White-tailed Deer Damage Management in a Forested High-Density Residential Community

Gino J. D'Angelo and **Willard L. Wenner**
USDA APHIS Wildlife Services, Harrisburg, Pennsylvania
Marian S. Keegan
Hemlock Farms Community Association, Department of Community Conservation, Lords Valley, Pennsylvania

Abstract: Hemlock Farms Community Association (HFCA) is a >4,500-acre private, gated community located in Pike County, Pennsylvania, established in the 1960s. During our study, 3,150 homes existed in HFCA, with 400 more homes expected to be built in the future. In recent years, the community took proactive steps to coexist with white-tailed deer in the community. Residents were fully involved in deer management decision making early in the process. Through the Pennsylvania Game Commission Deer Management Assistance Program, HFCA has allowed hunting by residents in undeveloped areas of the community to assist in reducing and maintaining deer densities. Non-lethal techniques to prevent browsing of the forest understory and landscape vegetation by deer–other than fencing–were ineffective. U.S. Department of Agriculture Wildlife Services was consulted in 2005 by HFCA to initiate an integrated white-tailed deer damage management program to reduce damage to forest regeneration and landscaping, and to protect human health and safety. In October 2005, we began lethal deer removal via sharpshooting to reduce the deer population to 10 deer per square mile of forested habitat (50 deer) from an estimated ≥125 deer per square mile of forested habitat. By winter 2009-2010, we removed a total of 830 deer, bringing the population within the management goals of the community. The forest understory rebounded, deer-vehicle collisions were reduced to an annual level of near zero. Physiological indices suggested that the health of deer improved as population densities were decreased. Residents voted annually on a referendum to continue culling of deer. Therefore, monitoring of the deer population and education of residents will remain important components of the deer management regime.

Key Words: damage, deer-vehicle collisions, education, effort, residential, sharpshooting, *Odocoileus virginianus*, Pennsylvania, white-tailed deer

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INTRODUCTION

Deer-human conflicts occur when overabundant deer threaten human livelihood, health and safety, property; and natural resources. These conflicts are common in communities throughout the range of the white-tailed deer (*Odocoileus virginianus*). Controversy often arises at the community level when lethal management is proposed to reduce deer densities and associated damage (Kilpatrick et al. 1997a). However, in the absence of adequate natural mortality, managers have a responsibility to evaluate deer herds and their impacts, and to develop a plan to regulate deer populations (Coffey and Johnston 1997).

Fulton et al. (2004) surveyed residents near Cuyahoga Valley National Park where deer were known to be overabundant for decades. They found that there was overwhelming support (≥70%) for lethal deer management actions. However, people were more likely to support lethal management if overabundant deer threatened human health and safety or the natural environment, rather than just damaging personal property or aesthetics. Deer foraging habits and preferences are known to change plant composition and structure over time (Brown and Parker 1997, Stromayer and Warren 1997, Augustine and Jordan 1998, Russell and Fowler 1999) and such alterations have subsequent impacts on other wildlife, such as songbird species richness and abundance (DeCalesta 1994). Alverson et al. (1988) suggested maintaining deer densities at 10 deer per square mile to minimize impacts caused by overbrowsing.

Sport hunting is the primary mechanism to manage deer numbers in Pennsylvania on an annual basis. The Pennsylvania Game Commission (PGC) regulates deer harvest via prescription of licenses for harvest of antlerless deer per 22 different wildlife management units. Statewide goals for deer management include minimizing deer-human conflicts, and management of deer for healthy forest habitat and healthy deer (Rosenberry et al. 2009). In urban areas, because of dense human housing and reluctance of residents to allow hunters access to their properties, sport hunting may not adequately regulate deer populations (Storm et al. 2007). PGC provides for alternative deer management actions including the Deer Management Assistance Program (DMAP) and Deer Control Permits for which sharpshooting may be used to reduce deer densities in urban areas (Rosenberry et al. 2009).

Our study represents a case history of managing damage caused by white-tailed deer in a forested high-density residential community. These conditions may be found in many communities throughout the eastern U.S. where hunting is prohibited or limited. Our goals were to describe the complexities of implementing sharpshooting in a quasi-urban environment, expectations for effort required to reach management goals, and the potential for minimizing damage.

STUDY AREA

Hemlock Farms Community Association (HFCA) is a >4,500-acre community in Blooming Grove, Porter,

and Dingman Townships, Pike County, PA. HFCA was in the Glaciated Low Plateau Section of the Appalachian Plateaus Province, which was characterized by rounded hills and valleys with thin, moist soils and glacially deposited boulders (PADCNR 2012). Land cover of HFCA included 74% mixed hardwood forests (*Quercus* spp., *Acer rubrum*), 6% forested wetlands (*A. rubrum*, *Betula* spp., *Populus* spp., *Quercus alba*), 8% recreational areas including golf courses, 6% open water, and 6% paved roads (75 linear miles). Land uses adjacent to HFCA included state forests, hunting clubs, and similar residential communities.

