

**White-tailed Deer Management Plan
for Lower Merion Township,
Montgomery County, Pennsylvania**

Prepared by:

**U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services**

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BACKGROUND

Lower Merion Township (LMT) encompasses 23.64 square miles in Montgomery County, Pennsylvania. LMT is a first ring suburban community bordering the City of Philadelphia, and is also bounded by the Boroughs of Conshohocken and West Conshohocken, and the Townships of Upper Merion, Haverford, Radnor, and Philadelphia. According to U.S. Census data from 2010, the population of LMT was approximated at 57,825, and people inhabiting 22,868 housing units as of 2000. Single-family, detached homes numbered 13,691 or nearly 580 per square mile. LMT was categorized as the most populated and affluent municipality in Montgomery County. Public property in LMT totals approximately 665 acres.

With increased urbanization in recent decades, conflicts with white-tailed deer have risen substantially in southeastern Pennsylvania. During this time, residents of LMT have incurred estimated millions of dollars of damage from white-tailed deer as evidenced by high rates of deer-vehicle collisions (Figure 1), confirmed cases of Lyme disease (Figure 2), and complaints from residents regarding deer consumption of landscape plants. Few natural predators of deer remain in southeastern Pennsylvania; therefore most mortality of deer is from sport-hunting and through deer-vehicle collisions. Although sport-hunting has and continues to occur in LMT, deer find refuge on residential lots, commercial properties, and public parks where hunting is either not permitted by the landowner or is not legal due to safety zone restrictions (i.e., an archery hunter must be at least 50 yards from a building unless they obtain the permission of the occupants). With inadequate harvest, the deer population has become overabundant for the existing habitat conditions. Overabundant deer have devastated the forest understory through browsing, which has resulted in a park-like appearance in many areas of mature forest in LMT where little natural seedling regeneration exists within the reach of deer. Degradation of the native plants has allowed invasive exotic plants (e.g., English ivy, Chinese privet, bamboo) to proliferate with little competition for resources and innate resistance to deer browsing. Dense habitats are almost completely composed of invasive exotic plants. The limited forage remaining in natural habitats has caused deer to rely on additional sources of sustenance available in residential landscaping, thus causing deer-human conflicts.

Since at least the early 1990's, the government of LMT has been called upon by its residents to address deer-human conflicts. In 1991, LMT held a public hearing on issues associated with deer. Subsequently, from 1991 through 1994, an Ad-Hoc Deer Committee and a Citizens Task Force were established to explore the deer issue with the assistance of a hired natural resource consultant. Along with seven other townships in the region, LMT contracted with a company to conduct aerial counts of deer with infrared equipment. The results of these surveys suggested that the deer density within LMT was 32 deer per square, and was substantially less than all other townships surveyed. This estimate for LMT was seemingly low relative to the level of complaints from residents regarding deer. The low estimate of deer density was attributed to poor detection of deer by the infrared equipment because of the dense forest canopy that existed throughout

most of the township. In late 1994, at the recommendation of the Ad-Hoc Deer Committee, the LMT Board of Commissioners voted in favor of pursuing a deer

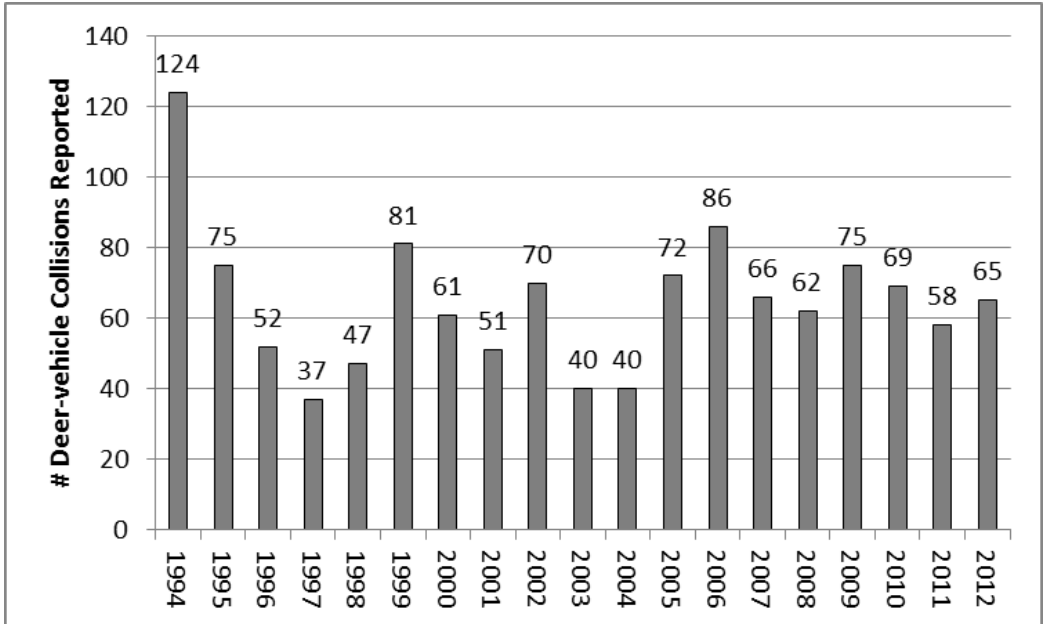


Figure 1. Incidence of deer-vehicle collisions occurring in Lower Merion Township, Montgomery County, PA as reported to Lower Merion Township Police Department from 1994 through 2012.

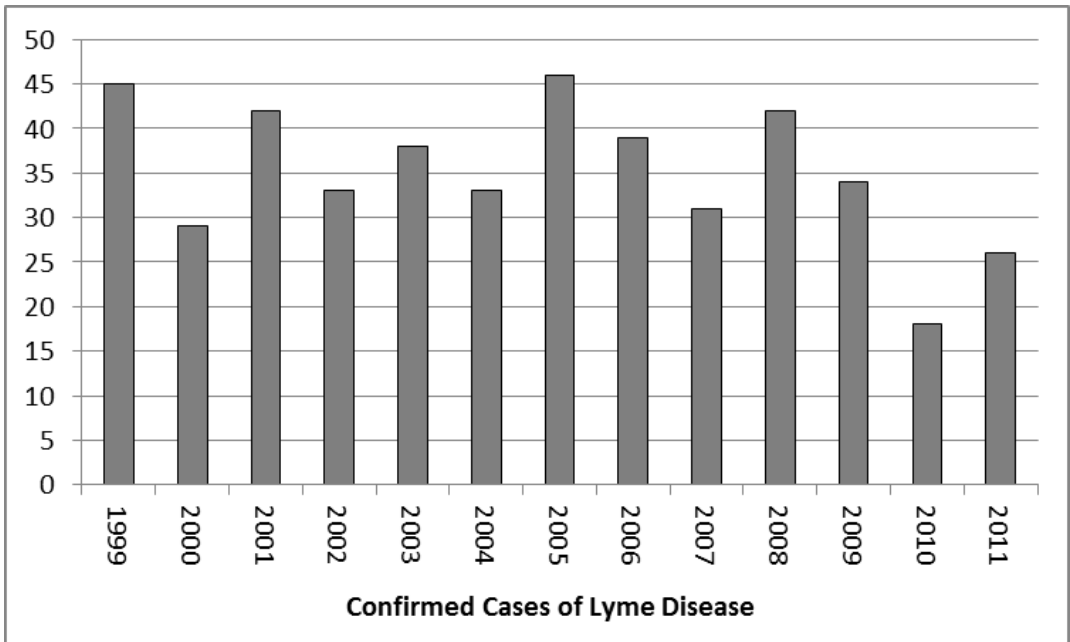


Figure 2. Confirmed cases of Lyme disease in Lower Merion Township, Montgomery County, PA from 1999 through 2011 as reported to Montgomery County Department of Health.

control permit to be issued by the Pennsylvania Game Commission for lethal reduction of the deer population through sharpshooting. However, such a deer removal effort was never undertaken.

In 1996, the LMT Police Department acted as a liaison between approved licensed bowhunters and residents to facilitate hunting on private property in order to better manage the deer population. During the same time, LMT entered into a partnership with the Riverbend Environmental Education Center to develop an educational pamphlet to address the issues concerning the deer population.

