



**Natural Resource
Consultants, Inc.**

DEER MANAGEMENT PLAN

for

Lower Makefield Twp.



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Executive Summary

Lower Makefield Township is experiencing deer/human conflicts such as deer/vehicle collisions, damage to ornamental and garden plantings and Lyme disease. Of equal concern, are the negative impacts that “overabundant” deer are having on the township’s wildlife populations, wildlife habitat and forest ecology. The current overabundance of white-tailed deer is the result of human-caused extinction of large predators.

Deer are described as overabundant when they limit the abundance or occurrence of another valued resource or interfere with some valued ecological process or human activity. How to deal with overabundant deer impacts is a value based decision. The primary values identified in Lower Makefield Township are the protection, maintenance and restoration of the structure, diversity and function of the community’s open space from an ecosystem management perspective and reducing deer/human conflicts in a safe, humane, and socially responsible manner.

Lower Makefield Township represents one of the most challenging situations for deer managers. The community is nearing the point of being “built out” with most of its land area covered by single family homes surrounded by spacious, mature “lawn forests” which in combination with preserved land, and larger residential holdings, provide excellent deer habitat.

Experience and the published literature do not support the conclusion that the currently available contraceptives or recreational hunting would be effective in realizing the deer management goals for Lower Makefield Township. Recreational hunting can, in many landscapes, be an effective mechanism for mimicking the population-stabilizing effects of natural predators on deer. However, in Lower Makefield where deer vulnerability is low, deer refugia abundant and the deer density goal low, traditional hunting is unlikely to provide effective deer management.

Sharpshooting, in suburban landscapes, has been shown to be an effective localized tool for reducing deer populations by removing up to 90% of deer within a single year. Sharpshooting involves the use of a suppressed, small caliber rifle by trained personnel to remove deer at multiple pre-approved and prepared bait sites at night or during the daylight. Properly designed

sharpshoots can be very efficient and result in safe, humane, socially responsible and effective deer management programs. One shooter may remove dozens of deer in one night. As with any type of management program, the success of a sharpshoot depends on the quality of the program design and field personnel compliance.

If it is to be effective, deer management is a long-term, perennial obligation. Therefore, NRC Inc. recommends the use of a credentialed, experienced contractor/consultant to conduct the initial removals while simultaneously training personnel during the first two years to conduct removals thereafter. It is suggested that local hunters, many of whom may possess the needed skill set, attitudes and commitment to balancing deer impacts with community needs, be screened and considered for training and supervised participation.

The exclusion, elimination, or reduction of deer has been shown to substantially reduce tick abundance. One community reported an 83% decrease in human cases of Lyme disease following a 92% reduction in deer. Given the primary deer management goal of reducing deer impacts to levels that protect and restore the structure, diversity and function of Lower Makefield Township forests and open space, deer densities may well be reduced to levels that interrupt the enzootic cycle and transmission of Lyme disease. It is suggested that the incidence of Lyme disease and baseline tick abundance be estimated and monitored. If tick populations and or incidence of Lyme disease remain above acceptable levels the use of 4-poster feeders may be considered.

Compliance monitoring is simply a formalized process of documenting that the treatments agreed to within a management/monitoring program are being applied as designed and the data properly recorded. It is suggested that once a course of action is decided upon, Lower Makefield Township identify a compliance monitoring coordinator. This individual should develop compliance monitoring protocol for each aspect of the management program that is adopted and annually review monitoring and deer removal activities for completeness and conformity to the agreed design.

Effectiveness monitoring involves using a group of indicators to quantitatively measure whether your management program is successfully accomplishing the goals and objectives it was designed to do. In Lower Makefield, effectiveness monitoring will focus on 1). deer impacts on vegetation, 2). measurements of relative tick abundance and 3). the number of cases of Lyme disease within the township. If community goals are achieved, some treatments may be modified, gradually reduced or dropped to maximize cost effectiveness both in dollars and effort.



Introduction

Lower Makefield Township is in Bucks County, Pennsylvania, and located within the Philadelphia Metropolitan Area. The Township contains 18.3 square miles. Based on the 2000 census, there are 32,681 people, 11,706 households, and 9,388 families residing in the township. Nearly 41% of households have children and 27.6% of township residences are under the age of 18. The human population density is 1,821.8/mi² with an average density of 665.1/mi² of housing or an average of 0.96 acres per house.

Lower Makefield Twp., according to 2004 census estimations, is the fastest growing municipality in Lower Bucks County. Many housing developments and some corporate centers have been constructed since 2000, especially in the area around Shady Brook Farm and I-95. However, the township has been well-planned and maintains a strong balance between growth and preservation, and is considered to be very desirable for the high quality of life it offers residents (Wikipedia 2007).

Like many areas within the state and country, Lower Makefield Township is experiencing deer/human conflicts such as deer/vehicle collisions, damage to ornamental and garden plantings and Lyme disease. Of equal concern, are the negative impacts that “overabundant” deer are having on the township’s wildlife populations, wildlife habitat and forest ecology.



Over time, high deer densities will alter forest understories, reduce or eliminate native wildflowers and shrub species and dramatically decrease the variety of tree species (Latham et al. 2005).

Problem

For hundreds of thousands of years, the white-tailed deer (*Odocoileus virginianus*) and its ancestor species shared habitats with a diverse array of predators. Predation controlled and limited both deer numbers and deer impacts through the millennium. The current overabundance of white-tailed deer throughout much of the country, and their consequent impacts on ecosystems are the result of human-caused extinction of large predators. There is broad agreement within the scientific community that forests throughout the northeast are in a seriously degraded ecological condition as a result of high deer densities and impacts (Latham et al. 2005). It is widely recognized that deer are a keystone species in wildlife communities (Waller and Alverson 1997) because they can directly affect habitat conditions (Anderson and Katz 1993, Augustine and deCalesta 2003, Horsely et al. 2003) and thus, indirectly affect wildlife species (deCalesta 1994). An independent evaluation by a team of scientists on behalf of the Forest Certification Council found that deer had decimated the diversity and sustainability of flora and fauna on the Pennsylvania State Forest system (Wager et al. 2004). Over time, high deer densities will alter forest understories, reduce or eliminate native wildflowers and shrub species and dramatically decrease the variety of tree species (Latham et al. 2005). Deer may also depress reproductive success of native plants while simultaneously facilitating the spread of exotic species (Williams and Ward 2006). In Lower Makefield Township deer are currently overabundant, resulting in deer/human conflicts and negative impacts on township habitats and forest ecosystem.

Deer are described as overabundant when they limit the abundance or occurrence of another valued resource or interfere with some valued ecological process or human activity. How to deal with overabundant deer impacts is a “value” decision. The primary values identified in Lower Makefield Township are the protection, maintenance and restoration of the structure, diversity and function of the community’s open space from an ecosystem management perspective with a special focus on Five Mile Woods, and reducing deer/human conflicts in a safe, humane, socially responsible manner.

Deer Management

Goals

for Lower Makefield Township

- 1.** Maintain white-tailed deer as a valued component of Lower Makefield Township's native fauna while implementing a restoration plan for mimicking the population-stabilizing effects of natural predators on deer in order to protect, maintain and restore the structure, diversity and function of the township's forests and open space.
- 2.** Reduce the probability of contracting Lyme disease within Lower Makefield Township.
- 3.** Reduce deer/human conflicts, particularly deer/vehicle collisions and agricultural, ornamental and garden damage.
- 4.** Manage deer in a safe, humane, socially responsible manner.
- 5.** Establish a permanent, quantitative monitoring program to assess deer impacts on forest vegetation.

Deer Management

Objectives

for Lower Makefield Township

- 1.** Reduce deer impacts to levels that allow forest understories to meet the quantitative standards for advanced forest regeneration in hardwood stands (Marquis et al. 1992).
- 2.** Reduce deer impacts to a level that result in deer browsing intensity of less than 50% on preferred woody species using standardized browse sampling techniques (Benner 2006).
- 3.** Reduce deer impacts to levels that allow similar species richness, equability, structure, robustness and percent flowering within deer exclosures and adjacent control plots with a special focus on native wildflowers.
- 4.** Reduce tick abundance by 75% and reduce human cases of Lyme disease by 70% through reducing overall deer densities and possible placement of 4-poster feeders.
- 5.** Reduce agricultural, ornamental and garden damage to levels acceptable to township farmers, gardeners and landscapers.

AERIAL INFRARED DEER COUNT AT FIVE MILE WOODS

An aerial infrared deer count for the Five Mile Woods area of Lower Makefield Township was flown on the night of December 16, 2004 between 7:30 p.m. and 8:00 p.m. by Davis Aviation out of Kent, OH. The flight revealed a minimum of 49 deer on 285 acres in and around Five Mile Woods. This suggests a minimum deer density at the time of the survey of approximately 110 deer per square mile in the general area (Davis 2004).

Human nature is to see these numbers as absolute measures of deer densities rather than minimum counts. The contractor suggests an accuracy of 90%. Other contractors have suggested accuracy of 85% to 100%. These assessments may be influenced by enthusiasm for the technology itself. Where this technique has been evaluated under controlled conditions it has not been shown to deliver such a high degree of accuracy.

Thermal infrared sensing technology is not new to the field of wildlife management. In fact, researchers have been studying its application since the late 1960's (Cochran 1977). Forward Looking Infrared (FLIR) systems use a special camera mounted beneath an aircraft that can detect heat emitted by deer, other mammals and birds. The aircraft flies a pre-determined grid until a specified tract is surveyed. Biologists then count observed deer to estimate deer density within the area.

