in 1999, mean number applied for in 2000, and future willingness.

This hypothesis will be supported if the following ANOVA results are found. First, mean future willingness must be significantly higher ($P < 0.05$) for those who support NEWSYS compared to those who oppose NEWSYS. Second, mean future willingness must be significantly higher for those who support NEWSYS compared to those who support KEEPSYS. Third, mean number of antlerless permits applied for in 1999 and in 2000 must be significantly lower than mean future willingness for those who support NEWSYS because hunters' "willingness" to harvest antlerless deer in 1999 and 2000 was constrained by regulation.

RESULTS

Study results are presented in 4 sections. The first section describes response rates, nonrespondents' characteristics, and handling of any nonresponse bias in the results. The second section describes baseline behaviors of Pennsylvania deer hunters in 2000. The third section examines factors affecting hunters' willingness to harvest antlerless deer using the Theory of Reasoned Action (TRA) as a conceptual foundation. The final section presents findings pertaining to the 7 hypotheses relating to Quality Hunting Ecology (QHE).

Response To The Mail Survey

The initial sample of 1,500 deer hunters resulted in 24 undeliverable questionnaires, and 963 usable returns (65.2% of the deliverable questionnaires). A sample of 300 nonrespondents to the mail survey was selected for our assessment of nonresponse bias. We tried to contact each of these hunters at least 3 times between 30 October and 11 November 2000. Of the 187 households reached, 51 hunters were unavailable to be interviewed at the time of the call, 38 refused to participate (28% of those available), and 100 (72% of those available) completed interviews.

Characteristics of Nonrespondents and Nonresponse Bias in the Data

Nonrespondents were similar to respondents for most demographic variables assessed. The same percentage of respondents (94%) and nonrespondents (94%) hunted deer in 1999 ($X^2 = 0.026$, $P = 0.871$, $df = 1$). Male hunters accounted for 95% of both respondents and nonrespondents ($X^2 = 0.000$, $P = 0.998$, $df = 1$). Although nonrespondents mean age was 41.9 years compared to 48.3 years for respondents, the difference was not significant ($t = 1.644$, $P > 0.05$).

The only difference in demographic information pertained to residential category. A greater percentage of nonrespondents than respondents lived in farm/rural areas or in villages while a larger percentage of respondents lived in cities ($X^2 = 13.620$, $P = 0.001$, $df = 2$). Data presented below for respondents are adjusted to account for this nonresponse bias.

No differences were found between nonrespondents and respondents for the number of antlerless permits applied for in 1999 ($t = 0.830$, $P > 0.05$). However, compared to respondents, nonrespondents received fewer antlerless permits in 1999 ($t = 1.672$, $P < 0.05$), filled fewer in 1999 ($t = 3.953$, $P < 0.05$) and applied for fewer in 2000 ($t = 3.286$, $P < 0.05$). Data for these latter 3 variables are adjusted below to account for the nonresponse bias.

No difference was found between respondents and nonrespondents with respect to their future willingness to harvest antlerless deer ($t = 0.640$, $P > 0.05$). However, a greater percentage of nonrespondents (69.0%) compared to respondents (60.8%) had positive feelings towards harvest of antlerless deer ($X^2 = 9.837$, $P = 0.007$, $df = 2$). Similarly, a greater percentage of nonrespondents (88.0%) compared to respondents (76.6%) had positive feelings towards harvest of antlered bucks ($X^2 = 15.309$, $P < 0.001$, $df = 2$). These differences are presented here, but are not adjusted in the data below because respondents' attitudes towards harvesting antlerless deer and antlered bucks was measured using responses to multiple questions.

Nonrespondents' and respondents' attitudes towards each of 4 possible changes in deer hunting regulations did not differ. Similarly high percentages supported allowing hunters to donate for free any extra venison they had to a local food bank ($X^2 = 5.602$, $P = 0.062$, $df = 2$). Attitudes were about split for both nonrespondents and respondents with respect to making the regular firearms license valid for an antlerless deer ($X^2 = 5.566$, $P = 0.062$, $df = 2$). Similarly high percentages of nonrespondents and respondents opposed requiring hunters to harvest and check-in an antlerless deer prior to becoming eligible to harvest a buck ($X^2 = 0.554$, $P = 0.758$, $df = 2$). Also, similarly high percentages of nonrespondents and respondents opposed allowing hunters to earn a $50 state tax credit for every antlerless deer they harvest ($X^2 = 4.280$, $P = 0.118$, $df = 2$).

Finally, nonrespondents were similar to respondents with respect to the level of impact they believed deer have on the forest plant (P-IMPACT) and wildlife (W-IMPACT) components of the Land Community in their hunting areas. Similar percentages of both groups believed that deer have no, slight, moderate, or great P-IMPACT ($X^2 = 4.381$, $P = 0.286$, $df = 3$). Similar percentages also believed that deer have no, slight, moderate, or great W-IMPACT ($X^2 = 3.264$, $P = 0.353$, $df = 3$).