In 2005, LMT Police Department hosted a public meeting in the Township Administration Building to discuss the issues surrounding deer management. The meeting was attended by representatives of the Schuylkill Center for Environmental Education and the Pennsylvania Game Commission and was telecast live on Government Access Channel 7. During this public meeting a power point presentation was shown detailing the history of white-tailed deer and the associated health and environmental problems that occur when the deer population becomes excessive. Public questions and input were encouraged by the moderators during the meeting. At the conclusion of the meeting, Township officials expressed their commitment to continue to have an open dialogue with the public and to pursue solutions to the perceived deer problems.

In February 2008, LMT Police Department invited representatives of the U.S. Department of Agriculture Wildlife Services (WS) to participate in a meeting about resolving deer-human conflicts in LMT. Also in attendance at the meeting were a local conservation officer from the Pennsylvania Game Commission; representatives from Delaware Valley Wildlife Management, an archery hunting group; and an LMT citizen representative.

In August 2008, LMT requested the assistance of WS, and entered into a cooperative service agreement for WS to conduct deer density surveys and to develop a deer management plan. The management plan was finalized during February 2009. As a result of the plan and the recommendations contained therein, LMT requested assistance with professional deer removal and entered into a cooperative service agreement in the fall of 2009 with WS to conduct the removal operations.

The following includes the methods used by WS to assess deer densities, conduct professional deer removal, results, analysis, and recommendations for the continued management of deer damage according to the goals of LMT.

Deer Management Goals of Lower Merion Township

- 1). To protect the health and safety of its residents and visitors by minimizing deer-related accidents and the risk of Lyme disease.
- 2). To reduce the effects of deer browsing on natural habitats.
- 3). To reduce destruction of private property by deer including consumption of landscape plants and damage to fences and other structures.

Deer Management Actions of Lower Merion Township

- 1). Encourage continued sport hunting on properties where it is legal and safe to do so.
- 2). Discourage the feeding of deer on all properties within the township and recommend non-lethal management actions where feasible.
- 3). Conduct professional deer removal to augment hunting in the township to further reduce the deer population in effort to manage deer damage.

INTRODUCTION

History of White-tailed Deer in Southeastern Pennsylvania

It is estimated that white-tailed deer have been in existence for some 4.5 million years. Yet, with the exception of the Ice Ages, never before have deer populations seen such change in their habitat as those created by urbanization in the last several decades. Deer have adapted well to this change, and their numbers throughout the U.S. are estimated to be higher than at any other time in history. Today, the landscape of southeastern Pennsylvania presents an ideal combination of ample food resources, few natural predators, and sanctuary from hunting in close proximity to human development, which enables the deer population to grow overabundant.

Within the last 10,000 years, growth of white-tailed deer populations was controlled by predators including wolves, mountain lions, and bears; natural mortality such as starvation and disease; and harvest by Native Americans. Deer were also limited by the productivity of their habitat. Prior to European settlement, the majority of southeastern Pennsylvania was virgin forests with few openings to offer deer young nutritious vegetation.

Although it is difficult to determine at what densities deer historically occupied southeastern Pennsylvania, studies which have examined deer remains at Native American encampments suggest that deer densities were far lower than we see today—perhaps less than 10 deer per square mile. Even at presumably lower densities, deer were an important component of the Native American culture. Pennsylvania's founding father, William Penn, once noted that Native American men attained esteem among their tribesman "...by a good return of [deer] Skins...".

By the turn of the 20th century in Pennsylvania and throughout much of its range, the white-tailed deer was nearly driven to extinction primarily by unregulated market hunting and habitat loss via commercial logging. The reestablishment of white-tailed deer populations has been regarded as one of the greatest successes in the history of wildlife conservation. Deer are a key component of the ecosystem, and are valued by humans as an important big game animal hunted for recreation and a favorite of wildlife watchers.

Deer-human conflicts occur when overabundant deer threaten human livelihood, health and safety, property; and natural resources. These conflicts are common to communities throughout the whitetails range—especially along the eastern seaboard. Controversy often arises at the community level when lethal management is proposed to reduce deer densities and associated damage. However, in the absence of natural sources of mortality, communities have a responsibility to properly manage deer populations for the good of humans and deer alike.

The Pennsylvania Game Commission is the state agency responsible for the management of white-tailed deer as a game species, and sets all harvest guidelines for deer. Upon request, WS provides expertise in facilitating all phases of the management process to reduce deer-human conflicts.

General Deer Biology

White-tailed deer are found in a variety of habitats throughout most of the United States, Canada, Mexico, Central America and northern South America. Deer almost exclusively consume plants. They have a highly specialized four-chambered stomach, which allows them to digest a wide variety of plant species. Deer choose the most nutritious plants and plant parts available. Deer thrive in areas with young vegetation, especially where the edges of several habitat types converge, such as the suburban/agricultural interface.

Adult white-tailed deer weigh between 100 and 300 pounds with males being larger than females. Bucks produce their first set of antlers during their second year of life. Females do not grow antlers. The basic social group is the doe family unit including an adult doe, and her offspring. Outside of the breeding season, or rut, males may form groupings known as bachelor groups. In Pennsylvania, deer breed in the fall, and most fawns are born in late May and early June. Does generally produce one or two fawns each year. In ideal habitats, does may breed at approximately 6 months of age and some adult does may produce triplets.

Deer are crepuscular (primarily active near dawn and dusk), with their main movements occurring from daytime bedding areas to and from nighttime feeding locations. Bucks have larger home ranges than does, especially during the rut when bucks travel widely in search of mates. In Pennsylvania, deer home ranges average between 150 and 1,000 acres depending on the availability of local resources.

Winter months in Pennsylvania can be stressful for deer depending on the amount of snow fall, days with freezing temperatures, and availability of food (e.g., browse, mast crops, supplemental feeding, etc.) Deer populations are normally at their lowest just following the winter months, before birthing. The change in population size from year to year is defined as the growth rate, which is mainly driven by successful recruitment of young into the population.

Deer managers must balance the birth and death rates within a population to maintain herd health, reduce disease risks, protect ecosystems, and to reduce damage. In natural settings deer populations eventually reach the biological carrying capacity, which is the point at which deer consume most of the available browse in an area. At this point, the population is unable to sustain growth and reproduction. Each habitat has a different biological carrying capacity, which is continually dynamic in response to deer numbers, weather conditions, and other factors.

Although the biological carrying capacity is important to deer population dynamics, the social carrying capacity is more relevant in urban areas. The social carrying capacity is the level at which deer populations can coexist with the human population without negative impacts. Negative impacts on humans can include increased deer-vehicle collisions, deer damage to landscaping, biological damage, disease threats, and the emotional fear of interaction between the deer and humans. Deer populations can also experience negative impacts in urban settings including stress, trauma from encountering dogs, pools, large glass windows, vehicle traffic, and the lack of adequate habitat. Given these factors, the social carrying capacity may be lower or higher than the biological carrying capacity. It is important to understand that neither the biological or social carrying capacity is static.

Current Deer Management Conditions in Pennsylvania

Sport hunting is the primary mechanism to regulate deer numbers in Pennsylvania on an annual basis. The Pennsylvania Game Commission regulates deer harvest via prescription of licenses for harvest of antlerless deer per 22 different Wildlife Management Units (WMU). WMU's are based on land use/habitat, human density, public/private land ownership, and recognizable physical features. The Statewide goals established in the Pennsylvania Game Commission Deer Management Plan include: 1) manage deer for a healthy herd, 2) reduce deer-human conflicts, and 3) manage deer for healthy forest habitat. Allocations of antlerless deer licenses are determined annually to adjust deer densities relative to these goals within each WMU.