The advanced technology associated with this technique would suggest that it is widely used as a deer management tool. However, the wide variation in detection rates (the percentage of deer observed compared to the number actually present during the survey) typically limit its application to small areas with high deer densities or where repeated flights within a year are possible (Diefenbach 2005). The most recent peer-reviewed research evaluating FLIR technology in a deciduous forest environment (Haroldson et al. 2003) reported that FLIR technology provided biased and variable population estimates. Nine aerial surveys using FLIR technology missed 11-69% of the deer and, on average, detected 56% of deer on the study area (Haroldson et al. 2003). The researcher concluded, "Until the capabilities of thermal imaging are more fully understood and the sampling protocols refined, detection rates may be too variable to provide reliable counts of animal abundance." (Haroldson et al. 2003).

A literature review of FLIR technology, as applied to white-tailed deer, conducted by the Pennsylvania Game Commission in 2005 concluded that the technique provided inconsistent results (Mumma 2005). A study conducted by the Pennsylvania Cooperative Fish and Wildlife Unit in 2005 determined that a change in the number of deer observed from one year to the next based on single FLIR surveys simply could be caused by inherent variability in the detection rates using this technique, unless the decline was exceedingly large (Diefenbach 2005).

It is widely recognized that one of the primary variables that can affect the detection rate is tree canopy cover, because it can obstruct the camera's "view" of an animal's thermal image. Surveys are typically done at night (e.g. Wiggers and Beckerman 1993, Haroldson et al. 2003) and during winter when deciduous trees are bare, to reduce this influence (Graves et al. 1972, Wilde 2000, Potvin and Breton 2005). White-tailed deer, however, are adept



NRC Inc. recommends the use of infrared surveys only as a tool to determine an initial minimum estimate of deer densities.



The township's forests are comprised of relatively small, fragmented, wooded patches, many with linear configurations and surrounded or perforated by residential development, backyards or open fields.

at seeking out "micro-climates," such as hemlock stands, rhododendron or mountain laurel thickets (all evergreens) where they can conserve energy or reduce detection and disturbance in the sheltering cover. Thermal infrared sensing can miss deer hidden in such cover because the vegetation shields the body heat emitted by the deer (Haroldson et al. 2003).

A good example of the technique's limitations was learned by Hemlock Farms Community Association in Pike County, Pennsylvania in 2006. Vision Air Research, Inc. estimated 264 deer in March, 2004, 141 in March 2005 and 149 in November 2005 after 89 deer had been removed by sharpshooters (personal communication Marian Keegan, Natural Resource Coordinator, Hemlock Farms Community Association). The sharpshoot within this residential community eventually removed 379 deer or more than 2 1/2 times the number of deer the aerial infrared survey reported was present. Following the sharpshoot removal, a ground survey that sampled less than 50% of the community area counted an additional 128 deer demonstrating that the property had at a minimum 507 deer or 72 deer-per-square-mile. The infrared aerial survey reported less than 1/3 of the deer present.

NRC Inc. recommends the use of infrared surveys only as a tool to determine an initial minimum estimate of deer densities. We do not recommend its continuation once a deer reduction program is initiated for three reasons. First, the goal of most deer management programs in residential landscapes such as Lower Makefield, is not a particular deer number per se, but rather a quantifiable reduction in deer impacts. Therefore we recommend effectiveness monitoring programs that focus on the abatement of those conflicts for which the deer reduction was initiated, not an arbitrary deer density. Secondly, in the diverse landscapes that make up urban, suburban and exurban (Nelson 1992) environments there is very little science-based data that relates deer density to the abatement of a range of deer conflicts making deer

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density goals somewhat speculative and arbitrary. Finally, as deer numbers are reduced infrared surveys become increasingly unreliable. A detection rate of 50% when deer densities are at 80 deer/sq. mile provides a useful minimum population estimate. When deer are reduced to 15 deer/sq. mile a 50% detection rate may create the illusion that deer have been reduced to low numbers initiating debate over whether the detection rate was 30% or 100% with no constructive method of resolving the dispute. Effectiveness monitoring programs that focus on quantitative measures of those challenges for which a deer reduction was initiated are more meaningful, more reliable and less controversial.

It is possible to measure, with statistical confidence, deer densities in the township. Such efforts are however, costly and of questionable value given the community's deer management goals. If a program involving deer removal is implemented at Lower Makefield Township, it is exceedingly unlikely that too many deer can be removed. Therefore, instead of monitoring deer numbers, it is recommended that deer presence and reproduction be monitored. So long as deer and fawns are observed within the township the goal of maintaining a viable, reproducing population of deer will be confirmed. In the unlikely event that deer are not observed in the monitoring program the deer removal program should be reviewed and modified.

LANDSCAPE ANALYSIS

Exurbia is a residential land-use that occurs outside city limits and situated among working farms or undeveloped land where human populations density and average property size are intermediate between the suburbs and rural areas (Nelson 1992). Lower Makefield includes exurban areas near it's boundary with Upper Makefield and Newtown Township while those areas further south and surrounding Yardley are more suburban. The entire township is located within the [Philadelphia](#) Metro Area (Wikipedia 2007).

Along with human ecology, researchers and managers need to consider several approaches to examining suburban ecology (VanDruff et al. 1994) including the patch-dynamic approach. This perspective recognizes urban, suburban and exurban landscapes as mosaics of biological and physical patches within a matrix of infrastructure and social institutions (Nilon and Pais 1997, Zipperer et al. 2000). Lower Makefield presents just such a landscape.

In the context of deer management, these landscapes are viewed on three spatial scales; deer home range size; contiguous available habitat; and conductivity with additional habitats in the broader landscape.

Deer home ranges in the urban, suburban and exurban habitats have been shown to be small, often less than 100 acres, compared to more rural landscapes (Cornicelli 1992, Henderson et al. 2000, Grund 1998, Kilpatrick and Spohr 2000, Kilpatrick and Stober 2002). Gaughan and Destefano 2005, found that suburban deer home ranges were one-tenth that of deer in rural landscapes. However, with the exception of Five Mile Woods, it is unlikely that Lower Makefield Township has any single forested tract that encompasses the complete home range for any individual deer. The township's forests are comprised of relatively small, fragmented, wooded patches, many with linear configurations and surrounded or perforated by residential development,

Where deer can move freely between contiguous refuge and hunted areas, recreational hunting is unlikely to be successful in meeting township management goals.

backyards or open fields. It is likely that nearly all deer within the township include as part of their home range lawns with ornamental plantings, gardens, golf courses, agricultural fields and strips of conservation easements that make up the matrix of the community's landscape. In much of the township, open space is dominated by open fields not forests. For much of the year these fields provide food resources for deer but poor diurnal cover.

Human built environments create uninhabitable areas for deer as well as barriers to movement between habitat islands. In Lower Makefield Township there is good conductivity within the landscape to allow daily deer movements within their home range and dispersal and immigration between islands of habitat within and beyond the township boundaries. Much of the township conductivity exists within the matrix itself as large, treed, residential building lots and associated open space allow free deer movement within the landscape. Numerous corridors also exist that facilitate deer movement across and throughout the township in the form of linear covers associated with pipelines, railroad tracks, wetlands, conservation easements, Delaware Canal State Park, Interstate I-95 and the forested bank of the Delaware River.

The majority of Lower Makefield Township, including its woodlands, falls within safety zones that restrict hunting. Under Pennsylvania regulations, recreational firearm hunters may not shoot at, take, chase or disturb wildlife within 150 yards of any occupied residence, camp, industrial or commercial building, farm house or farm building, or school or playground without the permission of the occupants (Pennsylvania Game Commission 2006b). It is unlawful to shoot into a safety zone, even if the hunter is outside of the zone. Driving game, even without a firearm or bow, within a safety zone without permission of the occupant is unlawful. The safety zone for firearms around the average home is approximately 16 acres which normally requires a hunter to have safety zone waivers by multiple adjacent households to hunt any suburban property. Therefore, even if a majority of homeowners waved their safety zones to allow hunting the township would remain a mosaic of hunt-able and unhunt-able habitat with most deer having multiple functional refugia located within their home range into which they might escape during daylight hours when recreational hunting occurs. Safety zones do not apply to deer removals under a deer control permit.

LOCALIZED DEER MANAGEMENT

One of the more significant advances in deer ecology and management of the past two decades is the recognition that deer populations can be managed on a small spatial scale (Porter et al. 1991, McNulty et al. 1997, Oyer and Porter 2004). This approach to deer management utilizes the strong home range fidelity behavior of adult female deer (Van Deelen et al. 1998, Nelson and Mech 1999), the instinctive tendency of juvenile females to establish home ranges adjacent to their natal home range, social organizational patterns of female deer into genetically-related groups (Tierson et al. 1985, Nelson and Mech 1999) and the important role females play in deer population dynamics (Porter et al. 2004). Low female dispersal (0-20%) and strong home range fidelity (Aycrigg and Porter 1997, Lesage et al. 2000) allows for localized deer herd management to be effective at a small spatial scale, since social units of genetically-related female deer tend to remain in their respective home ranges. Studies have shown that creating local densities that are lower in comparison to those

on the surrounding landscape is possible (Behrend et al. 1970, McNulty et al. 1997, Kilpatrick et al. 2001).

The result is that any given area of habitat is occupied by discrete, genetically related groups of deer, who's removal, can result in deer densities that are significantly lower than the surrounding landscape. Removal is most effective when matrilineal groups are relatively undisturbed during removals, bait is used to shift individual deer core areas within their home range to removal sites, and where maintenance removals are conducted on an annual bases. This allows Lower Makefield Township to manage its deer population successfully regardless of whether neighboring townships address the issue or not.