Baseline Behaviors and Characteristics of Pennsylvania Deer Hunters

A large majority of deer hunters were male (95.0%). Their average age was 48.2 years ($\pm$1.1 years). Almost one-half (48.7%) had attended at least some college; 21% were college graduates (Table 2). Respondents reported a wide range of pre-tax household income, with 63% reporting household income of between $25,000 and $75,000 (Table 3). Like hunters in most states, Pennsylvania deer hunters (adjusted to address nonresponse bias) lived predominantly in rural areas (55%) or very small population centers (32%) (Table 4).

Most respondents were experienced hunters who tended not to be very successful over the years (Table 5). Respondents averaged 30.9 years of deer-hunting experience (range 1-75). They

had harvested an average of 10.4 antlered bucks (range 0-99) and 10.3 antlerless deer (range 0-99) during their lifetime in Pennsylvania or other places.

Table 2. Educational attainment of Pennsylvania deer hunters surveyed in 2000.

Highest level of education attained	n	%
Primary school	63	6.6
High School diploma or GED	488	51.3
Some college	201	21.1
College graduate	148	15.5
Postgraduate degree	52	5.5
	952	100.0

Table 3. Household income before taxes of deer hunters surveyed in Pennsylvania in 2000.

Household income	n	%
<$25,000	158	19.6
$25,000-49,999	302	37.4
$50,000-74,999	208	25.7
$75,000-99,999	79	9.8
≥$100,000	61	7.5
	808	100.0

Table 4. Type of area in which Pennsylvania deer hunters lived in 2000, adjusted to address nonresponse bias.

Residential category	%
On a farm	8.9
Rural area, not a farm	47.5
Small village with <10,000 residents	20.5
Large village with ≥10,000 residents	9.9
Small city with <50,000 residents	5.9
Medium city with 50,000-99,999 residents	3.8
Large city with ≥100,000 residents	3.6
	100.0

Table 5. Years of deer-hunting experience, mean number of antlered bucks bagged, and mean number of antlerless deer bagged in their lifetimes by Pennsylvania deer hunters surveyed in 2000.

Years of experience	Number of hunters	Percent of hunters	Mean number of bucks bagged in lifetime	Mean number of antlerless deer bagged in lifetime
≤10	132	13.8	1.2	1.6
11-20	147	15.3	5.0	6.5
21-30	217	22.6	8.7	10.1
31-40	202	21.0	11.3	12.5
41-50	130	13.5	16.6	13.9
≥51	132	13.8	20.2	16.4

During 1999, respondents reported hunting deer in 66 of the 67 Pennsylvania counties (not in Philadelphia County). A minimum[2] of 85% hunted during the regular firearms season for antlered bucks, spending an average of 4.5 days afield during that season (Table 6). More than one-half (at least 57%) hunted during the antlerless season. Of these antlerless hunters, nearly equal proportions hunted for 1 day (38%), 2 days (31%), or 3 days (31%).

Although a smaller percentage of big game hunters participated during the early archery season (32%) than during the firearms season, bow hunters hunted the greatest number of days on average (Table 6). About 1 in 7 big game hunters (13%) participated in the flintlock muzzleloader season. We did not ask about late archery season due to space considerations.

On average, hunters applied for 0.86 antlerless permits, received 0.83 , and filled 0.31 during the 1999 deer-hunting seasons. In 1999, 33% of hunters did not apply for any antlerless permit, compared to only 25% in 2000. Also, only 8.5% of hunters applied for 2 antlerless permits in 1999 whereas 21.6% applied for 2 in 2000. The difference between the 2 years is likely due to changes in regulations that increased opportunities for hunters to apply for multiple antlerless permits in 2000 compared to 1999.

Most hunters hunted typically either in forested areas (45%) or areas of mixed forest/agriculture (47%). Only 7% typically hunted in agricultural or developed landscapes. Overall, about one-third (35%) of hunters typically hunted on public land. Of those who generally hunted on private land, hunted on land with no access restrictions (30%) or where they simply had to ask permission to gain access (36%). One-quarter (23%) of those who typically hunted private land hunted on property where access was restricted to family members and close friends. About 6% hunted on land owned by private clubs, and 6% hunted on their own property where no one else was allowed to hunt.

Factors Affecting Hunters' Willingness to Harvest Antlerless Deer

The conceptual model based on the Theory of Reasoned Action (TRA) was helpful in identifying factors that affect hunters' future willingness to harvest antlerless deer (Table 7). As expected by the model, the most important factor influencing behavioral intention (i.e., future willingness) was attitude towards the target behavior (DOEATT). By itself, DOEATT was highly significant ($P < 0.001$) and explained about 13% of the variance in willingness. By including variables associated with antecedent attitudes and beliefs, past behavior, and the moderating variable AGE, we explained about 26% of the variance in future willingness.

[2] Some respondents left questions blank about the counties in which they hunted, how many days, and in what seasons. We do not know if these persons did not hunt, or if they simply chose not to provide answers to these questions.

Table 6. Mean number of days hunted and distribution of hunting effort during the 1999 deer-hunting seasons by deer hunters surveyed in Pennsylvania in 2000.