In hunting license year 2012-2013, an estimated total of 343,110 deer were harvested in Pennsylvania including 133,860 antlered deer and 209,250 antlerless deer. In WMU 5D, which includes Lower Merion Township, a relatively large number of antlerless deer licenses per square mile of land area are allocated versus other areas of the State to curtail population growth of deer and to reduce deer-human conflicts. For the 2012-2013 hunting license year, 19,000 antlerless deer licenses were allocated in WMU 5D and an estimated 5,100 deer were harvested including 1,300 antlered deer and 3,800 antlerless deer. Sport hunting for deer in WMU 5D occurred during 102 days from

September 2012 to January 2013, excluding Sundays and December 9-25. This allotment of licenses and days of hunting are similar annually in WMU 5D. Hunters are permitted one antlered deer per hunting license year. In WMU 5D, an individual hunter may harvest unlimited antlerless deer provided they possess the appropriate number of valid WMU-specific antlerless licenses. Deer harvest is not reported at the township level; however, hunting does occur in Lower Merion Township. Every deer harvested legally by sport-hunters is important to reducing deer overabundance and the damages associated with deer.

Because of dense human housing and development, sport hunters in Montgomery County are not permitted to discharge high-powered rifles and may only use shotguns or archery equipment to harvest deer. Without specific permission of the occupants, hunters must be a minimum of 50 yards from any occupied residence or building to hunt with archery equipment (herein, 50-yard safety zone). Around playgrounds, schools, nursery schools or day-care centers, archery hunters must remain a minimum of 150 yards away (herein, 150-yard safety zone). When using a shotgun, hunters must be a minimum of 150 yards from any occupied residence or building without the specific permission of the occupants (herein, 150-yard safety zone). Hunters also must be 25 yards from the traveled portion of public roads. Although hunters are afforded liberal seasons and bag limits for deer in Montgomery County, harvest of sufficient numbers of deer is confounded by firearms and safety zone restrictions coupled with extensive division of property ownership.

An Integrated Approach to Managing Damage by Deer

A well-designed deer damage management program is a progressive approach to wildlife management, which includes developing beneficial relationships among the public, landowners, hunters, and wildlife professionals to reduce and maintain deer densities at desirable levels; education about wildlife conservation and deer damage management; implementation of non-lethal deer damage management techniques where practical—fencing, repellents, deterrents; and monitoring the impacts of deer on the environment.

WS recommends that our cooperators adopt an integrated approach to managing damage by white-tailed deer. WS provides Federal leadership in the deer management process by conducting personal consultations with individuals and communities, educational programs, assessments of damage by deer, and direct management in the removal of overabundant deer. The following are the components of the integrated approach to deer damage management.

Define Goals.—Those seeking to make deer damage management decisions involve representatives of all stakeholder groups with an interest in managing deer in the target area. Providing education on basic deer biology and damage management techniques is integral to the process, so that stakeholders may make informed decisions. Goals should define acceptable levels of damage by deer, which minimize deer-human conflicts.

Identify the Problem. Stakeholder groups obtain information on the impacts of deer damage such as deer-vehicle accident records, rates of Lyme disease, and estimates of damage to landscape and commercial plants. Establishing the extent and timing of how deer may be impacting the target area is the first step towards identifying whether a problem exists with deer.

Establish Monitoring. Information collected during the problem identification phase may be used as baseline data for long-term indices relative to goals of the program and as the basis for making management decisions. Estimates of deer abundance are necessary to assess the effects of any management actions relative to the program goals. WS specializes in conducting deer density surveys using a variety of techniques tailored to individual situations.

Develop a Management Plan. A deer damage management plan documents clearly defined program goals, identifies the level of damage caused by deer based on the supporting evidence collected, and should propose management actions to achieve the program goals. Effective management plans must allow for the flexibility to adapt future management actions based on data collected during continued monitoring.

Since the 1990's, LMT has implemented most steps of the integrated approach to deer management, particularly in garnering public input and involving and educating all involved stakeholder groups. LMT has done an outstanding job of recording deer-related accidents to support the necessary monitoring. LMT has also proactively developed relationships between hunters and landowners to increase deer harvest in line with their deer management goals. The process that this management plan represents is a continued commitment by LMT to protect the interests of its citizens. During 2008, LMT evaluated the following options for deer damage management.

Options for Management

No Action. The “no action” alternative is appropriate if monitoring indicates that current management practices are maintaining deer densities in balance with program goals. For example, on some public lands this means allowing the deer population to grow unrestricted. Often, deer numbers grow above levels which the habitat can support and above that which humans are willing to tolerate. In urban situations, deer densities may be maintained by a high rate of deer-vehicle collisions. In extreme cases, mortality may occur in the form of starvation. Alternatively, the “no action” alternative often means that sport hunting continues as the established management practice because hunters are achieving adequate harvests to meet program goals.

Non-lethal Damage Management. A myriad of non-lethal deer damage management techniques are available, and fall under three general categories: exclusion, deterrents, and repellents. Research has demonstrated that some practices are effective while others appear to be marketing ploys. Properly installed and maintained fencing 10 feet in height and secured to the ground is the most effective exclusion tactic. Fencing can be cost prohibitive for large acreages, and many communities have ordinances limiting the use or height of fences. However, fencing used to protect young plant growth

can be beneficial in deterring deer browsing until plants are no longer vulnerable. Deterrents use sound, visual, or tactile cues to frighten deer from areas where they are causing damage. Deterrents which are set off by the offending deer or those with irregular cues tend to be most effective since deer may easily become acclimated to deterrents. Repellents use taste or scent to discourage deer from eating treated plants or entering treated areas. A wide variety of commercially available repellents have been reported to be effective in independent research. Repellents require reapplication after rain events and may lose effectiveness at temperatures below freezing.

Population Management. When deer become overabundant, a rapid reduction in deer density is necessary to suppress annual population growth and to reduce damages. Once management goals are reached, annual deer harvests must be conducted to maintain acceptable population levels. The methods used to remove deer will depend on safety, legal restrictions, financial constraints, timing of the management action, and effectiveness of the removal methods employed. In many deer management situations, using a combination of deer removal methods is necessary to achieve management goals.

Population Management Alternatives

Sport Hunting. Sport hunting should be encouraged whenever safe and legal to do so, as it is generally the most economically feasible strategy to manage deer. However, legal restrictions (e.g., safety zones, timing of hunting activity) and other limitations (e.g., hunters resistant to harvesting adequate numbers of does) may limit the effectiveness of sport hunting in some situations. In recent years, the Pennsylvania Game Commission has provided for additional deer to be taken through extended seasons, and increases of antlerless licenses in urban centers, and has provided for additional deer harvest opportunities under depredation permits outside of the normal hunting seasons.

Controlled Hunts. Controlled hunts using sport hunters can be structured to maximize deer removal efforts. Stipulations may include designated dates and times of hunts, weapon restrictions, and safety certification of hunters. By concentrating hunting pressure during specific times, controlled public hunts usually increase deer harvest and require less time than normal sport hunting.

Professional Deer Removal. In instances where sport hunting is not practical or effective, deer removal may be conducted under a deer control permit by WS, private contractors, or other agents of the cooperator. Professional deer removal operators are permitted to use specialized equipment and methods such as high-powered rifles fitted with suppressors to minimize noise; infrared and night vision technologies for identification of safe shooting opportunities and to increase the ability to locate deer; baiting; and shooting at night, from vehicles, and in close proximity to buildings. Deer harvested by professional operators provide venison for charitable donation. Professional deer removal usually requires the least amount of time versus other methods to reach population goals.

Relocation. Capturing deer and relocating them to another location is not an option in Pennsylvania because this practice is not legal. The Pennsylvania Game

Commission does not recognize trap and transfer of deer as a viable alternative for localized population reduction and prohibits trap and transfer of deer to prevent the spread of disease (personal communication, Christopher Rosenberry, Deer and Elk Section Supervisor, Pennsylvania Game Commission). Legal considerations notwithstanding, trap and transfer of deer is expensive, ideal relocation sites are limited, and relocated deer suffer greater than 50% mortality due to stress.

Fertility Control. WS is conducting ongoing research through its National Wildlife Research Center in the development of a fertility control agent to limit deer population growth. To date, tests of fertility control in deer populations in fenced enclosures have demonstrated limited effectiveness. Currently, no fertility control agents for use in white-tailed deer have been registered for use in Pennsylvania. If registered, future use of fertility control will have limited applicability, especially for large populations of free-ranging deer. Implementation of a fertility control program would be costly and herd reductions would still be necessary to reduce damage since fertility control does not directly reduce deer numbers.