Food at temporary bait sites has been used to manipulate the behavior and movement of white-tailed deer for research and management purposes for decades (Hawkins et al. 1967, Ishmael and Rongstad 1984, Drummond 1995, Rudolph et al. 2000). Deer with bait sites in their home range have been shown to use them while bait sites outside of deer home ranges will have no, or limited, effects on deer movement (Darrow 1993, Kilpatrick and Stober 2002). Deer with no bait sites within the core area of their home range have been shown to shift the core area closer to, or including, the bait site (Kilpatrick and Stober 2002). Deer are more vulnerable to harvest when certain food attractants such as corn are available (Hansen et al. 1986). Using bait, managers can increase access to deer for management purposes.

DEER MANAGEMENT GRADIENT

The Deer Management Gradient is a concept that attempts to explain how factors that impact deer management change across landscapes. Some of the most important factors are hunter access, deer vulnerability, deer refugia, safety issues, community values and goals, hunter skill level and hunter values and goals. Foster et al. (1997) documented that landscape pattern and human population influence deer vulnerability to harvest by hunters.

In a recent two-year study in Pennsylvania's Wildlife Management Units 2G and 4B, both "big woods" areas, hunters harvested less than an average of 6% and 22% respectively, of radio-collared female deer (Keenan et al. 2007). These deer were on public lands open to any recreational hunter in any season. In healthy deer populations managers typically need to remove approximately 25-40% of the female deer to stabilize the herd and often more to effect a population reduction. These data suggest that hunter mortality

In landscapes that are dominated by contiguous forests, deer vulnerability is low, and managers can be challenged to kill sufficient antlerless deer to balance deer impacts with healthy habitats.



In Lower Makefield Township, much of the landscape is not huntable due to safety zones and areas where recreational hunting is felt by the landowner or community to be an incompatible use.

was insufficient to control deer populations in the study area. In addition the study determined that hunter density was less than 6 hunters/square mile on the most active hunting period, opening morning, in both study areas (Keenan et al. 2007). A previous Pennsylvania “big woods” study found that relative hunter density could be predicted based on distance from the nearest road and slope. (Diefenbach et al. 2005). The study found 87% of the hunters hunted within 3/10 of a mile or less of a road open to vehicular travel. More interior areas, have low hunter densities and likely served as deer refugia where deer had a low probability of being harvested. The study provided further evidence that recreational deer hunting may not keep deer populations in balance with available habitat in big woods landscapes. The level of skill and effort required for a hunter to be consistently successful in “big woods” situations is high.

Foster et al. (1997) found that the major factor influencing deer vulnerability to hunters was the relative proportion of forest cover. As forested landscapes become more fragmented and interspersed with agriculture, deer vulnerability increases because there is limited cover in which deer can hide and deer movements are more predictable, requiring less skill and effort on the part of hunters to be successful in harvesting an animal.

In landscapes like Lower Makefield, forest covers are small and highly fragmented. If these forests and the areas around them were huntable, deer vulnerability would be high. Under such conditions recreational hunting can be very effective. However, in Lower Makefield Township, much of the landscape is not huntable due to safety zones and areas where recreational hunting is felt by the landowner or community to be an incompatible use. These, deer “refugia”, areas of habitat that cannot be hunted, dominate much of the landscape. Sufficient access to deer habitat and distribution of hunters are key factors affecting the success of hunting to control deer in both developed and rural areas (Brown et al. 2000). Even when deer population dynamics are well understood and willing hunters are available, differential vulnerability of deer to hunting may preclude the harvest of sufficient females to achieve the population reduction objective (Rosenberry and Klimstra 1974).

Deer have been shown to utilize refugia, or refuges, both formal and informal, to avoid hunting pressure and harvest (Nixon et al. 1991, Kammermeyer and Marchinton 1975). Kammermeyer and Marchinton (1975) concluded that if deer can move freely between contiguous refuge and hunted areas, inadequate harvest and overpopulation may result. Harden et al. (2005) determined that as safety zone (legally defined as all areas within 150 yards of occupied buildings for firearm hunting and 50 yards for archery hunting) areas expanded due to development, excluding more deer habitat from hunting, harvest efficiency decreased. They concluded that as human development increases deer management relying on traditional methods will become more difficult. To effectively serve communities, managers, now and in the future, will be required to identify likely areas of conflict in which nontraditional deer management options will prove to be more effective (Harden et al. 2005). Storm et al. (2007) suggests that deer in exurbia cannot be managed as they currently are in rural areas. Traditional management techniques, such as adjusting license availability and season length will not work since only a small portion of the habitat is open to hunting.

White-tailed deer adapt to habitat changes caused by human development (Conover 1995). They habituate to human presence (Hansen et al. 1997) and

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do well in and around suburban neighborhoods because there is little hunting, abundant food and cover, and few remaining predators (DeStefano and DeGraaf 2003). Often, residents of suburban neighborhoods exhibit weak support for recreational hunting near their homes. Fragmentation of land ownership into smaller parcels and a lack of cooperation between the various levels of government that must work together in suburban areas can also pose challenges to effective deer management through traditional recreation hunting (Messmer et al. 1997b, Lauber and Knuth 2000). Some residents may oppose any lethal management options (Messmer et al. 1997a, Stout et al. 1997, Lauber and Knuth 2000). Consequently, deer vulnerability generally declines as the landscape becomes a mosaic of deer refugia that include backyards, high use recreation open space, safety zones and the numerous areas within such landscapes that provide cover for deer but where recreational hunting is not felt to be a compatible use. Deer in whatever huntable habitats do exist may recognize areas near human dwellings as refuges of “lower hunting pressure” and temporarily utilize these areas to escape harvest (Harden et al. 2005).

Acceptable hunting tackle also changes along the deer management gradient from rifles to shotguns and archery equipment as safety issues are considered by local communities, the Game Commission and hunters themselves. The use of rifles is prohibited by the Game Commission within all Special Regulation Zones (designated suburban/urban areas that include Lower Makefield Township) in Pennsylvania. Shotguns and muzzleloading firearms, however, may be used in those designated areas. In Philadelphia County, however, only bows and arrows are permitted for recreational hunting (Pennsylvania Game Commission 2006b).

As deer, hunters and non-hunters occupy more confined spaces, differences in values and goals regarding deer management become more apparent requiring shifts in management techniques. Many hunters are committed to a deer management approach that focuses on managing deer for hunting recreation. Communities with an overabundant deer problem, however, are interested primarily in management techniques that are effective in reducing deer numbers, humane, (Lauber and Knuth 2000) safe for residents, and entail minimal community disruption. Management of urban deer populations may involve lethal or nonlethal means of population control (DeNicola et al. 1997, Hansen and Berringer 1997). However, urban residents often prefer nonlethal tactics (Jones and Witham 1990, Warren 1995, Stout et al. 1997, Peterson et al. 2003). But as deer impacts and deer/human conflicts increase suburban residents may shift their attitude from viewing deer as a local environmental resource to one of perceiving deer as pests (Winston 1997).

Lower Makefield Township represents one of the most challenging situations along the deer management gradient and one that will become increasingly common. The community is nearing the point of being “built out” with most of its land area covered by single family homes surrounded by sparsely, mature “lawn forests,” which in combination with preserved land and larger residential holdings provide excellent deer habitat. Managing deer in these types of landscapes is the greatest challenge deer managers face today.

SOCIOPOLITICAL OBSERVATIONS

If human directed mortality is used, what happens to the deer that are killed?

All deer killed, whether harvested by hunters or under a deer control permit, must be processed and consumed by people. In the case of recreational hunters the meat may be eaten by the hunter and his family, given away to friends or donated to one of several programs that provide meat to charitable organizations. Deer taken under a deer control permit must be processed and provided to a suitable food bank, needy family or as otherwise determined by the PGC Executive Director.

Deer processing costs are in the range of \$45 to \$75/deer. A deer control program may not charge for the venison but may ask the recipient of the meat to pay the processing fee. The statewide Hunters Sharing the Harvest Program pays the processing fee for some community deer control programs.

The American Heart Association recommends venison as a healthy alternative to beef. For those individuals who eat meat, “wild harvested” venison has the lowest ecological cost of any meat available. Where human directed deer mortality is used to mimic the population-stabilizing effects of natural predators on deer, there is the simultaneous positive ecological benefit to harvesting and consuming venison. Such harvest contributes to the protection and restoration of the structure, diversity and function of the forest.

May deer treated with fertility control drugs be consumed by humans?

Currently, the two most promising products for fertility control, GonaCon™ and Spay-Vac™, are not approved for human consumption. As a result, in states like Pennsylvania, where hunters may harvest deer for venison or motorists may retrieve, process and consume road killed deer, animals treated with these products must first be captured and marked in such a way as to allow a potential consumer to know that the animal has been injected with these drugs.

How do values and science impact deer management discussions and decisions?

Deer management is not driven by quantitative equations, studies, and science, but by human values.

The role of science in natural resource management is to flesh out the options, outline the probable results of decisions, and provide the tools for manipulating, monitoring, inventorying, and understanding the resource. Ultimately, however, the decision as to what to do with that resource utilizing our scientific knowledge of it, is a product of personal and societal values—not science.