1999 deer-hunting season	Respondents		Mean days hunted	Distribution of effort within each season						Harvest					
				1-3 days		4-6 days		7+ days		Buck		Antlerless		Both	
	n	%		n	%	n	%	n	%	n	%	n	%	n	%
Early archery	311	34	11.6	50	16	56	18	205	66	48	15	27	9	13	4
Regular firearms for antlered bucks	815	90	4.5	367	45	277	34	177	21	173	21	---	---	---	---
Statewide antlerless deer	548	60	1.9	548	100	---	---	---	---	---	---	216	39	---	---
Muzzleloader	125	14	4.0	54	43	67	54	4	3	3	2	23	18	---	---
All seasons combined	908	100	10.1	175	19	198	22	535	59	---	---	---	---	---	---

Table 7. Results of a regression model of variables influencing Pennsylvania deer hunters' future willingness to harvest antlerless deer in 2000.

Variables	Final Beta	p-value	Variance explained by this variable	Adjusted R^2 with variable
Constant	1.41	< 0.001	---	---
DOEATT	0.23	< 0.001	0.125	0.13
Attitude towards a tax credit for each doe harvested	0.12	< 0.001	0.070	0.20
Mean annual doe harvest in lifetime	0.70	< 0.001	0.043	0.24
W-IMPACT	0.21	0.002	0.013	0.25
Hunter's age	-0.01	0.014	0.007	0.26
Attitude towards Requiring antlerless harvest first	0.06	0.049	0.004	0.26

An important antecedent attitude/belief was the level of impact that hunters believe deer have on forest wildlife species abundance and diversity in their hunting areas (W-IMPACT). The greater the impact recognized by hunters, the greater their willingness. A second antecedent attitude/belief was attitude towards a $50 tax credit for each antlerless deer harvested. Greater levels of support for this possible change in the current hunting system that places primary emphasis on buck-harvest opportunity was associated with higher future willingness. The third antecedent attitude/belief to enter the model was attitude towards requiring all hunters to harvest and check-in an antlerless deer prior to becoming eligible to harvest an antlered buck.

The only indicator of past behavior that directly influenced future willingness was the mean number of antlerless deer that hunters had harvested per year in their lifetimes. The only moderating variable with significant influence was hunters' age (P = 0.014); older hunters were less willing to harvest antlerless deer.

Exploratory regression analyses also showed that several antecedent attitudes/beliefs, past behaviors, and moderating variables have important indirect influences on future willingness by acting through DOEATT (Table 8). Our model explained about 36% of the

Table 8. Results of a regression model of variables influencing Pennsylvania deer hunters' attitudes towards personally harvesting antlerless deer in 2000.

Variables	Final Beta	p-value	Variance explained by this variable	Adjusted R^2 with variable
Constant	0.82	< 0.001	---	---
Attitude towards doubling the length of doe season	0.21	< 0.001	0.141	0.14
BUCKATT	0.20	< 0.001	0.107	0.25
Mean annual doe harvest in lifetime	1.26	< 0.001	0.064	0.30
Mean annual buck harvest in lifetime	-1.13	< 0.001	0.032	0.33
LANDETH	0.31	< 0.001	0.020	0.35
HABQUAL	0.16	0.019	0.007	0.36
Hunter's age	-0.01	0.048	0.003	0.36

variance in DOEATT, and included several variables that did not come into the model as direct predictors of willingness. Two of the significant predictors of DOEATT are of importance for the implementation of QHE. We anticipated the positive influence of hunters' attitudes towards the Land Ethic (LANDETH) on DOEATT. We also anticipated that hunters' overall assessments of the condition of the Land Community in their hunting areas (HABQUAL) would influence attitudes towards harvesting antlerless deer, but we did not anticipate that this influence would be positive. That is, we expected that worse (i.e., negative) HABQUAL conditions would correspond to higher willingness. We cannot explain why the Beta for HABQUAL is positive.

The analysis of variables influencing DOEATT provide evidence that some types of influences operate both directly and indirectly on hunters' willingness. For example, the Betas for (1) consistent antlerless harvest over a hunter's lifetime and (2) a hunter's age in each model are not particularly high. Yet, the fact that these variables enter both models suggests that their total influence on willingness to harvest antlerless deer is substantial.

Examination of Research Hypotheses

Hypothesis 1: Hunters have a positive attitude towards the Land Ethic.

This hypothesis was supported (Table 9). Only 6% of hunters held a negative attitude, and the mean Land Ethic attitude score was 1.04 on a scale from -2.00 to +2.00. A majority of hunters (61.5%) also agreed with all 3 of the premises of the Land Ethic. Almost all respondents (91%) agreed that hunters are part of an ecological community that also includes plants, deer, other wildlife, soil, and water. Almost all respondents (90%) also agreed that deer managers should give equal consideration to habitat needs of deer, growth and survival of forest plants, and hunter satisfaction when setting antlerless harvest quotas. However, only 67% agreed that hunters have a responsibility to reduce the deer population when it is out of balance with its habitat; 21% disagreed with this statement.