METHODS

Establishing regular monitoring of the deer population was an important initial step toward long-term management. The highly fragmented habitat of LMT, especially dense residential housing with many property fences and walls provided a challenging arena for assessing the abundance of deer. Such objects act as obstacles to even the most sophisticated imaging equipment. Two survey methods were chosen in 2008 to most accurately evaluate the abundance of deer in LMT: 1) a roving infrared camera survey from a vehicle (herein, roving survey), and 2) baited infrared camera stations (herein, baited survey). The roving survey was replicated in 2012 to monitor changes in deer abundance from 2008. LMT requested assistance with professional deer removal as a result of the surveys conducted in 2008 and the subsequent recommendations initially contained in the deer management plan. WS instituted professional deer removal in the fall of 2009 and was requested to continue those operations on a yearly basis through the fall/winter of 2012-13.

Roving Surveys

The roving surveys in 2008 were conducted by establishing an evenly distributed 29-mile survey route throughout LMT on public roadways (Figure 3). In establishing the roving survey route, WS conducted several site visits to LMT and consulted with LMT Police Department and LMT Animal Control. The placement of the roving survey route considered factors including, but not limited to: 1) even distribution throughout the majority of habitat types in LMT, 2) a minimum of one-half mile between segments of the survey route to avoid counting the same deer multiple times in an individual survey, 3) minimization of obstacles prohibiting adequate surveillance of the habitat, and 4) traffic patterns to protect the safety of the survey crew.

Roving survey teams consisted of a driver/data recorder, and one observer in the back of a mobile truck. Roving surveys were initiated each night after 10:00 PM and

concluded the following morning by 5:00 AM. Deer observations were conducted utilizing Forward Looking Infrared (FLIR) units, spotlights and binoculars. Observers recorded number of deer, deer locations (referenced by grid quadrant); distance deer were from the closest point on the survey route, time, gender, and age class. The survey vehicle moved at approximately 10 miles per hour, stopping only to accurately record data or for traffic considerations.

Survey data was entered into a deer density estimator that determines area surveyed by factoring the survey route distance and the distance deer were observed from the closest point on the survey route. The estimator then calculated average observation distances, area surveyed (square miles), and deer density estimates (deer per square mile).

Additional surveys conducted in 2012 to monitor changes in deer abundance from 2008 followed the same survey route and protocol as described above.

Baited Surveys

Baited surveys were conducted in 2008 only to obtain finer estimates of the number of deer utilizing key open spaces in LMT. This method was conducted according to previous research by Jacobson et al. (1997). These researchers demonstrated that the abundance of deer in an area could be determined using baited surveys, where bucks could be uniquely identified by antler characteristics (Figures 4, 5) and their number used to infer the number of does and fawns (Figure 6) visiting repeatedly the bait site.

Due to financial and logistical constraints only three areas were surveyed in this manner: two open spaces owned by LMT, Kenealy Park and Rolling Hill Park, and one large privately owned parcel (herein, Private Land A). These properties were selected for baited surveys because future access for surveying deer abundance was likely and the large size and habitat features of each property increased the likelihood that the property would act as a reliable sentinel to gauge deer abundance across LMT as a whole.

On each property, one site was selected for placement of a bait station and an infrared camera. Criteria for the bait sites included: 1) regular utilization of the area by deer before bait was placed, and 2) uncommon use by humans to avoid theft or vandalism of equipment, and to avoid disturbance of deer. During a 7-day pre-baiting period, whole kernel corn was placed at each bait site in a quantity sufficient to maintain consistent access by deer 24 hours a day. Following this acclimatization period, an infrared camera was installed in a stationary position and was set to record still photographs of deer 24 hours a day during a 14-day survey period. As in the pre-baiting period, whole kernel corn was provided ad libitum. The infrared cameras were triggered to photograph by movement and/or changes in heat within a sensing cone, which was 50-feet long and 30-feet wide at the placement of the bait station.

A WS wildlife biologist analyzed photographs from each camera to ascertain the number of deer by age and gender. Photographs selected for analysis were taken at least 10 minutes apart during the 14-day survey period. When possible, adult bucks were identified separately by their antler characteristics.

To establish an estimator of deer abundance the following analysis was conducted. The number of bucks uniquely identified was divided by the total number of bucks photographed to calculate a *population factor*. Jacobson et al. (1997) established *extrapolation factors* for baited cameras set to service particular land areas during differing survey lengths. The extrapolation factor adjusts the estimator to account for the percentage of the total deer population likely to be photographed at the bait site during the survey. For the sizes of the properties surveyed over a 14-day period in this LMT study, the extrapolation factor used assumed that 70% of the total deer population in the area of the bait sites was photographed. The estimate of the total number of bucks was calculated by multiplying the total number of bucks times the extrapolation factor. The total number of does was calculated by multiplying the number of does counted in the photographs times the population factor, and times the extrapolation factor. The total number of fawns was calculated by multiplying the number of fawns counted in the photographs times the population factor, and times the extrapolation factor. The total deer abundance in the area of each bait site was calculated by adding the total number of bucks, the total number of does, and the total number of fawns.

Professional Deer Removal

In cooperation with WS, LMT actively engaged in communications with property owners that had previously reported high levels of deer damage, and property owners in and around areas with high rates of deer vehicle collisions, to discuss the implementation of professional deer removal. Professional deer removal, and its success on a township wide basis, depends on the number of property owners enlisted into the program and the size and habitat characteristics of each respective property. LMT was, and continues to be, successful in acquiring additional properties for professional deer removal. Professional deer removal activities were initially conducted in 2009, and have been conducted yearly through the winter of 2012-13.

Professional deer removal conducted by WS is a specialized management tool that differs from sport hunting because deer may be removed throughout the year at any time of day or night using specialized equipment. All deer removal operations consisted of a mobile unit of three personnel including a vehicle operator; a spotter operating a Forward Looking Infrared camera and a spotlight to locate deer and safe shooting opportunities; and a shooter. Shooting was conducted from the vehicle using suppressed rifles firing frangible bullets, which fragment upon expansion to reduce pass-through.

The mobile unit actively observed for deer on properties enrolled into the program while driving planned routes on up to six nights per year. Deer were removed on a first opportunity basis provided safe shots could be taken. Adult does were targeted first when more than one deer was observed in a safe shooting location. Properties enrolled into the program that contained minimal safe shooting areas had bait applied to concentrate deer in safe shooting areas during active operational periods.

WS collected data on deer that were removed including gender, age, tail fat, the number of PGC tag affixed to the carcass, location of removal, and time of removal. Age was evaluated by tooth wear and replacement. Additionally, LMT defined deer

management areas in 2010 to facilitate ease of reporting. The deer management area was recorded as well for each deer removed.

RESULTS

Roving Surveys

Three separate roving surveys were conducted in 2008 along the same survey route to obtain an average estimate of deer density in LMT (Table 1, Figure 4). The average deer density estimate for LMT based on the three initial roving surveys was 58 deer per square mile. The variability of estimates of deer density on different nights of survey was typical of the technique. These data suggest with 95% statistical confidence that deer densities throughout LMT were between 41 deer per square mile and 74 deer per square mile.

Three separate roving surveys were conducted in October 2012, during the nights of October 24-26, along the same survey route to obtain an average estimate of deer density in LMT (Table 1, Figure 4a) to monitor changes in density from 2008. A total of 179 deer observations were made during the surveys with 56 deer observed on October 24, 74 observed on October 25, and 49 observed on October 26. Deer observed averaged 58 yards from the survey route. The average deer density observed for LMT during 2012 was 40.5 deer per square mile (standard deviation = 8.7) or 958 deer in the Township. These data suggest with 95% statistical confidence, the deer population was between 723 and 1,188 deer at the time of surveys in 2012.

Individual surveys are snapshots of the deer herd on one particular night with many factors affecting deer observations. Weather conditions, seasonal movements, and hunting pressure can increase or decrease deer observations on any one night. These data represent indices more than actual densities or population estimates. Trends in deer density indices may be used over time to assess damage by deer relative to changing deer densities, which may be especially useful if a deer population management action is initiated.

Table 1. Summary of white-tailed deer density surveys completed by USDA APHIS Wildlife Services in Lower Merion Township, Montgomery County, PA during November and December 2008, and in October 2012. Data presented are the averages of surveys for each respective time period.