HFCA was established in the 1960s and at the time of our study had 3,150 homes. Lots were primarily forested and averaged 0.75 acres. An additional 400 homes were expected to be built in the future. About 50% of members were permanent residents and about 50% of members used their homes on weekends and during summer. The community was governed by a board of directors.

HFCA instituted measures to protect the rural forested nature of the community, which included: 1) regulations limited manipulations of trees on private land and required impervious surfaces to be ≤20% per lot, 2) educated members about the environment, 3) managed risks (i.e., wild fire, hazardous trees), 4) controlled invasive plants and insects, 5) augmented the forest (i.e., planting native trees, shrubs), and 6) managed deer.

The community took proactive steps to coexist with the deer. The speed limit was set at a maximum of 35 miles per hour to reduce deer-vehicle collisions, a code was passed prohibiting the feeding of deer, and the community tolerated natural predators including American black bears (*Ursus ursus*), bobcats (*Lynx rufus*), and coyotes (*Canis latrans*). Prior to initiating lethal deer removal, other than fencing, non-lethal techniques to prevent browsing by deer were ineffective in HFCA because of high deer densities and because deer lacked fear of humans.

HFCA conducted studies to understand the deer and their impacts on the community. The HFCA Environmental Committee performed daylight road surveys for deer with volunteers. HFCA also commissioned professional studies to count the deer and consulted with PGC.

In 1997, the board of the community association voted to allow a controlled archery hunt to reduce the deer population in the community. The hunt was limited to 9 days on 500 acres of open space, and 9 deer were harvested. Due to conflict among community members about the hunt, future lethal deer management would be voted on by the membership in a proposition. Approval by >50% of the membership was necessary to allow lethal deer management. Through the PGC DMAP, HFCA later allowed hunting by residents in undeveloped areas of the community to assist in reducing and maintaining deer densities.

U.S. Department of Agriculture Wildlife Services (WS) was consulted in 2005 by Hemlock Farms Community Association (HFCA) to initiate a sharpshooting program to reduce the density of white-tailed deer to reduce damage to forest regeneration and property, and to minimize risks to human health and safety. In October 2005, we began lethal deer removal activities to reduce deer densities to 10 deer per square mile of forested habitat on the property.

METHODS

Aerial Deer Surveys

Initial goals for deer removal were based on survey data collected by a private company commissioned by HFCA (S. Bernatas, Vision Air Inc., unpubl. data). The survey was conducted using fixed-wing aircraft with a wing-mounted infrared camera, which was remotely adjustable for scanning. The survey was conducted at night along 1,000-foot transects spaced 1,000 feet apart across HFCA.

Ground-Based Deer Surveys

After initiation of deer removal, we conducted ground-based surveys along a standardized 31-mile survey route throughout HFCA along paved roads. Surveys were initiated after sunset. Deer were observed using an infrared camera, and perpendicular distances of deer from the survey route deer were estimated with a laser rangefinder. Sex and age class of deer were determined. The survey vehicle moved at ≤10 miles per hour, stopping only to accurately record data or for traffic considerations. We modified a standard deer abundance estimator (Hahn 1948) to adjust for detection rates and to derive logical deer density estimates per forested square mile on HFCA, excluding buildings, roads, and water.

Deer Removal

PGC issued deer control permits directly to HFCA annually. We conducted deer removal activities based upon a standard protocol used by WS in urban environments. All deer were removed from mobile units at night. The typical mobile unit consisted of two WS personnel and one driver from HFCA. Hours per deer removed was calculated for each night based on the total number of hours of operation multiplied by 3 crew members and divided by the number of deer removed. We used a hand-held infrared camera to locate and observe deer. These capabilities enhanced our ability to ensure safe removal operations by detecting people, non-target animals, ricochet hazards, and buildings. Shots were taken using spotlights with red filters to alight deer. All deer were humanely euthanized with head and neck shots under normal protocols established by WS Directive 2.505 (USDA 2011) and recommended by the American Veterinary Medical Association (AVMA 2007). We used small caliber, high-powered, sound-suppressed rifles with frangible ammunition to minimize pass-through and ricochets.

Bait sites were placed on properties where permission was obtained to conduct deer removal. Bait was used to position deer for safe shooting out of dense cover and away from ricochet hazards. Adult female deer were targeted for removal first. When possible, adult males with large antlers were not removed. Remaining deer were removed on a first opportunity basis, provided safe shots could be taken.