Table 9. Pennsylvania deer hunters' attitudes towards 3 premises associated with Leopold's Land Ethic, and their attitudes towards a mean LANDETH index, in 2000.

	Strongly Agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
Land Ethic premises	n	%	n	%	n	%	n	%	n	%
Deer hunters are a part of the Land Community	428	47.1	397	43.7	32	3.5	26	2.9	26	2.9
Equal consideration for habitat needs of wildlife, impacts on plants, and hunter satisfaction	329	36.3	491	54.2	34	3.8	34	3.8	18	2.0
Hunters have a responsibility to restore balance if deer are too numerous	186	20.4	428	46.9	109	12.0	148	16.2	41	4.5

LANDETH index	Positive		Neutral		Negative	
	n	%	n	%	n	%
Mean = 1.04 scaled from -2.00 to +2.00.	811	90.5	32	3.6	53	3.9

Hypothesis 2: Hunters recognize that the condition of the Land Community in their hunting area is unacceptable in the context of the Land Ethic.

This hypothesis was not supported for the statewide sample, and likely reflects differing habitat conditions across the state. Respondents' average evaluation of habitat conditions in their hunting areas (HABQUAL) was positive (0.64 on a scale of -2.00 to +2.00). Only 15% of respondents had a negative HABQUAL index whereas 72% believed the overall condition of the Land Community was "good" in their hunting areas (Table 10). In addition, only 32% of respondents disagreed with the statement "deer numbers are in balance with their habitat" in "the area where you hunt most often."

Table 10. Pennsylvania deer hunters' assessments of the condition of habitat characteristics in their hunting areas in 2000.

	Bad condition		Neither		Good condition	
Habitat characteristic	n	%	n	%	n	%
Diversity of plants other than trees	147	15.5	157	16.6	643	67.9
Diversity of wildlife	143	15.2	98	10.4	698	74.3
Deer population in balance with habitat	301	32.0	243	25.9	396	42.1
Diversity of young trees	261	27.7	232	24.7	448	47.6
Nongame wildlife habitat	141	15.0	148	15.7	654	69.4
Tree seedling survival	176	18.7	252	26.7	515	54.6

HABQUAL index	Positive		Neutral		Negative	
	n	%	n	%	n	%
Mean = 0.64 scaled from -2.00 to +2.00.	708	76.5	77	8.3	141	15.2

Hunters generally believed that specific indicators of the Land Community were in "good" rather than "bad" condition. Most respondents (55-74%) disagreed that non-tree plant diversity was low, forest wildlife diversity was low, habitat for nongame wildlife was poor, or that tree

seedling survival was low. About half (48%) disagreed that diversity of young trees was low.

Hunters also generally did not recognize many interactions among these indicators. Hunters with negative HABQUAL indices were more likely than those with positive HABQUAL indices to recognize that a negative condition in 1 indicator linked to a negative condition in another indicator. However, no statistically significant ($P < 0.05$) correlation coefficients exceeded 0.33.

Four of the 5 significant relationships found among Land Community variables for hunters with a negative HABQUAL index supported this hypothesis. Low wildlife diversity was correlated with low diversity of non-tree plants ($r = 0.27$). Low understory tree diversity was correlated with low tree seedling survival ($r = 0.33$). Poor habitat for nongame wildlife was correlated with deer being out of balance with their habitat ($r = 0.25$) and low tree seedling survival ($r = 0.21$). The other relationship found seems inexplicable; low understory tree diversity was correlated with deer being in balance with their habitat ($r = -0.22$).

Only 1 of 6 significant relationships found among Land Community variables for hunters with a positive HABQUAL index supported this hypothesis. Low understory tree diversity was correlated with low wildlife diversity ($r = 0.22$). The other relationships do not support the hypothesis. Deer being out of balance with their habitat was correlated with good habitat for other forest wildlife ($r = -0.15$) and with high tree seedling survival ($r = -0.21$). Low understory tree diversity is correlated with deer being in balance with their habitat ($r = -0.29$). Poor habitat for forest nongame wildlife species is correlated with high non-tree plant diversity ($r = -0.26$) and high understory tree diversity ($r = -0.27$).

Hypothesis 3: Hunters who believe the condition of the Land Community is unacceptable believe that overpopulation by the deer component of the Community is the main reason.

This hypothesis generally was supported although some findings were inconsistent. Overall, hunters were most likely to believe that the impact of deer on plants (P-IMPACT) in their hunting area was slight (39.4%) or moderate (34.4%), compared to great (13.6%) or none (12.6%). Hunters were most likely to believe that the impact of deer on wildlife (W-IMPACT) was none (39.6%) or slight (39.1%), compared to moderate (17.9%) or great (3.4%).

A slight majority (58%) of hunters with a negative HABQUAL index ($n = 141$) believed that deer had at least a $\geq$ moderate P-IMPACT (Table 11). However, 82% of the 443 hunters who believed that deer have a $\geq$ moderate P-IMPACT in their hunting areas had a positive HABQUAL index. These latter hunters apparently did not associate moderate/great deer herbivory with decreased condition of the Land Community.