Date of survey	# deer observed	Average distance (yards)	Deer density estimate (deer/square mile)
2008	63	46	58
2012	50	58	40.5

Baited Surveys

The pre-baiting period for the baited infrared camera surveys was started on 19 November 2008. Infrared cameras were installed and the survey period began on 25 November 2008. The baited surveys were concluded on 09 December 2008. One additional survey location was established on Mill Creek Park, however the camera malfunctioned and data were not usable. Deer acclimated well to the bait sites and were photographed throughout the day and night. However, the majority of photographs were recorded near dawn and dusk, which is consistent with normal peaks in activity for deer.

Table 2. Data collected by USDA APHIS Wildlife Services during baited infrared camera surveys to estimate white-tailed deer abundance on two open space public properties and one private property in Lower Merion Township, Montgomery County, PA during November and December 2008.

Survey location	Total photos with deer	# unique bucks	# buck photos	# doe photos	# fawn photos
Kenealy Park	1,046	10	156	209	155
Rolling Hill Park	525	8	112	118	91
Private Land A	1,644	11	171	194	173

Table 3. Estimates of deer abundance via baited infrared camera surveys conducted by USDA APHIS Wildlife Services on two open space public properties and one private property in Lower Merion Township, Montgomery County, PA during November and December 2008.

Survey location	# bucks	# does	# fawns	Total # deer
Kenealy Park	14	19	14	47
Rolling Hill Park	11	12	9	32
Private Land A	16	20	18	54

Home ranges of female white-tailed deer may vary in different habitats, latitudes, and deer population densities (Appendix B). However, data from previous studies suggested that home ranges for female white-tailed deer in suburban habitats range between approximately 50-1,974 acres with most averaging less than 640 acres (1 square mile). In general, the home ranges of adult males are twice that of adult females. Baited surveys are designed to develop an index of deer abundance for a particular area rather than a deer density or exact population estimate. However, given knowledge of the home range size of deer in suburban habitats and the capability of the baited survey technique for capturing by photograph a high percentage of deer in an area, it is likely that these

estimates of deer abundance approximate deer density per square mile. Therefore, the average deer density estimate by the baited survey method was 44 deer per square mile (variability = plus or minus 13 deer per square mile), which corresponds with estimates determined by the roving survey method. Baited camera surveys were not conducted again in 2012 as a result of the similarities of results in both methods in 2008.

Professional Deer Removal

Commencement of professional deer removal varied by year dependent on factors of availability for the WS team members and LMT officials that assisted with the operation. Removal operations were conducted on 36 properties in 2009, 65 in 2010, 69 in 2011, and 76 properties in the fall/winter of 2012-13. All properties included in the program were categorized into management areas for reporting purposes (Figure 8). A total of 387 deer have been removed from LMT with an average of 96.75 deer removed per year from 2009 through 2012-13, with a high of 126 in 2010 and a low of 42 in 2011 (Table 4 and 5, Figure 8). Female deer were targeted first when multiple deer were observed. Since 2009, 63% of deer removed were female, including fawns (Table 4). The sex of a deer at or above the age of 1.5 years is easily distinguished from the antler growth in males. Of the deer removed that were aged at 1.5 or older, 80.6% were female deer.

Table 4. Age and sex of white-tailed deer removed by USDA APHIS Wildlife Services during professional deer removal efforts in Lower Merion Township, Montgomery County, PA during 2009 through the winter of 2013.

Age/Sex	Year				Totals	
	2009	2010 ¹	2011	2012-13	Cumulative	Percent
0.5	67	55	19	45	186	48.06%
Female	26	28	9	18	81	20.93%
Male	41	27	10	27	105	27.13%
1.5	13	26	6	18	63	16.28%
Female	13	16	2	7	38	9.82%
Male		10	4	11	25	6.46%
2.5 +	39	45	17	37	138	35.66%
Female	39	42	12	31	124	32.04%
Male		3	5	6	14	3.62%
Total Female	78	86	23	56	243	62.79%
% Female	65.5%	68.3%	54.8%	56.0%	-	-
Total Male	41	40	19	44	144	37.21%
% Male	34.5%	31.7%	45.2%	44.0%	-	-
Yearly Total	119	126	42	100	387	100.00%

¹One additional deer was donated, as a result of a road kill, and recorded in Lower Merion Township and Pennsylvania Game Commission deer take totals.

Table 5. Number of white-tailed deer removed by USDA APHIS Wildlife Services during professional deer removal efforts in Lower Merion Township, Montgomery County, PA during 2009 through the winter of 2013.

Deer Management Area	2009	2010¹	2011	2012-13	Total
1	47	53	13	34	147
2	18	7	2	5	33
3	11	18	2	14	45
4	10	2	5	14	31
5	20	21	9	13	63
6	3	8	7	17	35
7	10	17	4	3	33
Total	119	126	42	100	387

¹One additional deer was donated, as a result of a road kill, and recorded in Lower Merion Township and Pennsylvania Game Commission deer take totals.

DISCUSSION

The deer densities derived during the study in 2008 and again in 2012 may be considered a conservative estimate of the LMT deer population since sport hunting for deer had occurred by the conclusion of the surveys and deer-vehicle collisions had already occurred for the during the respective calendar years. Despite this, deer density estimates for LMT were a minimum 4 times greater in 2012 than recommendations by WS for minimization of deer-human conflicts in suburban habitats (10 deer per square mile). Likewise, the density of deer observed in LMT was high relative to deer densities recommended for maintaining plant diversity in forested areas (6 deer per square mile, Alverson et al. 1988). The deer density average estimate in 2012 showed a decrease of 30.17% from estimates in 2008, a reduction in density of approximately 7.5% per year. This decrease is likely due to the institution of the deer management plan and chosen actions. The pre-fawning, post removal deer density in the spring of 2013 would be approximately 33.5 deer per square mile

In the absence of continued professional deer removal, the population of deer in LMT is likely in a state of slow population increase or a state of annual maintenance by the limited harvest by sport hunters and mortality via deer-vehicle collisions. The yearly rate of deer-related accidents and complaints reported by LMT Police Department has remained consistent over the last 15 years, and may be used as an index in the absence of deer abundance estimates previous to this study. This corroborates that the deer population is not in a state of decrease.

A true estimate of deer harvested by annual sport hunting is not available. Although hunters are required by law to report all deer they harvest, the reporting rate is too low for deer harvest estimates to be provided on the township level by the Pennsylvania Game Commission (personal communication, Deer Management Coordinator Dr. Christopher Rosenberry). Rather, the Pennsylvania Game Commission manages deer on a more regional scale of the Wildlife Management Unit. Much of the annual deer population in LMT likely remains unharvested by sport hunting due to the constraints of regulations and access to private property that hunters face. The conditions for increasing deer harvest through sport hunting may not improve. The safety zone requirements are not likely to be relaxed further. Also, deer harvested by archery equipment typically run greater than 100 feet from where they are shot, which presents further complications for recovering harvested deer when hunters have limited permission to trespass on adjacent properties. Alternative deer reduction strategies should be continued, including increased promotion of hunting to the non-hunting public to allow hunters access to more urbanized areas. Positive relationships among hunters and landowners fosters an environment in which deer are harvested free of charge in a manner which can be mutually beneficial to the hunter and landowner. However, landowners must look critically at the hunting that takes place on their property and in the surrounding area. Are hunters harvesting enough female deer? Do your neighbors allow hunting? Landowners should establish open communication with the hunters that use their land, and talk with their neighbors about how they might consider allowing hunting

if they do not already. Landowners may request that WS or the Pennsylvania Game Commission participates in this process by consulting with the hunters on their property and their neighbors to improve the management of deer in their local area.

RECCOMENDATIONS

To continually progress towards reduction of deer-human conflicts, deer densities in LMT must be reduced to a point where acceptable levels of damage by deer are aligned with the desire of society to appreciate deer in a natural state and in balance with their habitat. For suburban habitats such as LMT, deer densities less than 10 deer per square mile are appropriate. But, reducing deer densities to such a low level is difficult when the majority of the land area is composed of low-acreage private parcels. Once a balance is achieved, the deer population must be maintained through persistent annual harvest by professional deer removal and continued sport hunting where safe and legal.