An excellent example of this is the current movement towards sustainable forestry. The idea that a forest should be managed for more than short-term timber production is not an idea of science. It is, instead, a reflection of values. Science can work to define what sustainable forestry is, how it can be achieved, and what the outcome of the alternative paths might be. But it



The challenge for suburban communities grappling with deer is to find methods that are acceptable to a broad range of public stakeholders, effective, and applicable at reasonable cost.



Providing accurate, unbiased information and encouraging open public discussion and input regarding deer management concerns is essential to successful programs.

is mute on whether an appropriate management goal involves balancing short-term, self-interest with the needs of future generations. So it is with deer.

Society has the resources and tools for regulating deer numbers, altering herd sex and age composition, estimating deer densities and measuring their impacts on the forest environment. The question is, what is it you are trying to use science to achieve, based on what values and goals?

The public has been relatively clear about its values in the field of forestry. While people want and need forest products, recreational opportunities, and the ecological services that forests provide, they also want the diversity and sustainability of these systems protected. The upshot is that forest management on public lands has been evolving. The focus has shifted from simply growing trees for timber to recognizing that forests are complex interdependent systems. The result has been a slow but continuing shift from a management paradigm rooted in farming trees to one based on managing ecosystems, driven by public values and expectations.

Historically deer management is also rooted in a wildlife agriculture paradigm. In this value system, deer are viewed as a type of crop or livestock and the forest as the pasture to be managed to produce them (Shissler 1999). This historic approach to managing deer is built on the North American Wildlife Model which uses hunter license fees to fund wildlife conservation and management with a focus on hunter recreation, not ecosystem health (Alt et al. 2006, Frye 2006). For the most part deer management has only been viewed as a potential “side-effect” of the recreational activity.

As deer populations repopulated landscapes where hunting has not typically occurred, and as residential communities have developed in more rural areas, more diverse deer management values, goals and perspectives have come into play.

The challenge for suburban communities grappling with deer management is to find methods that are acceptable to a broad range of public stakeholders, effective at decreasing deer numbers, and applicable at reasonable cost (Decker and Gavin 1987, Stout et al. 1993, Conover 1995, Swihart et al. 1995). The following are generalizations regarding some common perspectives of deer management stakeholders observed by NRC Inc. over the years. It should be noted that this is not an attempt to either speak for these stakeholders or understate the diversity of opinions that exist within various groups. Instead it is an attempt at help provide context for understanding discussions that influence deer management decisions in residential landscapes.

It is useful to know that studies of other communities have found that residents’ attitudes towards management techniques are not necessarily fixed and that communication can influence attitudes (Lauber and Knuth 2004). Suburban residents may have different concerns about management techniques than wildlife managers. Determining what those concerns are and distributing accurate, unbiased information about those concerns is most likely to influence public perceptions of deer management techniques (Lauber and Knuth 2004).

Preserving and promoting traditional uses of wildlife, such as hunting and trapping, is a primary focus of the Game Commission

■ **COMMUNITY MEMBER**

The majority of the community members typically favor non-lethal methods of deer removal for the residential landscapes in which they live if those techniques can be shown to be affordable and effective at resolving deer conflicts. When that is not the case, community members generally support human directed mortality, including hunting, provided it is safe, humane, affordable and effective at resolving the deer conflicts.

■ **ANIMAL RIGHTS ADVOCATE**

Animal right advocates take the position that deer are not to be harmed. Deer /human conflicts have resulted from human actions for which deer should not be made to suffer. They suggest that non-lethal techniques and options are available and present them from an optimistic perspective that often goes well beyond what the science will support.

■ **RECREATIONAL HUNTER**

Many hunters believe sincerely that recreational hunting can reduce deer impacts within residential communities like Lower Makefield to levels that will address community concerns. They may see nontraditional approaches such as sharpshooting as a threat to hunting and view its advocates as philosophically opposed to hunting in any form, anywhere. Some hunters view the killing of deer by animal control personnel as unethical, contradicting the concept of “fair chase” or diminishing the value of the deer as a wildlife species. Often, these hunters are unable to distinguish between those landscape situations where hunting can be an effective management tool and where it cannot.

■ **ORGANIZED SUBURBAN HUNTING GROUPS**

Recreational hunters can be particularly effective when operating as organizations that self-manage their memberships, thereby offering landowners and communities the ability to customize hunting activities to their individual situations. Such programs allow the hunting organization to largely administer and monitor the management program.

In those communities where deer vulnerability, juxtapositioning of deer refugia, allowable tackle, recreational threshold of hunters, and compatible land use are such that hunting can be effective, organized and committed hunters can partner with landowners and communities to successfully manage deer. Such programs and partnerships can be productive and positive. However, many of these organizations fail to distinguish between where they can and cannot be effective, believing that recreational hunting will work nearly everywhere. Independent effectiveness monitoring, a critical component of any successful program, is often nonexistent or focused only on the number of deer killed or reductions in deer/vehicle collisions rather than quantitative measures of the conflicts for which the deer removal was initiated in the first place. The failure to distinguish between where hunting can be an effective management tool and where it simply provides hunter recreation can lead to false expectations, failed programs, wasted community resources and a credibility gap between hunters and the communities they partner with.

■ **PENNSYLVANIA GAME COMMISSION**

Created in 1895 as an independent state agency, the Game Commission is responsible for conserving and managing all wild birds and mammals in the Commonwealth, establishing hunting seasons and bag limits, enforc-

Lower Makefield Township
represents one of the most
challenging situations along the
deer management gradient

ing hunting and trapping laws, and managing habitat on the 1.4 million acres of State Game Lands it has purchased over the years with hunting and furtaking license dollars to safeguard wildlife habitat. The Game Commission does not receive any general state taxpayer dollars for its annual operating budget. The agency is funded by license sales revenues; the state's share of the federal Pittman-Robertson program, which is an excise tax collected through the sale of sporting arms and ammunition; and monies from the sale of oil, gas, coal, timber and minerals derived from State Game Lands (Pennsylvania Game Commission, 2007b).

Preserving and promoting traditional uses of wildlife, such as hunting and trapping, is a primary focus of the Game Commission (Pennsylvania Game Commission 2007c). The PGC is directed by law to utilize hunting as a method of management for white-tailed deer (Pennsylvania Game Commission 2006c) The PGC has a special relationship with recreational hunters who provide its' funding. Like hunters themselves, PGC policies promote the concept that recreational hunting can solve most suburban deer challenges if hunters are simply provided access to the land. The benefits and effectiveness of recreational hunting in communities has traditionally been presented by the PGC from an optimistic perspective that is not supported by existing realities in urbanized landscapes. This strong focus on providing hunting recreation is reflected in PGC agency policy, which requires communities to include traditional regulated hunting and controlled hunts within their management plans in order to receive a Deer Control Permit from the commission (Pennsylvania Game Commission 2007e). Deer control permits as allowed by Section 147.321-329, Subchapter R of Title 58 Pennsylvania Code 2.3.2 have no such requirement.

The PGC has knowledgeable, capable and competent staff. However, communities grappling with overabundant deer, and seeking solutions, should be aware of the PGC's real or perceived obligation to promote hunting for recreation, as well as for management, and realize that the agency's recreational perspective, appropriately rooted in rural landscapes, may influence its interaction with more urbanized communities and municipalities.

■ CONSERVATION/ENVIRONMENTALISTS

The vast majority of conservation/environmental organizations value deer as an important part of our native fauna, while supporting the management of their numbers so that deer impacts are in balance with the goals of biodiversity conservation and maintaining healthy habitats. The use of recreational hunting is supported where it can be effective and is appropriate.

■ SHARPSHOOTING CONTRACTORS

Many sharpshooters have the same sincere, confidence as recreational hunters, that they can reduce deer impacts within residential communities to levels that will address community concerns. The success of sharpshoots however can vary widely depending on the program design and implementation, landscape conditions and level of deer vulnerability. Nearly any sharpshoot contractors, regardless of their skill level and techniques can kill a lot of deer in the initial years and reduce the number of deer/vehicle collisions. The challenge is continually removing deer without educating those that remain, rendering them less vulnerable. Poorly run sharpshoots reduce deer numbers initially but may fall short of the sustained reduction required for ecological recovery.

Sharpshooting contractors, whether a government agency, private for profit, or nonprofit organization, have as their primary goal, a positive cash flow. Negotiated contracts with sharpshooters should always be for a minimum of 4 years with scheduled payments tied to the successful achievement of quantitative deer program goals and an independent compliance and effectiveness monitoring program. Payments should never be based solely on units of time and expense, or on a “per deer removed” basis.

DEER MANAGEMENT OPTIONS

GOAL 1: Maintain white-tailed deer as a valued component of Lower Makefield Township’s native fauna while implementing a restoration plan for mimicking the population-stabilizing effects of natural predators on deer in order to protect, maintain and restore the structure, diversity and function of habitats in Lower Makefield Township.

GOAL 3: Reduce deer/human conflicts in the areas of deer/vehicle collisions and agricultural, ornamental and garden damage.

GOAL 4: Manage deer in a safe, humane, socially responsible manner.

Managing overabundant deer has emerged as one of the most challenging issues in natural resource management. Warren (1997) eloquently summarized the problem by stating: “... It is such a great management challenge because it is not simply a biological or ecological problem. Certainly, deer biology and ecology are important aspects to the problem: however, even more challenging are the social, political, legal, and economic aspects that are collectively referred to as human dimensions.”

No Action - Not Recommended

No action could be considered as one deer management option. The result of inaction would be continued negative impacts by overabundant deer, increasing deer numbers, and a widening area of overabundant deer challenges within Lower Makefield Township. Inaction would not allow the realization of the goal of protecting, maintaining and restoring the structure, diversity and function of Lower Makefield Township’s open space habitat and reducing deer/human conflicts.