Support for this hypothesis was not found when we examined the relationship between HABQUAL and W-IMPACT (Table 11). Of the 141 respondents who had a negative

HABQUAL index, only 28% believed that deer have a ≥ moderate W-IMPACT. Most (80%) of hunters who thought deer had a ≥ moderate W-IMPACT (n = 196) had a positive HABQUAL index. We did not expect these findings considering that 91% of hunters believe non-deer wildlife species to be part of the overall Land Community.

Table 11. Comparison of Pennsylvania deer hunters' assessments of overall habitat quality (HABQUAL) in their hunting areas with the level of impact hunters believe deer have on plant species abundance and diversity (P-IMPACT), and on wildlife abundance and diversity (W-IMPACT) in their hunting areas, in 2000.

	P-IMPACT				W-IMPACT			
	≤ slight		≥ moderate		≤ slight		≥ moderate	
HABQUAL	n	%	n	%	n	%	n	%
negative	59	41.8	82	58.2	101	71.6	40	29.9
neutral/positive	423	54.0	361	46.0	627	80.1	156	19.9
	482		443		728		196	

Hunters' assessments of the condition of specific Land Community variables provided evidence of support for the hypothesis. Higher percentages of respondents with a negative HABQUAL index compared to those with a positive HABQUAL index believed that specific variables were in bad condition (Table 12). It is important to note, however, that substantial percentages of hunters with a negative HABQUAL index believed that specific Land Community variables were in good condition.

We tried to assess how hunters think deer impact the various components of the Land Community. Of those who believed that deer have a ≥ moderate P-IMPACT, 34% believed the diversity of young trees was low, 25% believed that survival of young woody stems was low, and 16% believed that non-tree plant diversity was low. Relatively few hunters who believed that deer have a ≤ slight P-IMPACT also believed that specific components of the Land Community were in bad condition. Of all hunters who believed that deer have a ≥ moderate W-IMPACT, 21% indicated that habitat quality for those wildlife was poor and 17% believed that wildlife species diversity was low.

Table 12. Numbers and percentages of Pennsylvania deer hunters surveyed in 2000 who believed that various variables associated with the Land Community in their hunting areas were in "good" or "bad" condition, compared by hunters' overall assessments of habitat quality (HABQUAL) in their hunting areas.

	Overall HABQUAL negative						Overall HABQUAL positive or neutral					
	Condition of specific indicator variables						Condition of specific indicator variables					
Specific Land Community variables	Bad condition		Neutral		Good condition		Bad condition		Neutral		Good condition	
	n	%	n	%	n	%	n	%	n	%	n	%
Diversity of plants other than trees	71	50.4	29	20.6	41	29.0	74	9.4	124	15.8	587	74.8
Diversity of wildlife	67	47.5	26	18.4	48	34.0	74	9.4	68	8.7	643	81.9
Balance between deer population and habitat	111	71.6	21	14.9	19	13.5	192	24.5	221	28.2	372	47.3
Understory tree diversity	82	58.2	39	27.7	20	14.1	175	22.3	189	24.1	421	53.6
Nongame wildlife habitat	74	52.5	36	25.5	31	22.0	65	8.3	111	14.1	609	77.6
Tree seedling survival	77	54.6	44	31.2	20	14.2	94	12.0	202	25.7	489	62.3

Hypothesis 4: Hunters who believe that the condition of the Land Community is unacceptable believe that increased harvest of antlerless deer (compared to current harvest levels) will restore the well-being of the ecological community.

This hypothesis was supported. In the questionnaire, hunters were informed that implementing QHE would mean (a) reducing the deer population and (b) making sure some bucks live to maturity. Greater percentages of hunters who believed that deer had a $\geq$ moderate impact on forest plants (P-IMPACT), compared to those who believed that deer had a $\leq$ slight P-IMPACT, believed that implementation of QHE would result increased forest plant and wildlife growth, abundance, and diversity.

In addition, the hypothesis was partially supported when comparisons were made between 8 specific indicators of Land Community condition and likelihood that QHE would result in an improvement in that indicator (Table 13). For 3 of the 8 indicators, higher percentages of respondents who believed that specific habitat conditions were "bad," compared to "good" or "don't know," thought that QHE would improve those conditions. For example, a higher percentage of hunters who believed that survival of forest tree seedlings was bad thought QHE would increase diversity of forest trees (56.87% vs. 40.8%; $X^2 = 14.42$; $P < 0.01$). Another example is that a higher percentage of hunters who believed that diversity of forest trees was bad, compared to those who believed diversity of forest trees was good/unknown, believed that QHE would increase diversity of forest trees (56.0% vs. 39.1%; $X^2 = 21.65$; $P < 0.01$). It should be emphasized, however, that for each of the 8 indicators we assessed, only 35-57% of respondents rating current habitat conditions as being "bad" believed that QHE would improve those conditions (Table 13).

Hypothesis 5: Hunters' willingness to harvest antlerless deer in the future is greater than hunters' current level of antlerless harvest that is constrained by regulation.