The methods by which the deer population is reduced and maintained are at the discretion of LMT within the guidelines set forth by the Pennsylvania Game Commission. Desirable conditions resulting from such lowered deer densities would likely include: 1) a healthy deer population well below biological carrying capacity, 2) a reduction in deer-vehicle collisions and other human health and safety risks (e.g., Lyme disease), 3) reduced damage to native vegetation and landscape plants, and 4) continued participation by sport hunters to help maintain the desired deer population level. Deer population densities relative to the goals of LMT (i.e. reduced deer-vehicle collision rate, successful forest regeneration) should continue to be monitored. Deer density goals should be further reduced if these goals are not satisfied.

In addition to promoting hunting on private property, LMT has the ability to acutely implement deer management actions on public property where hunting has been prohibited. The majority of public land in LMT lies in the northern portion of the township where housing density is less and deer densities were observed to be greatest. Public property, approximately 665 acres, is minimal compared to LMT as a whole. However, the interspersed nature of multiple public properties across a relatively wide geographic scale could have a positive wide-ranging effect if deer population management is continued on these parcels. To maximize the effects of reducing deer densities across as large an area as possible (i.e., deer utilize habitat adjacent to public land), deer should be continually managed on public lands. Further justification for reduction of deer on public lands is demonstrated by public forests being some of the most highly afflicted natural habitats in LMT due to deer browsing. While not a complete remedy for problems with overabundant deer, administering deer management actions on public land demonstrates to its residents that LMT is committed to taking necessary steps to benefit the public good, the deer resource itself, and other native wildlife and plants.

As professional deer removal continues on private properties that have been enrolled in the program for multiple years, the number and density of deer found on those properties decreases. Those actions benefit the property owner and surrounding

properties by reducing local damages to property, the potential for vehicle collisions and Lyme disease within the immediate area, and reduce the deer density estimate when estimated on a township wide basis. LMT must continue to seek out and enroll additional properties on a yearly basis as it has done over the past four years to see continued success with overall reduction of damages throughout the township. In addition, if LMT desired to decrease the timeframe to obtain their damage management goals, or to further increase the benefits observed, LMT could add more unit nights per operational year. More unit nights and additional properties would further decrease the density each year and obtain management goals in a more rapid manner.

WS recommends deer density roving surveys, as outlined in this plan, be conducted on an annual basis prior to scheduling professional deer removal. The surveys can function as a baseline for monitoring deer populations in the township in addition to deer vehicle collisions and known cases of Lyme disease. The results of the survey can, and should, be used to determine the level of removal needed to work towards deer management goals for inclusion on the application for the municipal deer control permit issued by the Pennsylvania Game Commission.

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Figure 3. Route of roving vehicle used for three white-tailed deer density surveys completed by USDA APHIS Wildlife Services in Lower Merion Township, Montgomery County, PA during November and December 2008, and October 2012.

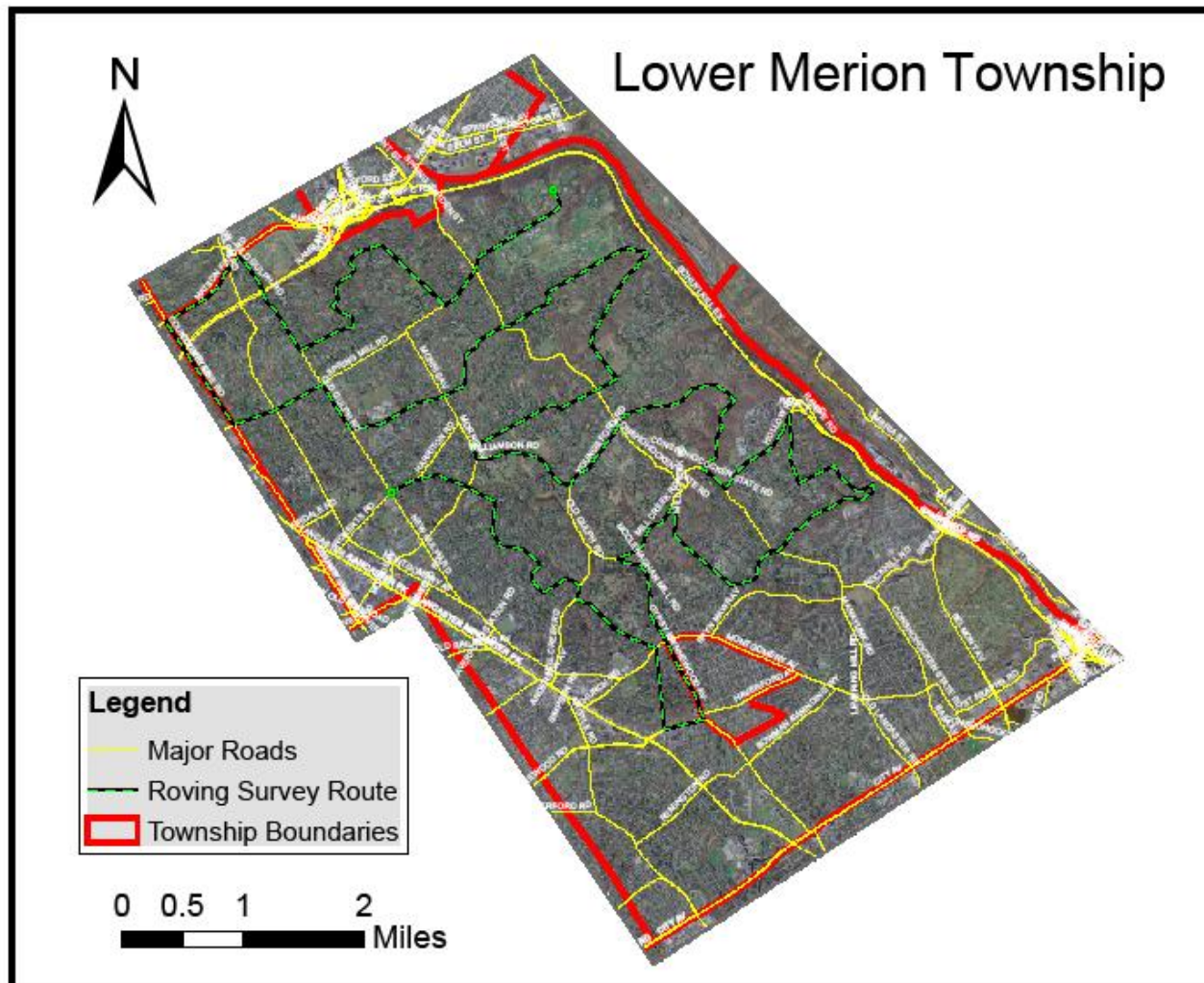


Figure 4. Total number of deer observed in 1-square mile area quadrants (numbers within grids) during three white-tailed deer density surveys completed by USDA APHIS Wildlife Services in Lower Merion Township, Montgomery County, PA during November and December 2008.