Mitigation Techniques - Not Recommended

Mitigation techniques such as fencing, repellents, feeding and establishing landscape planting resistant to deer browsing have value in addressing individual problem properties but not larger functioning landscapes on the scale of Lower Makefield Township. It is neither practical nor effective to use deer repellants to protect forest ecosystems. Fencing, although costly, could be used to exclude deer from some select areas but not without changing the character and function of those areas as part of an interacting landscape. Protecting representative areas from overabundant deer impacts can create diverse “gardens” representing what would have existed on the broader



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unprotected landscape had deer numbers and thus impacts been reduced. Fencing is not consistent with the goal of maintaining white-tailed deer as a valued component of the township’s open space.

Feeding is sometimes suggested as a method of mitigating deer impacts on vegetation. However, in the absence of predation deer have no density limiting mechanisms independent of available nutrition. This allows deer populations, unrestricted by mortality, to increase to nearly unlimited densities so long as adequate nutrition is provided. Feeding deer without introducing some method of preventing population growth will exacerbate the current challenges, not eliminate them.

A variety of ultrasonic devices inaudible to humans but purported to deter deer from entering a homeowners property are on the market today. No science based literature supports their effectiveness.

Restoration of Predators – Not Recommended

Predation controlled and limited both deer numbers and deer impacts through the millennium. The current overabundance of white-tailed deer and their pervasive effects on ecosystems is the result of human-caused extinction of large predators, including indigenous hunting cultures. Predator restoration is sometimes suggested as a way to restore this ecosystem process and re-establish a balance between deer and forested ecosystems. The restoration of large predators capable of having a population limiting effect on deer may have merit in more rural landscapes. In suburban settings such as Lower Makefield Township, it does not.

Predators capable of limiting deer populations are also animals that see humans and our pets, as potential prey. And while human fatalities from large predators such as cougars are rare they do occur with sufficient frequency to present social resistance to their reintroduction to residential landscapes. In addition, residential landscapes such as those found in Lower Makefield Township do not offer the quality of habitat required to support predator populations of sufficient density to control and limit deer numbers and deer impacts.

If deer populations are to be reduced and maintained at densities low enough to maintain healthy forest ecosystems in residential landscapes, it will require human intervention to mimic the population-stabilizing effects of natural predators.

Trap and Transfer – Not Recommended

One method used within some communities has been the trapping and transferring of deer from the problem areas to off-site locations. Typically the location of release is either a commercial cervid “farming” operation where deer are treated as livestock either for meat or recreational “hunting”. In nearly all cases trapping and moving deer simply involved transferring the site at which mortality will occur. In Texas for example, deer can be live trapped by a community and sent either directly to a slaughterhouse where they will be killed and processed for meat or to a property with a management plan that limits deer numbers through hunting.

In most states, including Pennsylvania, live-trapping and relocating deer is not permitted because of high costs, disease and parasite transmission

The available published literature does not support the conclusion that contraception would be effective in realizing the deer management goals for Lower Makefield Township.

risks, unavailability of suitable release sites, and concerns over stress to captured deer. Most relocated deer do not survive a year in their new locations (Conover 2002).

Contraception – Not Recommended

A number of communities around the country are exploring one form or another of reproductive control (Rutberg et al. 2004), including; contraception through synthetic steroid hormones designed to prevent ovulation or conception by providing a daily dose of hormones similar to a birth control pill; immunocontraception vaccines which involve remotely injecting deer using a dart gun with a vaccine that will cause their immune systems to develop antibodies that will attach to their own reproductive cells or hormones blocking fertility and; contragestation which is a technique that terminates pregnancy by injecting the female with a drug that induces the aborting of the fetus.

The small home range size and strong site fidelity of urban female deer suggest localized management using immunocontraception is theoretically possible in suburban communities. Immunocontraceptive vaccines offer significant promise for wildlife management (Turner and Kirkpatrick 1991, Kirkpatrick et al 1997, Warren et al 1997 and Kirkpatrick and Rutberg. 2001). Great progress has been made in the past two decades toward practical contraception tools, yet no fertility control agents have been approved by the Food and Drug Administration (FDA) or Environmental Protection Administration (EPA) for non-investigational use on wildlife populations in the United States. Several materials such as GonaCon™ and Spay-Vac™ show good promise but may only be used in rigidly controlled research studies. Their use requires each animal to be captured and marked before treatment. The regulation of GonaCon™ has been moved from the FDA to EPA and may be approved for management use this year. Any contraception treatment must be permitted by the Pennsylvania Game Commission. To date, the PGC has not announced a written public policy on the use of contraception in the state.

The specific application of any form of contraception at Lower Makefield Township has several challenges:

- Contraception is experimental and has not been shown to be an effective management tool for free ranging deer populations in situations like those at Lower Makefield Township. Any use of contraception would need to be viewed as research and experimental not as a management solution.
- Contraception by design requires time and non-directed mortality in order for a population reduction through attrition to occur. Under the best of circumstances a time lag of several years would be required for deer numbers and impacts to be reduced to the levels required to meet the deer management goals for Lower Makefield Township.
- No experimental applications of these drugs have targeted the low deer densities required to achieve the goals of protecting, maintaining and restoring the structure, diversity and function of forested ecosystems. Instead their use has focused on eliminating or reducing deer/human conflicts which typically can be realized at higher deer densities. No field studies to date document that contraception is capable of reducing deer in a non-insular population to the deer densities required to meet the management goals at Lower Makefield Township.

Recreational hunting can, in many landscapes, be an effective mechanism for mimicking the population-stabilizing effects of natural predators on deer.

- If localized management of deer in suburban environments is to be successful, the geographic scale of movements will need to be limited, site fidelity high, and dispersal rates low (Porter et al. 2004). The geographic scale at which localized management can be effective is therefore determined by the movement behavior of females. Suburban deer appear to possess the necessary behavior attributes, but the dispersal rates can complicate management. It may not be possible for a program that requires low deer densities to overcome immigration from surrounding populations (Porter et al. 2004). This is particularly true for populations where deer removal is through attrition using fertility control.

Lower Makefield Township has good conductivity within and between township deer habitat and neighboring townships, including the islands on the Delaware River.

- Contraception does not mimic the population-stabilizing effects of natural predators on deer from an ecosystem perspective. Instead it artificially reduces recruitment altering both the behavior and interaction of individual animals and that of the deer herd.

The available published literature does not support the conclusion that available contraceptives would be effective in realizing the deer management goals for Lower Makefield Township. If proponents of these techniques disagree, it is suggested that they be given the opportunity by the township, to provide a detailed written proposal specific to Lower Makefield Township, referencing the published literature, including a budget and with a credible research partner as co-author.

Trap and Euthanize – Not Recommended

Trap and euthanize typically involves either clover traps or drop nets. With clover traps a single deer is baited into a box trap, where a telemetry signal notifies the trapper of a capture. The trapper then euthanizes the deer with a gunshot to the brain. With drop nets, multiple deer are lured under a net using bait. The net is then dropped over the group. Trappers, who are on site to activate the net, and then euthanize the animals either with a gunshot to the brain or a bolt gun such as is used in slaughterhouses. Trap and euthanize using drop nets may not be viewed as humane because of the time interval between capture and euthanization. Clover traps are not recommended in high use recreation areas due to the risk of vandalism. Neither technique is recommended as a single treatment approach due to the fact that deer eventually learn to avoid traps, reducing program effectiveness.

Recreational Hunting – Recommended with reservations

In the absence of predators recreational hunting has been the primary means of managing annual mortality rates in deer populations (Woolf and Roseberry 1998), which ultimately determines the number of deer in the population (McCullough 1987). Recreational hunting can, in many landscapes, be an effective mechanism for mimicking the population-stabilizing effects of natural predators on deer. Skilled committed hunters can and do partner with landowners and communities in many situations to successfully manage deer (Kilpatrick et al. 2002). However, similar to contraceptive techniques, and despite the good intentions, confidence and optimism of many hunt-

ers and wildlife agencies, the available published literature does not support the conclusion that traditional recreational hunting would be effective in realizing the deer management goals for Lower Makefield Township.

A review of urban/suburban deer programs, throughout the contiguous 48 states, has failed to produce a single, practical example, supported by quantitative, science-based data, in which recreational hunting reduced deer impacts to levels that would protect, maintain and restore the structure, diversity and function of the municipality's forests in a landscape situation similar to Lower Makefield. The limited effectiveness of recreational hunting in these types of situations results from four primary constraints:

1. Recreational Threshold

"Recreational Threshold," is defined as a deer density at which many hunters do not see enough deer to justify their continuing to hunt (Moyer and Shissler 2006). Hunters hunt for many reasons, but central to all motivation is recreational enjoyment. If the hunting experience fails to meet that expectation, hunters are likely to hunt somewhere else, hunt less or stop hunting. Pennsylvania hunters grew up and formed their expectations of hunting during decades of high deer densities, sometimes seeing scores of deer per day. Many hunters judge the success of their hunt more by how frequently they see deer than by what they eventually kill. Others take pride in providing healthy meat for their families, harvesting a large buck, refining their skills or simply spending time in the woods. Few hunters hunt to restore ecological balance and, understandably, few pursue deer solely to interrupt the enzootic cycle and transmission of Lyme disease.

One challenge to deer management programs that strive for low deer densities in order to restore or maintain ecological integrity is that, at some point, hunters are being asked to work against what they may see as their own interests. As deer numbers are reduced, the effort required to harvest additional deer increases and moves toward the recreational threshold. Finding a balance between the deer density recreational hunters find satisfying and one sought by the community to meet its goals can be difficult.