This hypothesis was supported (Table 14). Hunters applied for an average of 0.9 county-specific antlerless permits in 1999 and 1.0 in 2000. If hunters could harvest as many antlerless deer as they wanted, they would take an average of 1.7 antlerless deer per year. Differences between 1999 and future willingness and between 2000 and future willingness both were significant ($t = 11.35$, $P < 0.001$ and $t = 9.39$, $P < 0.001$, respectively).

Table 13. Comparisons between Pennsylvania deer hunters' assessments of the condition of specific habitat variables and hunters' beliefs about whether increasing antlerless deer harvest through Quality Hunting Ecology (QHE) would improve those conditions.

Diversity of forest wildlife other than deer	Likelihood of seeing more wildlife diversity under QHE: Unlikely/unknown	Likely	Row total n
Bad	64.8%	35.2%	142
Good/unknown	72.1%	27.9%	780
Column total n	654	268	
	$X^2 = 3.07$	P = 0.08	

Condition of habitat for forest wildlife (not deer)	Likelihood of seeing more wildlife diversity under QHE: Unlikely/unknown	Likely	Row total n
Bad	68.6%	31.4%	140
Good/unknown	71.4%	28.6%	786
Column total n	657	269	
	$X^2 = 0.45$	P = 0.50	

Diversity of non-tree forest plants	Likelihood of seeing more plant diversity under QHE: Unlikely/unknown	Likely	Row total n
Bad	51.4%	45.9%	146
Good/unknown	56.7%	43.4%	781
Column total n	522	405	
	$X^2 = 0.34$	P = 0.56	

Diversity of non-tree forest plants	Likelihood of seeing less far in the forest due to more vegetation growth under QHE: Unlikely/unknown	Likely	Row total n
Bad	54.8%	45.2%	146
Good/unknown	51.2%	48.8%	782
Column total n	480	448	
	$X^2 = 0.65$	P = 0.42	

Table 13. Continued.

	Likelihood of seeing more plant diversity under QHE		Row
Diversity of forest trees	Unlikely/unknown	Likely	total n
Bad	44.0%	56.0%	259
Good/unknown	60.9%	39.1%	663
Column total n	518	404	
	$X^2 = 21.65$	$P < 0.01$	

	Likelihood of seeing less far in the forest due to more vegetation growth under QHE		Row
Diversity of forest trees	Unlikely/unknown	Likely	total n
Bad	44.2%	55.8%	260
Good/unknown	54.6%	45.4%	663
Column total n	477	446	
	$X^2 = 8.04$	$P < 0.01$	

	Likelihood of seeing more forest plant diversity under QHE		Row
Survival of tree seedlings	Unlikely/unknown	Likely	total n
Bad	43.3%	56.7%	171
Good/unknown	59.2%	40.8%	753
Column total n	520	404	
	$X^2 = 14.42$	$P < 0.01$	

	Likelihood of seeing less far in the forest due to more vegetation growth under QHE		Row
Survival of tree seedlings	Unlikely/unknown	Likely	total n
Bad	45.6%	54.4%	171
Good/unknown	52.9%	47.1%	754
Column total n	477	448	
	$X^2 = 2.98$	$P = 0.08$	

Table 14. Mean number of antlerless permits applied for by Pennsylvania deer hunters in 1999 and 2000, and their willingness to harvest antlerless deer under a scenario in which they could harvest an unlimited number.

Number of antlerless permits applied for in 1999 and 2000 or future willingness to harvest antlerless deer	1999 regulations		2000 regulations[a]		Future willingness	
	n	%	n	%	n	%
0	216	22.9	---	25.1	89	9.9
1	646	68.6	---	53.3	392	43.2
2	80	8.5	---	21.6	321	35.4
3	---	---	---	---	60	6.6
≥ 4	---	---	---	----	45	5.0

[a]Year 2000 data were adjusted to account for nonresponse bias. Thus, sample sizes cannot be determined for this year.

In addition, a greater percentage of hunters (90%) would take $\geq$1 antlerless deer under the scenario of unlimited antlerless opportunity, compared to 77% who applied for $\geq$1 antlerless permits in 1999 ($X^2 = 31.576$, $P < 0.001$, df = 1) and 75% who applied for $\geq$1 antlerless permit in 2000 ($X^2 = 34.719$, $P < 0.001$, df = 1). However, even under a scenario of unlimited antlerless opportunity, individual hunters would not take a very large number of antlerless deer--only 11.6% would take $\geq$3.

Hypothesis 6: Hunters who believe that potential changes in their experiences would be both likely and desirable if QHE was implemented will have a higher willingness to harvest antlerless deer in the future compared to hunters who believe that potential changes would be likely but undesirable.

This hypothesis was largely unsupported, perhaps due to small numbers of hunters who believed that various potential impacts to their hunting experiences would be both likely and desirable. For 7 of the 10 impacts examined, >75% of respondents had positive or neutral evaluative beliefs (Table 15). Respondents generally were split between positive, neutral, and negative evaluative beliefs for the other 3 impacts examined (Table 16).