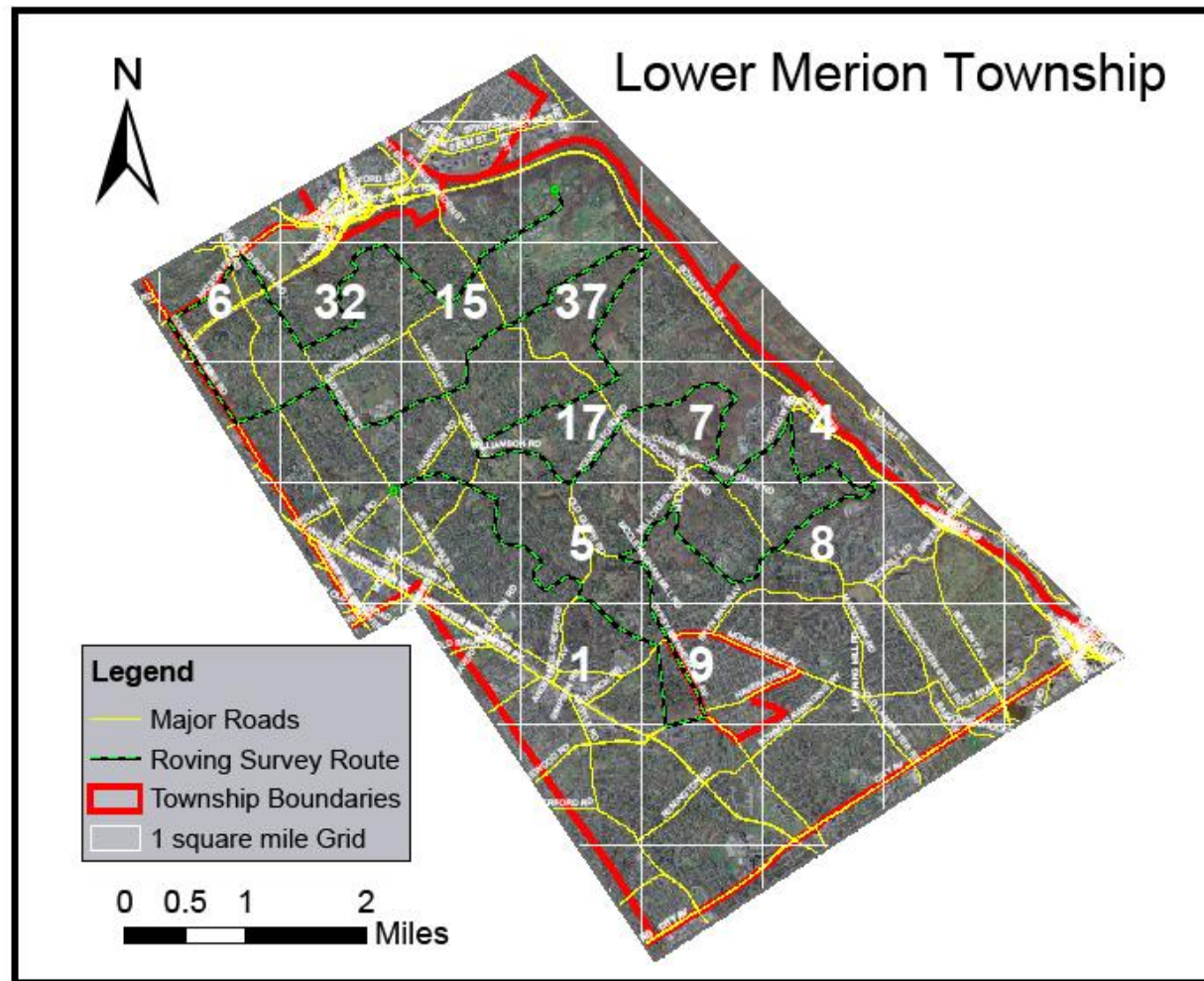


Figure 4a. Total number of deer observed in 1-square mile area quadrants (numbers within grids) during three white-tailed deer density surveys completed by USDA APHIS Wildlife Services in Lower Merion Township, Montgomery County, PA during October 2012.

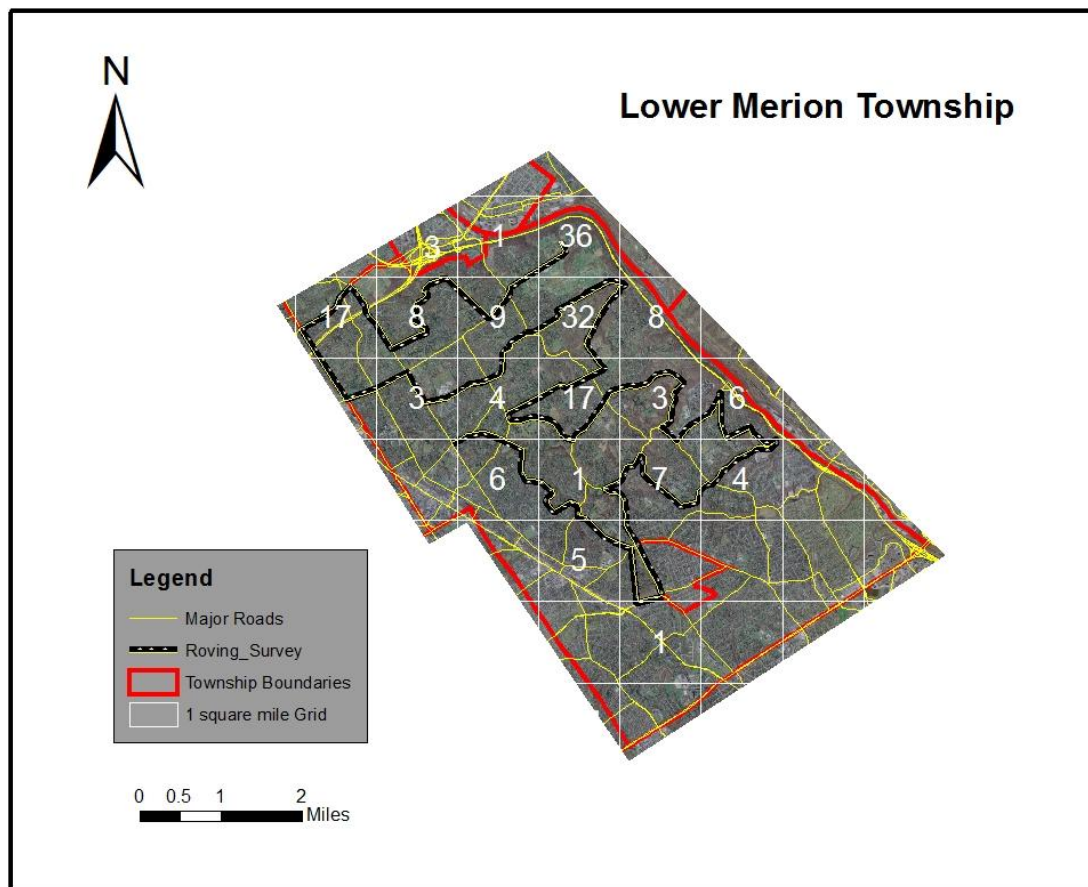


Figure 5. Photograph of a uniquely antlered buck captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on two open space public properties and one private property in Lower Merion Township, Montgomery County, PA during November and December 2008.



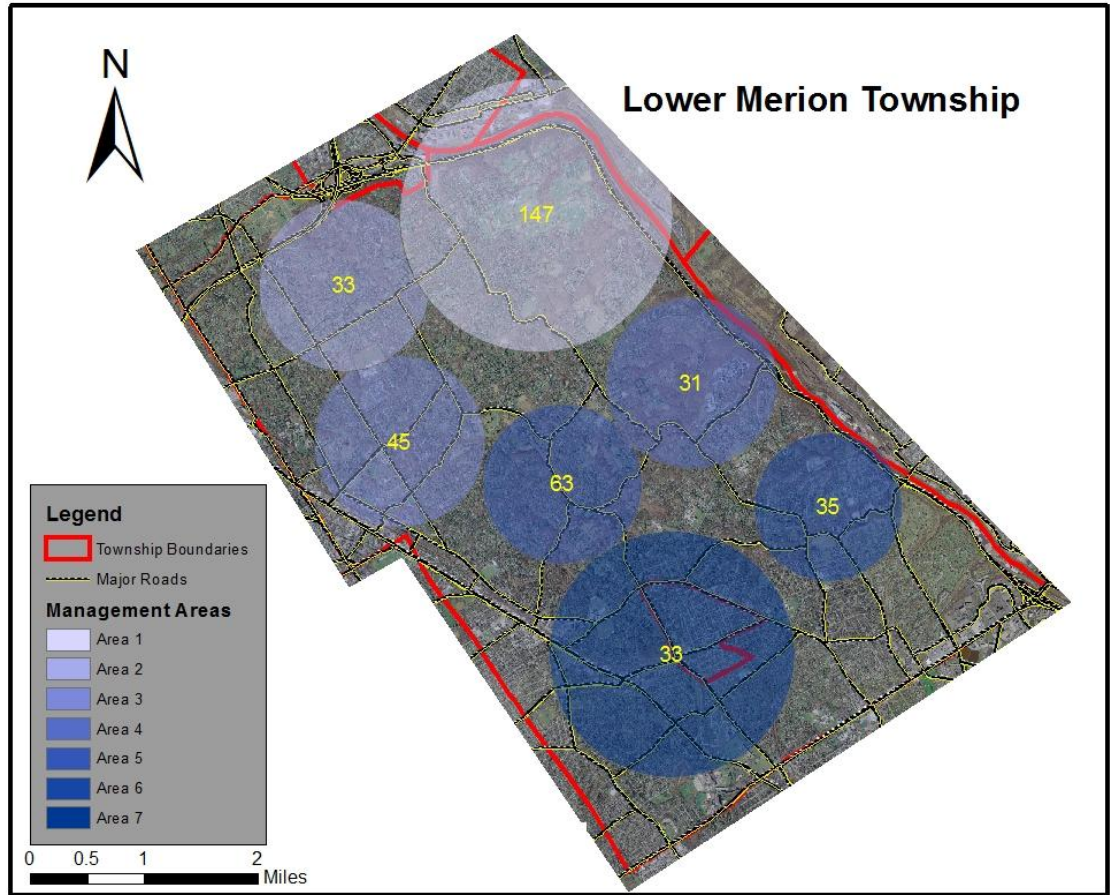
Figure 6. Photograph of two uniquely antlered bucks captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on two open space public properties and one private property in Lower Merion Township, Montgomery County, PA during November and December 2008.