We estimated the age of each deer by tooth eruption and wear (Severinghaus 1949). Beginning in 2008, we weighed deer using a suspended spring scale. Deer-vehicle collisions were recorded by HFCA office of public safety.

Table 1. Annual seasons of lethal deer removal via sharpshooting by U.S. Department of Agriculture Wildlife Services, number of deer pre-removal, number of deer removed, and the annual number of deer-vehicle collisions on Hemlock Farms Community Association, Pike County, PA, during 2004-2011.

Deer removal season	No. days	No. hours	No. deer removed	Hours /deer removed[a]
2005 - 2006	24	204	379	1.61
2006 - 2007	23	164	201	2.44
2007 - 2008	16	106	120	2.64
2008 - 2009	14	113	102	3.32
2009 - 2010	3	24	28	2.57
2010 - 2011	4	41	25	4.89

[a] Hours per deer removed was calculated for each night based on the total number of hours of operation multiplied by 3 crew members and divided by the number of deer removed.

Table 2. Annual seasons of lethal deer removal via sharpshooting by U.S. Department of Agriculture Wildlife Services, number of nights of deer removal, total annual number of hours of deer removal, number of deer removed, and the number of person hours expended per deer removed on Hemlock Farms Community Association, Pike County, PA, during 2004-2011.

Deer removal season	No. deer pre-removal	No. deer removed	No. deer-vehicle collisions[a]
2004	≥660	0	164
2005 - 2006	660	379	81
2006 - 2007	480	201	27
2007 - 2008	205	120	9
2008 - 2009	150	102	10

[a] Reported for year beginning deer removal season

RESULTS

Initiation of Deer Removal, 2005-2006

Every year beginning in 2005, the majority of HFCA membership voted to conduct lethal deer management. From 26 October - 8 November 2005, we removed 89 deer during 4 nights of operation. On 18 November 2005, Vision Air Inc. (Boise, ID) conducted an aerial infrared deer survey and counted 149 deer. Based on these data, the deer population in HFCA was estimated to be 238 deer before initiation of lethal deer removal. To achieve 10 deer per forested square mile (50 deer remaining on HFCA), the deer removal goal for 2005-2006 was set at ≥188 deer.

From 12 December 2005 - 19 January 2006, we removed an additional 100 deer during 7 nights of operation. On 1 February 2006, we conducted a ground-based deer survey and observed 232 deer. With no extrapolation, these data suggested that the population still was ≥182 deer above the goal of 50 deer on HFCA. From 6 February - 29 March 2006, we removed an additional 190 deer during 13 nights of operation, and terminated deer removal operations for the season.

We conducted another ground-based deer survey and observed 128 deer. With application of deer abundance estimation, the post-removal deer population on HFCA was 281 deer. These data, coupled with 379 deer removed, suggested that the pre-removal deer population was ≥660 deer (132 deer per forested square mile). During the first season of deer removal, we operated for 24 nights and person hours per deer removed averaged 1.61 hours per deer (Table 1). We reduced deer abundance by approximately 58%.

Continuation of Deer Removal, 2006-2010

From 2006-2010, we conducted 2 or 3 ground-based surveys to generate an average estimate of deer abundance prior to initiating deer removal operations to set goals for the number of deer to be removed annually. From 2006-2010, we removed 451 deer, for a total of 830 deer removed during the project. Generally, as deer densities were reduced, we removed fewer deer per year and our effort per deer (hours) increased (Table 2). We reduced deer abundance by an estimated 32-68% annually.

All deer removed from HFCA were processed and donated for charitable food distribution. Approximately 24,643 pounds of venison were donated during the project. In addition to our sharpshooting efforts, sport hunters on HFCA harvested ≤10 deer annually through DMAP.

Biological Data

As deer abundance was reduced towards maintenance levels, the age structure of the deer removed was skewed towards younger age classes, and there was a preponderance of bucks >1.5 years old culled. During 2005-2006, 61% of deer removed were ≤3.5 years old, whereas during 2010-2011 81% of deer removed were ≤3.5 years old. As the deer population was reduced, we anecdotally observed an improvement in the antler size of bucks, and more bucks were passed over for removal. However, during the 2005-2006 deer removal season 13% of the deer removed were bucks ≥1.5 years old, versus an average of 51% of deer removed during the 2009-2011 removal seasons were bucks ≥1.5 years old.

The body mass of adult female deer removed on HFCA during the 2008-2011 deer removal seasons averaged 123.5 pounds (SE = 3.4, n = 58). Deer from HFCA had 8.5% more body mass than another deer population (control, mean = 113.8 pounds, SE = 2.0, n = 63) where we conducted deer removal during 2009. The control deer population was within 10 miles of HFCA and had an estimated density of 140 deer per square mile before we initiated deer removal during 2009.