In addition, hunting activities cause deer to be increasingly wary and nocturnal, reducing their visibility and vulnerability to hunters and other control methods. Consequently, hunters who see few deer may be tempted, from their perspective, to declare the management program a success, even though deer numbers and impacts remain well above the community's goals. Maintaining hunter effectiveness under such conditions is challenging, particularly given the widespread overabundance of deer in southeastern Pennsylvania, where a hunter can easily find another location where deer are dramatically more vulnerable and easy to observe.

2. Deer Vulnerability

Deer vulnerability is defined as the effort required to harvest a deer, independent of the hunter's skill level. In suburban landscapes deer are less vulnerable due to smaller home ranges, nocturnal behavior and the abundant deer refugia where hunters cannot responsibly pursue them. These refugia include backyards, high use recreation open space, safety

In Lower Makefield Township where deer vulnerability is low and deer refugia abundant, traditional hunting can provide some recreation but is unlikely to provide cost effective deer management to the community.



In landscape mosaics with abundant unhuntable ground, it becomes easy for deer to avoid hunters during daylight hours, by remaining on properties within their home range where recreational hunting is not permitted or practical.

zones and the numerous areas within such landscapes that provide cover for deer but where recreational hunting is judged by a landowner or community not to be a compatible use. Functional refugia set a constraint on the lower limit to which deer populations can be reduced and limit what traditional management can be accomplished (McCullough 1984).

Deer successfully avoid hunters not by covering long distances, but by finding the least disturbed or most protective cover available within their home range and “hiding out.” In landscape mosaics with abundant unhuntable ground, it becomes easy for deer to avoid hunters during daylight hours, by remaining on properties within their home range where recreational hunting is not permitted or practical. This behavior of avoiding hunted areas until after dark reduces deer vulnerability to hunters while allowing deer access to hunted habitats. This problem is compounded by the realities of recreational hunting itself. Those deer most easily removed by hunters tend to be those that are less cautious, while those that remain are further advantaged by learned behavior, allowing survivors to become more cautious, more nocturnal and less vulnerable. Finally, as deer are removed and their numbers decline there is more space for the remaining individuals to hide and elude hunters.

Recreational hunting is often offered as “the no cost option”. However, managing hunters in residential communities does involve costs (Doerr et al. 2001, Kilpatrick et al. 1997), in staff time and loss of recreation values as the woods are closed to other activities. Doerr et al. (2001) determined the cost of deer removal using controlled hunts, (\$117 per deer removed), was similar to using sharpshooting by wildlife conservation officers, (\$108 per deer removed), and park staff, (\$121 per deer removed). He concluded that sharpshooting over bait was the most adaptable method in many urban deer management situations. In addition, unhunted suburban deer are very naïve to gunshots, and are reluctant to flee a bait site once shooting is initiated (DeNicola et al. In Press (b)), increasing their vulnerability and the efficiency and effectiveness of sharpshooting. Conversely, recreational hunting may remove some deer but because of its inherent nature, which provides for “fair chase” opportunities for deer escape, survivors are “educated” making their ultimate removal more difficult and expensive. In areas where sharpshoots are required to reach the community’s goals, recreational hunting, unfortunately, can increase costs and undermine the potential success of the program by “educating” those animals not immediately removed.

Deer vulnerability varies dramatically between different communities for both recreational hunters and sharpshooting based on topography, amount and juxtaposition of deer habitat and deer refugia, cover type, size of huntable areas, density of housing, community values, etc. Based on these variables, recreational hunting can play an important role in meeting community deer management goals in some situations but not in others. In Lower Makefield Township where deer vulnerability is low and deer refugia abundant, traditional hunting can provide some recreation but is unlikely to provide cost effective deer management to the community.

There is no quantitative data that demonstrates that archery hunting alone can successfully reduce deer impacts to levels compatible with healthy forest ecosystems within densely populated residential communities or heavily used suburban open space.

3. Tackle

Archery hunting has been promoted as a vital and cost effective tool for suburban deer management (New York State Department of Environmental Conservation 2007).

Many urban deer management programs implement archery hunts with the goal of resolving deer overabundance challenges. Archery hunters are among our most skilled hunters, many of whom have chosen archery equipment specifically to increase the challenge of harvesting deer. The commitment of these hunters and their organizations has contributed to the public's general philosophical support of hunting. However, there is no quantitative data that demonstrates that archery hunting alone can successfully reduce deer impacts to levels compatible with healthy forest ecosystems within densely populated residential communities or heavily used suburban open space.

Archery equipment, by design, is less efficient than other forms of hunting tackle. Deer at 50 yards are beyond the responsible reach of a bow but not a rifle, shotgun or muzzleloader. To consistently kill deer, the archery hunter must be closer to the animal and far more concerned about scent, movement and camouflage than a firearm hunter. Furthermore, while a firearm hunter can shoot with a minimum amount of movement, the archer must draw the bow in the near presence of the animal, and hold the draw until taking a shot. Crossbows reduce movement but do not increase range and have the limitation of one shot. A skilled rifle hunter can remove entire groups of deer, particularly if the rifle is suppressed (modified to minimize noise), while an archery hunter cannot. As a result, not only are individual deer less vulnerable to a hunter using archery equipment rather than some other form of tackle, local deer populations are also more likely to learn to avoid archery hunters because of the inherent limitations of reduced range, increased movement and inability to remove entire groups of deer.

Muzzleloading rifles of .44 caliber or larger are permitted as legal tackle for recreational hunting in Wildlife Management Unit 5D by the Pennsylvania Game Commission. However, hunter activity and access are restricted by safety zones laws. Recreational firearm hunters may not shoot at, take, chase or disturb wildlife within 150 yards of any occupied residence, camp, industrial or commercial building, farmhouse or farm building, or school or playground without the permission of the occupants. It is unlawful to shoot into a safety zone, even if the hunter is outside of the zone. Driving game, even without a firearm or bow, within a safety zone without permission of the occupant is unlawful. The safety zone around the typical home is approximately 16 acres. In densely developed communities like Lower Makefield, safety zones exclude much of the landscape and deer habitat from recreational hunting. Safety zones in Lower Makefield include most of the township and its wooded habitat.

Also, similar to archery tackle, muzzleloaders have serious limitations that do not lend them to controlling deer populations in suburban and exurban landscapes. Of greatest concern are the limitations of one shot, the time and movement required to reload, and the smoke and odor associated with black powder and black powder substitutes.

“The concept of sport hunting was first advanced in America in the mid-nineteenth century by an Englishman named Henry William Herbert.”

Manual or autoloading shotguns, .410 or larger using slugs and 20-gauge or larger using buckshot, are permitted as legal tackle for recreational hunting in Wildlife Management Unit 5D by the Pennsylvania Game Commission. For deer management purposes it is recommended that shotgun hunters use only autoloading shotguns equipped with scopes, rifled barrels and sabots. The biggest limitation of well equipped shotguns is the inability to suppress noise. The loud report from an initial shot usually alarms deer both in the group being culled and within the surrounding landscape making multiple removals more difficult while increasing the potential for educating deer.

Rifles are not legal tackle for recreational hunters in Wildlife Management Unit 5D, in which Lower Makefield Township is located. Because of safety concerns, the Pennsylvania Game Commission has disallowed rifles for recreational hunting in special regulation areas like WMU 5D, where land use is dominated by homes, businesses and institutions. A new study requested by Pennsylvania House Resolution 61 and supported by the PGC reports, however, that rifles are no less safe than shotguns (Bacastow and Kenan 2007). Whether the report will result in regulation changes is unknown.

One advantage of rifles over autoloading shotguns equipped with scopes, rifled barrels and sabots, is the ability to suppress noise. Rifles can have suppressers added that dramatically reduce noise and negative deer responses. This modification allows deer in groups of up to half a dozen to be removed without allowing any member of the group to escape thereby avoiding learned behavior and decreased deer vulnerability. Where rifles are legal tackle in Pennsylvania for recreational hunting they may legally be equipped with suppressers provided the hunter has the proper permits from the federal Department of Alcohol, Tobacco and Firearms.

The requirement that hunters tag each deer following its harvest, prior to shooting an additional deer (Pennsylvania Game Commission 2006b), also limits the effectiveness of recreational hunting for assisting communities in effective deer management. This limitation makes removing groups of deer virtually impossible regardless of tackle used and is rooted in the values of sport hunting, fair chase and equitable distribution of game among hunters. Also, firearm hunters in residential landscapes are required to wear a minimum of 250 square inches of florescent orange material on the head, chest and back combined so as to be visible from 360 degrees (Pennsylvania Game Commission 2006b). This requirement is a deterrent to landowners who, while willing to allow discrete hunting efforts on their property, are not comfortable with hunters dressed in conspicuous florescent orange standing in elevated tree stands announcing their presence to the neighborhood. Some skilled and responsible hunters find that being so conspicuous within densely populated landscapes diminishes the quality of the experience enough that they are reluctant to hunt.

Rifles may be used in Wildlife Management Unit 5D under a deer control permit issued by the PGC with no limitation on the number of deer shot prior to tagging. Safety zones do not apply to deer removals under a deer control permit nor do the florescent orange requirements.