Table 15. Possible QHE-related impacts for which Pennsylvania hunters generally held either neutral or positive perceptions, and reasons for positive perceptions in 2000.

Possible impact	Those with neutral perception		Those with positive perception		Of those with positive perception… Likely to occur, would be good		Would be bad but unlikely to occur		Mean evaluation belief product
	n	% of total	n	% of total	n	% of total	n	% of total	
See older, mature bucks	234	25.0	519	55.5	452	48.3	67	7.2	1.902
Better chance to harvest older, mature bucks	238	25.4	504	53.9	434	46.4	70	7.5	1.719
See more buck sign	291	31.2	448	48.0	389	41.7	59	6.3	1.358
See more equal sex ratio	336	36.0	415	44.4	326	34.9	89	9.5	1.235
See more plant diversity	449	48.3	343	36.9	296	31.8	47	5.1	0.992
See shorter distance due to more vegetation	396	42.4	334	35.8	238	25.5	96	10.3	0.551
See bigger variety of nongame	499	53.3	275	29.4	178	19.0	97	10.4	0.672

Table 16. Possible QHE-related impacts for which Pennsylvania hunters generally were split in 2000 about whether the impacts would be positive, neutral, or negative, and reasons for positive or negative perceptions.

Possible impact	Of those with negative perception… Likely to occur, would be bad		Would be good, but unlikely to occur		Those with neutral perception		Of those with a positive perception… Likely to occur, would be good		Would be bad, but unlikely to occur		Mean evaluative belief product
	n	%	n	%	n	%	n	%	n	%	
See fewer total deer	337	36.5	33	3.6	269	29.1	106	11.5	178	19.3	-0.574
See less overall deer sign	237	25.3	35	3.7	335	35.8	100	10.7	229	24.5	0.212
See more bucks	30	3.2	215	23.0	267	28.6	357	38.2	65	7.0	0.937

For 8 of 10 QHE-related impacts examined, hunters' future willingness to harvest antlerless deer under a scenario of unlimited opportunity did not differ between those who believed that impacts likely would happen and would be good, and hunters who believed the impacts would be likely but bad. Hunters who believed that seeing fewer deer would be good and was likely to occur under QHE had higher future willingness (mean 2.1 vs. 1.5), compared to hunters who believed they would see fewer deer and that would be bad ($P < 0.05$). Similarly, hunters who believed that seeing less overall deer sign would be good and was likely to occur under QHE had higher future willingness (mean 2.0 vs. 1.5) compared to hunters who believed they would see fewer deer and that would be bad ($P < 0.05$). This suggests that hunters with positive evaluative beliefs about QHE impacts are no more likely than those with negative evaluative beliefs to want to harvest more antlerless deer.

H7: Changing the characteristics of the hunting system to put primary emphasis on antlerless deer harvest rather than antlered buck harvest will have a grater influence on hunters' aggregate willingness than liberalizing regulations within the current hunting system.

This hypothesis was supported, although at least one-half of hunters opposed 6 of the 8 possible regulation changes we posed to them (Table 17). Future willingness to harvest antlerless deer was highest for those hunters supporting regulatory changes that would shift primary harvest emphasis to antlerless deer (Table 18). Hunters supporting regulatory changes that would maintain primary harvest emphasis on bucks had higher future willingness to harvest antlerless deer compared to hunters opposing either type of regulatory change. This suggests that hunters who are supportive of any kind of change that would result in additional antlerless harvest have higher willingness than those who oppose additional antlerless harvest in general.

The mean number of antlerless permits applied for by hunters in 1999 did not differ whether hunters supported or opposed either kind of regulatory change (range in means is from 0.86 to 0.88). The same results were found for the mean number of permits hunters applied for in 2000 (range in means is from 1.00 to 1.02). This suggests that support/opposition for change is not related to past behavior. The slight difference between the mean number of permits applied for in 1999 and 2000 probably is related to liberalized antlerless opportunity in 2000.

Support for changes towards placing primary emphasis on antlerless deer instead of bucks was higher for hunters who believed that seeing fewer deer in their hunting areas would be "good" compared to those who believed seeing fewer deer would be "bad" (15.3% support vs. 6.8% support, respectively). Support also was higher among those who believed seeing fewer deer would be "good" (35.4% support) as compared to "bad" (27.5% support) for changes that maintained primary emphasis on bucks while increasing antlerless harvest opportunities. It is possible that those who believe seeing fewer deer is "bad" would be less likely to participate in any increased opportunities to harvest antlerless deer. However, it is important to note that relatively few hunters with either belief about seeing deer support any changes in hunting opportunities.

Table 17. Levels of support or opposition by Pennsylvania deer hunters in 2000 for increasing antlerless deer harvest through a set of regulations or incentives.