The annual incidence of deer-vehicle collisions on HFCA lowered directly with the reduction in deer abundance on HFCA. Before lethal deer removal, roadsides, residential yards, and the forest understory was denuded. Anecdotal observations by HFCA residents and personnel, and WS personnel suggested that the forest understory rebounded substantially following deer removal. For years, HFCA maintenance did not mow roadside vegetation because there was none due to deer. Following deer removal, roadside mowing became necessary several times annually to improve visibility for motorists.

DISCUSSION

While the overall goal was to reduce rapidly the deer

population to ≤50 deer on HFCA, funding for deer removal or logistical constraints prevented us from approaching this goal for ≥5 years. DeNicola and Williams (2008) used 6 seasons of sharpshooting to reduce the deer population in suburban Princeton, New Jersey from 114 deer per square mile to 32 deer per square mile. McDonald et al. (2007) found that 2 to 4 years of controlled hunting was necessary to reduce deer densities to 10 deer per square mile from ≤72 deer per square mile on the rural forested Quabbin Reservation. Access for hunters within hunt zones on the Quabbin Reservation was contiguous, whereas we were limited to conducting deer removal on ≤15% of HFCA and around occupied residences. Our effort per deer removed was similar to previous deer management actions using sharpshooting (Butfiloski et al. 1997, DeNicola et al. 1997, Frost et al. 1997, Doerr et al. 2001).

As deer densities were reduced, effort to kill an adequate number of deer per year increased. Factors including fewer deer to engage for removal and behavioral responses of deer to sharpshooting activities likely increased effort. However, since fewer deer needed to be removed at lower deer densities, effort was still logistically and economically reasonable. As compared to the initial season of deer removal operations, effort required when the population reached maintenance levels was ≥80% less. For this project and others we conducted throughout Pennsylvania, we found that being adaptive with our approach to each project as deer numbers were reduced was important. Altering the seasonal and daily timing of operations, changing baiting regimes, and varying the tactical approach to sharpshooting operations was necessary to remain effective.

Deer densities were reduced substantially beginning in the first deer removal season on HFCA. As evidenced by the concomitant reduction in deer-vehicle collisions, benefits of fewer deer began immediately after initiation of lethal deer management. As early as 3 years after deer reduction began, the forest understory and the health of deer was noticeably improved. Although it is preferable to reduce deer densities rapidly to maintenance levels during the first season, it is rarely possible and this preference should not prevent undertaking lethal deer management.

Continued monitoring and annual deer removal will be necessary to maintain deer densities within the goals of HFCA. Using population simulations, McDonald et al. (2007) demonstrated that a >30% overall harvest rate (i.e., irrespective of sex of deer) was necessary during the maintenance phase of a deer management program. In an historically low-density deer population that was further reduced by severe winter weather, Oyer and Porter (2004) observed reduced deer densities for ≥5 years. However, deer densities in areas adjacent to HFCA remained relatively higher during this study. In areas of high deer densities, Miller et al. (2010) found that deer abundance rebounded on sites where intensive removal of deer was applied within 3 years, due to population growth within the removal area and from encroachment by deer in adjacent areas. The presence of common predators of deer fawns probably will aid in maintaining reduced deer densities on HFCA. Vreeland et al. (2004) found that predation accounted for 38% of fawn mortality in a forested study area in Pennsylvania with the same complement of predators as HFCA.

Educating the residents of HFCA about deer will continue to be important, especially since they vote on an annual referendum to allow culling of deer. Broad support for deer management may be garnered by basing management decisions on science, openly discussing the issues, and illustrating how decisions are made (Mitchell et al. 1997). Kilpatrick and Walter (1997b) found that effectiveness of deer management was more important to the public than the cost of such actions. Green et al. (1997) recommended using public opinion surveys to gear educational efforts so that the public could make more informed decisions. When voting on deer management, residents are more likely to feel like true stakeholders and managers, and therefore will be more prone to feel some sense of responsibility for the results of the program.

Our study on HFCA demonstrates that chronically overpopulated white-tailed deer herds may be successfully reduced utilizing sharpshooting. Although our access was limited to a small proportion of the community, by using bait and carefully managing sharpshooting operations we were able to maintain a high level of efficiency. In high-density residential communities, especially where ricochet hazards are common (i.e., paved surfaces), sharpshooting by experienced professionals may be the most safe and effective method of reducing deer densities. Managers should plan to conduct annual maintenance removals of deer using sharpshooting and/or controlled sport hunting with archery equipment.

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