4. Compatible Use

NRC Inc. has been unable to identify any organized deer hunting activity on properties in Lower Makefield Township despite inquires to local hunting clubs, township staff and the local Wildlife Conservation Officer. This is not surprising given that firearm safety zones preclude hunting nearly everywhere without multiple landowner permission to waive safety zones. As a result, traditional recreational hunters do not, and are unlikely to receive significant access. Some individual or small party hunting may be occurring on some private property.

In residential landscapes, residents typically view overabundant deer not as a recreational opportunity but as an animal control problem. Community goals are often simply the reduction of deer/human conflicts using methods that are safe, humane, unobtrusive, effective and fiscally responsible.

Recreational hunting may, under regulations designed for the realities of modern, urbanized environments, play a role in reducing deer in some communities. However, for many suburbanites, hunting is not a familiar or comfortable concept. Nor is the use of firearms and archery equipment within their community and around their homes an activity that is easily embraced. People whose “social values” lead them to reject hunting in their neighborhoods do not necessarily oppose the concept of hunting in a broader, philosophical way. Instead, they may simply see hunting as an incompatible use within the context of their immediate living environment.

A survey of representative citizens from across Pennsylvania concluded that over 81% either supported or did not object to hunting as a method for controlling deer populations (Reed et al. 2003). Suburban residents had an 82% level of support while rural and urban residents supported hunting by 86% and 71% respectively.

It has been stated that “when access is granted, hunters have proven they can be very efficient managers of deer populations. All you’ve got to do is tell people you want them to come hunt on your property. It’s that simple. And it doesn’t cost a dime.” (Feaser 2006). A homeowner may do this by waving their legal right to the safety zone surrounding their home. For many families this is not an acceptable option and for many communities it is not a realistic and workable solution.

Recreational firearm hunters may not shoot at, take, chase or disturb wildlife within 150 yards of any occupied residence, camp, industrial or commercial building, farmhouse or farm building, or school or playground without the permission of the occupants (PGC 2006b). It is unlawful to shoot into a safety zone, even if the hunter is outside of the zone. Driving game, even without a firearm or bow, within a safety zone without permission of the occupant is unlawful. The safety zone around the average home is approximately 16 acres.

Even in communities where the majority of homeowners waive their safety zones, abundant deer refugia remain. Consider a community with 2-acre building lots. Each home has a safety zone of 150 yards which means that the safety zone of any one home extends onto eight to 10 other



People whose “social values” lead them to reject hunting around their homes do not necessarily oppose the concept of hunting in a broader, philosophical way. Instead, they may simply see hunting as an incompatible use within the context of their immediate living environment.

Whether 10% or 80% of homeowners waive their safety zones, as long as deer refugia exist within the home ranges of most deer and community management goals target low deer densities, there is little evidence that traditional recreational hunting can effectively address the challenge of overabundance.

homeowner properties, regardless of whether these homeowners give hunters approval or not. Therefore, even in a community where 80% of homeowners waive their safety zone, recreational hunting could be functionally prohibited by the minority who do not.

More importantly, whether 10% or 80% of homeowners waive their safety zones, as long as deer refugia exist within the home ranges of most deer and community management goals target low deer densities, there is little evidence that traditional recreational hunting can effectively address the challenge of overabundance.

Recreational hunting is often presented as the most cost efficient method of deer management (New York State Department of Environmental Conservation. 2007). However, given the dearth of evidence regarding its effectiveness in achieving community goals in situations like Lower Makefield, this is a difficult assertion to support. In addition, quantitative comparisons of deer removal techniques in urban landscapes do not bear out such assertions (Doerr et al. 2001).

The use of baiting to lure deer to areas where they may be safely and legally removed was legalized for Wildlife Management Unit 5D in October 2006 (Pennsylvania Game Commission 2006a). Managers hope this tool will allow hunters to be more effective at controlling deer populations in residential landscapes by increasing deer vulnerability, lowering the recreational threshold for hunters and increasing acceptance of recreational hunting within communities. Baiting can be a useful tool to increase hunter effectiveness in some landscape situations. Baiting deer during regulated hunting seasons is permitted in 26 of 48 U.S. states (Durkin 2000) including most of Pennsylvania's neighbors such as Ohio, Maryland, New Jersey, Delaware, and West Virginia. Hunting over bait increases deer harvest rates, reduces mean shot distances and reduces hunter effort per kill (Synatzke 1981).

Regulated baiting can increase deer vulnerability if done properly. It will move the core area (area of highest use within a deer's home range and where it spends 50% or more of its time) of the deer closer to bait sites (Darrow 1993, Kilpatrick and Stober 2002), thus allowing for their more effective removal. Baiting also may be used to shift deer activity away from residential areas to enhance shooting safety (Kilpatrick and Stober 2002). Deer home ranges are relatively small in urban landscapes (Cornicelli 1992, Grund 1998, Kilpatrick and Spohr 2000), often averaging 100 acres or less.

However, even though baiting has been legal for use in situations similar to Lower Makefield Township in many states for decades, there remains no quantitative, science-based evidence that recreational hunting, even with bait, can successfully achieve and maintain the deer management goals established for Lower Makefield Township with the type of residential landscape presented there.

Sharpshoot Utilizing Bait and Nocturnal Removals – Recommended

Sharpshooting, in suburban landscapes, has been shown to be an effective localized tool for reducing deer populations by removing up to 90% of deer within a single year (DeNicola et al. In Press (a)). Sharpshooting involves the

To prevent “educating” deer and maintaining their naïve behavior it is critically important to only take shooting opportunities where all female deer present at a bait station can be removed at that time.

use of a suppressed, small caliber rifles by trained personnel to remove deer at multiple pre-approved and prepared bait sites at night or during the daylight. Deer are humanely euthanized (i.e., killed with a shot to the center of the brain) (American Veterinary Medical Association 2001) from a vehicle or from a tree stand (DeNicola et al. In Press (a), DeNicola et al. 1997). Human safety is ensured by only shooting when there is a known earthen backstop created through the shooter’s relative elevation (e.g. tree stand) or topography and a clear field of vision. Deer are not removed in brush, at random locations or while moving. Deer are shot on a first opportunity basis with antlerless deer being given priority. Unhunted suburban deer are very naïve to gunshots, and are reluctant to flee a bait site once shooting is initiated (DeNicola et al. In Press (b)). To prevent “educating” deer and maintaining their naïve behavior it is critically important to only take shooting opportunities where all female deer present at a bait station can be removed at that time.

Properly designed sharpshoots can be very efficient and result in safe, humane, socially responsible and effective deer management programs. One shooter may remove dozens of deer in one night. As with any type of management program, the success of a sharpshoot depends on the quality of the program design and field personnel compliance. Costs for contracted deer removals vary from \$100 to \$350 per deer, when using off-site contractors. Costs can be reduced significantly by training local personnel and/or using carefully selected, well trained hunters.

The township would need to apply for and obtain a deer removal permit from the Pennsylvania Game Commission. The application will require the township to substantiate the background and scope of the deer problem and include alternative approaches to the problem and propose what action is recommended to be taken under the permit. A complete map showing the boundaries of the area being considered and indicating the land use within the area, cover types, huntable areas, damage areas, deer concentration areas, safety zones and proposed control areas within the municipal boundary would need to be provided. In addition, a deer management plan would need to be submitted which provides deer density estimates and requesting the number of animals to be removed.

The permit removal period is February 1 to September 30, unless otherwise authorized by the PGC Director and listed on the permit. Deer could be removed safely, efficiently and unobtrusively anytime during the winter using nocturnal removals. Sharpshoots that are allowed to occur over a span of months are difficult for objectors to disrupt. Those that have short and specific removal periods can effectively be vandalized. The longer the removal period the more latitude staff or contractors have in removing deer and therefore the lower the cost. If local personnel are to be trained, a longer time frame provides the best outcome. NRC Inc. recommends requesting in the permit application, a removal period to begin January 1.

In the past, as a matter of policy, the PGC has requested that municipalities attempt recreational hunting to determine its effectiveness in achieving the community’s goals before issuing a deer control permit. NRC Inc. recommends requesting that the PGC waive this trial period based on the lack of documented evidence supporting the effectiveness of recreational hunting in landscapes situations like Lower Makefield. The PGC also has followed a policy of requiring communities to provide recreational hunting somewhere

As with any type of management program, the success of a sharpshoot depends on the quality of the program design and field personnel compliance.

in the community as part of their deer management plan in order to receive a deer control permit. In the case of Lower Makefield, such an effort would contribute little toward the actual deer reduction goal but would provide some public recreation. NRC Inc. does not recommend any township-directed, controlled firearm hunts, although where hunters can independently obtain permission from landowners and comply with the game law; we see no reason to discourage firearm or archery hunting. The PGC policy to include an element of recreational hunting could be met safely by a controlled archery hunt in Five Mile Woods if the township decides to pursue that option. The cost of the archery hunt would depend on whether the township would feel it necessary to close the preserve during the hunt, the degree to which the hunt would be managed, whether bait and feeders would be permitted and the level of supervision required. NRC Inc. would recommend closing the preserve during the hunt. Hunting on other township land which is dominated by open fields is possible but not productive. It is difficult for hunters to be effective in open fields due to a lack of cover for both hunters and deer while being quite visible from adjacent roads and bordering residential developments.

NRC Inc. has preliminarily identified and field-checked over 50 potential deer removal sites within the township, which will be more than adequate to meet deer management goals. Land ownership has not been evaluated and many more sites appear to be available. Permission from private property owners who have desirable removal sites must be obtained. Approval by adjacent property owners is not required but recommended. Safety zones do not apply to deer control permits. Four removal sites are recommended for Five Mile Woods.