Figure 7. Photograph of two adult does and four fawns captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on two open space public properties and one private property in Lower Merion Township, Montgomery County, PA during November and December 2008.



Figure 8. Deer management areas used to assign enrolled properties under for reporting purposes. Included in the figure are the number of deer removed (yellow text) within each area during professional deer removal conducted in Lower Merion Township, Montgomery County, PA during 2009 through the winter of 2013.



Appendix A. Summary table derived from studies which examined effort required to remove white-tailed deer by various methods.

Deer Removal Method	Hours per deer removed
Sharpshooting from stands over bait ^a	4.1
Sharpshooting from stands over bait ^b	2.2
Sharpshooting from vehicles at night ^a	1.1
Sharpshooting from stands over bait and Sharpshooting from vehicles at night- simultaneous effort in same area ^c	1.2
Opportunistic sharpshooting by conservation officers on patrol ^b	5.1
Controlled archery hunt ^d	97.3
Archery hunting during combined shotgun-archery controlled hunt ^e	38.0
Shotgun hunting during combined shotgun- archery controlled hunt ^e	23.5
Controlled shotgun hunt ^b	33.7
Controlled hunt with assigned stands (weapons not specified-probably shotguns with slugs) ^f	6.8

^a Butfiloski, J. W., D. I. Hall, D. H. Hoffman, and D. L. Forster. 1999. White-tailed deer management in a coastal Georgia residential community. *Wildlife Society Bulletin* 25:491-495. Note: Data averaged for 3 years of study.

Appendix A. Continued.

- ^b Doerr, M. L., J. B. McAninch, and E. P. Wiggers. 2001. Comparison of 4 methods to reduce white-tailed deer abundance in an urban community. *Wildlife Society Bulletin* 29:1105-1113. Note: Data averaged for 3 years of study. Sharpshooting from a stand over bait includes sharpshooting effort by police and park rangers.
- ^c DeNicola, A. J., S. J. Weber, C. A. Bridges, and J. L. Stokes. 1997. Nontraditional techniques for management of overabundant deer populations. *Wildlife Society Bulletin* 25:496-499.
- ^d Kilpatrick, H. J., and W. D. Walter. 1999. A controlled archery deer hunt in a residential community: cost, effectiveness, and deer recovery rates. Note: Based on total effort of 1,848 person-hours by archery hunters and 19 deer recovered.
- ^e Kilpatrick, H. J., A. M. LaBonte, and J. T. Seymour. 2002. A shotgun-archery hunt in a residential community: evaluation of hunt strategies and effectiveness. *Wildlife Society Bulletin* 30:478-486. Note: Actual hours hunted per day were not reported. Data presented were based on assumption of 5 hours hunted per individual hunter per day.
- ^f Kilpatrick, H. J., S. M. Spohr, and G. G. Chasko. 1997. A controlled deer hunt on a state-owned coastal reserve in Connecticut: controversies, strategies, and results. *Wildlife Society Bulletin* 25:451-456.

Please note: All estimates of effort for deer control methods do not include time for planning, law enforcement, or venison processing. This compilation represents studies of deer herds with differing densities and management histories in a variety of habitats and hunt structures.

Appendix B. Spatial dynamics of white-tailed deer in suburban habitats.

Foreword on Deer Spatial Dynamics:

Data on the spatial dynamics of suburban white-tailed deer are limited by individual study design. The information presented below represents a compilation from the primary literature. Data collection, ages of deer studied, and methods of home range size calculation differed among studies. Also, home ranges of female white-tailed deer may vary in different habitats, latitudes, and deer population densities. However, data from these studies suggested that home ranges for female white-tailed deer in suburban habitats ranged between approximately 50-1,974 acres with most averaging less than 640 acres (1 square miles). In general, the authors of these studies indicated that home range sizes of suburban deer were less than deer in rural forested and agricultural habitats.

Dispersal from their natal range by female white-tailed deer occurs at a very low rate regardless of habitat. Correspondingly, descriptions of dispersal rates of female white-tailed deer are rare in the literature. Only one study (Porter et al. 2004) described dispersal of female white-tailed deer in a suburban habitat. This suggests that immigration and emigration of female white-tailed deer has negligible effects on the change in abundance of deer populations. This is especially true for suburban habitats.

Please Note: Comparative table on following page.

Appendix B. Continued. Home ranges of female white-tailed deer in suburban habitats.

Location	Home Range Size (acres)^a	Study
Irondequoit, New York	53 ^b	Porter et al. (2004)
Chicago, Illinois	150	Piccolo et al. (2000)
Valley Forge, Pennsylvania	235 ^c	Lovallo and Tzilkowski (2003)
Bloomington, Minnesota	355 ^d	Grund et al. (2002)
Northeastern Massachusetts	1,050	Gaughan and DeStefano (2005)
Northwestern Massachusetts	1,974	Gaughan and DeStefano (2005)
Groton, Connecticut (control area, no reduction) ^e	84	Kilpatrick et al. (2001)
Groton, Connecticut (treatment area, pre-reduction) ^e	241	Kilpatrick et al. (2001)
Groton, Connecticut (treatment area, post-reduction) ^e	93	Kilpatrick et al. (2001)
Hilton Head Island, South Carolina (control area, no reduction) ^f	80	Henderson et al. (2000)
Hilton Head Island, South Carolina (treatment area, pre-reduction) ^f	108	Henderson et al. (2000)
Hilton Head Island, South Carolina (treatment area, post-reduction) ^f	130	Henderson et al. (2000)

^a Home ranges were calculated for locations collected over an annual period unless otherwise noted.

^b Represents average summer home range size for female white-tailed deer in several locales in Irondequoit, New York. Deer in this population exhibit winter migration.

^c Pooled average for adult female white-tailed deer for years 1997, 1998, and 1999.

^d Average seasonal home range size for spring. Other seasonal home ranges were less: winter = 211 acres, summer = 124 acres, and fall = 230 acres.

^e Kilpatrick et al. (2001) illustrates the effects of an experimental population reduction on home range size of female white-tailed deer. They reported a decrease in home range size from pre-reduction to post-reduction on the treatment area. Since no change in home

Appendix B. Continued.

range size was observed for deer in the control area, the home range size presented in the table represents an average for the years 1995, 1996, and 1997. The pre-reduction home range size on the treatment area represents an average for the years 1994 and 1995. The post-reduction home range size on the treatment area represents an average for the years 1996 and 1997.

^f Henderson et al. (2000) illustrates the effects on home range size of female white-tailed deer exposed to an experimental 50% population reduction. They reported an increase in home range size from pre-reduction to post-reduction on the treatment area. Since no change in home range size was observed for deer in the control area, the home range size presented in the table represents an average for the winter season for years 1996 and 1997. For the treatment area, the pre-reduction home range size is for the winter of 1996 and post-reduction home range size is for the winter of 1997.