Regulations that maintain primary harvest emphasis on antlered bucks	Support		Neither		Oppose	
	n	%	n	%	n	%
Double the length of the antlerless season from 3 to 6 days.	388	42.6	69	7.6	454	49.8
Let hunters donate to a local food bank any extra venison they could not use.	769	84.2	50	5.5	94	10.3
Let hunters earn 1 day of free access to hunt hunt bucks on posted private land next year for every antlerless deer they harvest this year.	209	22.9	122	13.4	580	63.7
Let hunters earn a $50 state tax credit for every antlerless deer they harvest.	229	25.1	87	9.5	597	65.4
Combine buck and antlerless deer seasons, and let hunters fill their antlerless license while hunting for a buck.	401	43.8	59	6.4	455	49.7
Regulations that change primary harvest emphasis to antlerless deer						
Make the regular deer license valid for an antlerless deer.	456	50.3	78	8.6	373	41.1
Combine buck and antlerless deer seasons, and require every hunter to harvest and take an antlerless deer to a check station before they can get a buck tag.	97	10.6	56	6.1	762	83.3
Have antlerless deer season before buck season, and require every hunter to harvest and take an antlerless deer to a check station to get a buck tag.	84	9.2	64	7.0	766	83.8

Table 18. Mean number of antlerless deer permits applied for in 1999, 2000, and number of antlerless deer hunters are willing to harvest under a scenario of unlimited opportunity, compared for those Pennsylvania deer hunters who (1) oppose possible regulatory changes that maintain primary harvest emphasis on bucks, (2) support possible regulatory changes that maintain primary harvest emphasis on bucks, (3) oppose possible regulatory changes that shift primary harvest emphasis to antlerless deer, and (4) support possible regulatory changes that shift primary harvest emphasis to antlerless deer.

Hunters who…	Mean number of antlerless permits applied for in … 1999	2000	Mean number of antlerless deer hunters are willing to harvest
Oppose regulations that still maintain buck emphasis	0.86 A	1.00 A	1.48 A
Oppose regulations that shift emphasis to antlerless deer	0.86 A	1.00 A	1.48 A
Support regulations that still maintain buck emphasis	0.88 A	1.01 A	2.08 B
Support regulations that shift emphasis to antlerless deer	0.87 A	1.02 A	2.33 C

Letters in columns identify significant differences. Means with same letter are not different within in that year/column.

DISCUSSION AND CONCLUSIONS

Most Pennsylvania deer hunters have a positive attitude towards the Land Ethic and do not need to be convinced of its merits. They overwhelmingly see themselves and deer as being parts of a larger Land Community in which all components of that community interact with and affect other components. If education about the Land Ethic is integrated into QHE demonstrations, the greatest benefit can be gained by focussing on hunters' "responsibility to restore balance in the Land Community" if deer overabundance is causing unacceptable negative impacts on other components. Our identification of this potential educational need for Pennsylvania hunters confirms earlier research from New York (Decker and Connelly 1990) and is consistent with a recent call for wildlife managers to communicate with hunters anywhere deer are overabundant about their "civic responsibility" to harvest more antlerless deer (Decker date).

One of the greatest challenges to overcome may be that most Pennsylvania hunters seem not to believe that habitat quality is compromised by deer in areas where they hunt. It may be difficult for hunters to believe that other components of the Land Community are being adversely impacted when deer are considered to be "numerous" or "overabundant" by managers and some other stakeholders. Our data support this conclusion in that most hunters did not connect deer browsing with the condition of the Land Community. Further, even hunters who believed that deer had negative effects on forest vegetation tended not to believe that habitat for other forest wildlife was adversely impacted.

Nonetheless, QHE does hold promise as a mechanism for reducing the negative effects of deer browsing in forested watersheds. Those hunters who believed that deer were adversely impacting the Land Community were most likely to believe that QHE will improve the condition of the Land Community. In particular, they believed that lowering the total deer population by increasing the harvest of antlerless deer would result in better vegetation survival, growth, and species diversity. QHE also holds promise because most Pennsylvania hunters are willing to harvest more antlerless deer than they can under current regulations.

One of the most important aspects of QHE to test on demonstration areas is the "earn-a-buck" concept. Current statewide regulations allow any deer hunter to hunt for a buck without linking that opportunity to harvest of antlerless deer (Enck and Brown 1999). Indeed, any hunter who wants an opportunity to hunt for antlerless deer must first purchase a buck license, and buck season for modern firearms traditionally has occurred prior to doe season. Implementing an "earn-a-buck" approach would shift primary harvest emphasis to antlerless deer instead of bucks. Most importantly, this would allow hunters who want to shoot few total deer to contribute their maximum potential harvest for antlerless deer.

Several important questions remain unanswered and should be examined as demonstration areas are implemented.

1. What role does site fidelity play in hunters' willingness to take advantage of hunting opportunities in places other than their traditional hunting sites?

2. If QHE reduces the overall deer population on demonstration areas, how will hunter retention be affected?

3. Given that hunters 48 years of age and older (median age) have a lower future willingness to harvest antlerless deer compared to younger hunters (1.4 vs. 2.0), what will be the impact on hunter willingness and capacity to harvest antlerless deer as the hunter population ages?

4. How many total deer would Pennsylvania hunters like to harvest in any year?

5. To what extent do Pennsylvania hunters have a preference to shoot bucks over antlerless deer, and what effect will this have on antlerless harvest under various regulatory scenarios?

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