Three weeks are required for deer to pattern well on bait sites. We suggest baiting begin three weeks prior to the earliest possible removal period. Baiting material should be bagged shell corn. Corn can be transported to or near the bait sites by small all-terrain vehicles. The amount of bait placed at each site should be regulated by use. Place sufficient corn to see most of the material gone by the next visit. This will mean some trial and error but the general pattern will be to begin with about 3 gallons of shell corn until the bait site is discovered by deer then increase the amount to keep bait available. Different bait sites will have varying amounts of bait removed and should be treated accordingly. Bait should not be dumped out but spread as if you were feeding chickens, so the grain is not piled but scattered over an area several yards in diameter. Bait site visits should begin at an interval of once every three days until sites are well used then every other day. Baiting should be as inconspicuous as possible. Baiting should be discontinued for periods when snow is on the ground.

The sex and age structure of non-hunted suburban deer populations are fairly uniform and predictable consisting of 60% females and 40% males with ~40% yearling adult females, ~20% yearling/adult males and ~40% fawns (DeNicola et al. In Press (b)). Adult female/male sex ratio of 2:1 is typical of unhunted suburban populations (DeNicola et al. In Press (b)). This is significantly smaller than that typically found in hunted populations (3:1 to 6:1; Mattfeld 1984, Van Deelen et al. 1997, Vercauteren and Hygnstrom 2000) because hunters prefer to shoot bucks. Males are more prone to dispersal than females (Holzenbein and Marchinton 1992), and are subject to increased rates of mortality (Nixon et al. 1994). There also may be disproportionately high male mortality rates related to the breeding season in suburbia because of

An independent compliance and effectiveness monitoring program should be implemented prior to any deer removal utilizing sharpshooters.

deer vehicle collisions and the potential for injury while competing for females (Gavin et al. 1984).

The Deer Control Permit application process will require the township to identify the number of deer you wish to remove and the areas from which removal will take place. Deer densities in the township undoubtedly vary widely from none, in non-habitat areas, to 110 deer per square mile or more, in the general area of Five Mile Woods. We suggest the township consider phasing in the removal program by first focusing on areas with larger blocks of habitat and township owned land the first year. The second year the removal could expand into more intensely developed areas with the eventual goal of addressing the entire township. NRC Inc. recommends the township request 200 permits for the initial removal year.

Since deer management is a long-term, perennial obligation if it is to be effective, NRC Inc. recommends the use of a credentialed, experienced contractor to conduct the initial removals while simultaneously training personnel during the first two years before shifting to locally trained personnel thereafter. An independent compliance and effectiveness monitoring program should be implemented prior to any deer removal.

Integrated Program – Recommended with reservations

Many communities, depending on their circumstances and where they lie along the deer management gradient, can combine deer management techniques successfully, either annually or sequentially. Sharp-shooting reductions, for example, may be followed by trap-and-shoot programs using local staff for population maintenance. Controlled hunts using recreational hunters may be used in larger open space areas, while sharpshoots are employed in areas where hunting cannot achieve deer management goals. Some communities, in order to provide hunting recreation, combine archery hunts followed by sharpshoots. Every situation is unique and communities are well advised to design their program based on their circumstances, resources, values and goals.

Integrated programs that use multiple tools at appropriate locations are often the most effective at controlling deer numbers. In Lower Makefield, an integrated program that would include a controlled archery hunt at Five Mile Woods, in addition to encouraging archery and shotgun hunting on private lands where landowners grant permission would be unlikely to improve program effectiveness. Indeed, in a landscape such as that present in Lower Makefield, a recreational hunting program would make deer removals more difficult due to increased deer wariness, particularly if hunters employed bait. It would however, provide some recreational hunting for those citizens wishing to pursue hunting. No organized deer hunting efforts are currently known to occur in the township. However, last year 10 antlered and 42 antlerless deer were reported as harvested in the township by hunters to the PGC (Personnel communication Brett Wallingford, Pennsylvania Game Commission Biologist) suggesting that individual hunting is occurring within the township.

Deer managers have a history of requiring communities to first use traditional recreational hunting to address their deer management goals prior to using alternative techniques, even when experience and the available evidence suggest little chance of success. This pattern often occurs because

“Where experience and evidence indicates traditional recreational hunting methods will not meet community deer management goals, hunters may still be able to participate as skilled partners, using nontraditional techniques.”

the manager confuses the management tools with the management goals. Although recreational hunting is certainly not discouraged where landowners grant permission in the township, providing hunting recreation is not the goal of Lower Makefield Township. Instead, the deer management goal of the township is balancing deer impacts with healthy habitat, biodiversity conservation and reducing deer human conflicts. Recreational hunting, where appropriate and effective, is simply one possible tool for achieving that goal.

If providing recreational hunting and the benefits it offers to the individual and the community is a goal, then hunting should be encouraged, except in those situations where it might conflict with the township’s deer management program.

Hunters may be able to play a significant role in meeting the deer management needs of communities like Lower Makefield provided hunters, their regulatory agencies and community leaders adapt realistically to local conditions and work together. Where experience and evidence indicates traditional recreational hunting methods will not meet community deer management goals, hunters may still be able to participate as skilled partners, using nontraditional techniques and tools, to manage deer, while enjoying traditional recreational hunting for themselves where permitted by landowners.

Brown et al. (2000) suggests that if deer populations are to be controlled, wildlife agencies will need to recognize the increasing importance of urban and suburban areas as elements of deer range while adopting hunting regulations that can address the expansion of deer refugia associated with urban development that limit hunter access to deer.

Holsman (2000:814) suggests that “Agencies should seek opportunities to encourage hunter consideration of and participation in broad-based management goals to develop a constituency that understands the provision of recreational opportunity in the context of a larger mission. He further suggested that stewardship behaviors may result from adherence to social norms and that the opinion of others can serve as a social norm for developing appropriate stewardship behaviors. “Agencies should consider opportunities to use social norms to influence individual hunters and hunting organization.” Holsman (2000:814). The current effort by PGC commissioners and some hunting organizations like the Pennsylvania Federation of Sportsmen Clubs who have stepped forward to encourage hunters to embrace their responsibility to manage deer based, at least in part, on the goals of habitat health, is an important step in that direction. Another step would be for hunters to use their skills, in the interest of the community, to balance deer impacts with healthy habitats and reduced deer-human conflicts in landscapes, like Lower Makefield, where traditional recreational hunting cannot achieve community goals.

The hunting tradition in North America has its roots in a utilitarian value system (Organ and Fritzell 2000) that recognized hunting as a skill and craft with some individuals becoming extremely proficient while many were not. Native Americans and early settlers held consistently successful hunters in high regard not because they were lucky or “well equipped”. Instead, they recognized them as individuals who had mastered the craft of hunting and whose skill often made the difference between having enough to eat or, going hungry, staying warm or going without clothing or blanket skins.

If providing recreational hunting and the benefits it offers to the individual and the community is a goal, then hunting should be encouraged, except in those situations where it might conflict with the township's deer management program.



The concept of sport hunting was first advanced in America in the mid-nineteenth century by an Englishman named Henry William Herbert (Herbert 1849, Mighetto 1991) and called for hunters to constrain their predatory abilities by modifying their behavior to include concepts such as “fair chase, equitable distribution and hunting for the sport of the adventure rather than to provide food, useful by-products or money. Turning hunters into sportsmen became a social movement in the late nineteenth century and was led by wealthy elites, primarily from urban areas, concerned about the dramatic decline in game populations as a result of overexploitation by subsistence and market hunting and wholesale habitat loss driven by unregulated resource extraction. The concepts of “fair chase, equitable distribution and sportsmanship became the cornerstones of the hunting ethic as a conservation tool to protect game populations from the efficiency of human hunters.

Today, most Americans support legal hunting, but, the perceived motivations of the hunter appear to influence public acceptance (Duda and Young 1998). Kellert (1978) reported that 60% of Americans did not approve of hunting for sport or recreation, whereas 80% approved of the traditional utilitarian values of hunting for meat. Duda et al. (1995) found that hunting for food, hunting to manage game populations, and hunting for animal population control are acceptable activities, whereas, hunting strictly for recreation and hunting for trophy animals are less acceptable.

Hunter skill levels today, as in the past, vary widely. Some hunters, who have mastered the craft of hunting, are consistently successful, while others are not. Hunter motivations also range widely, with many who have held onto the original, North American hunting values, rooted in providing healthy food. Some hunters see hunting as participating in something larger than themselves and a way of connecting to nature and natural cycles.

The primary management goal for Lower Makefield Township is to mimic the population-stabilizing effects of natural deer predators, to protect, maintain and restore the structure, diversity and function of the township's forests and open space, while reducing deer/human conflicts. Based on current experience and published evidence, traditional recreation hunting cannot achieve that goal, but hunters could.

One approach would be to select and train a subgroup of skilled hunters to be community deer managers under the guidance of the township and, as allowed by law, using a deer control permit from the PGC, along with specialized equipment and techniques to remove deer.

Hunters could be encouraged to apply to the township for consideration as urban deer managers. The selection process would include application criteria, interview, written and marksmanship test, workshop attendance, background check and, finally, field training. Hunter selection would occur throughout each step of the process. The final cut would identify five individuals for listing on the permit and 15 who would assist and be potential replacements. Selection and training would occur over two years. To be successful, such an effort would require township supervision, use of a credentialed, experienced contractor to conduct the initial removals while simultaneously training selected hunters, a well designed deer removal plan and an independent program for compliance and effectiveness monitoring. This approach may allow for the most cost effective, long-term management of the township's deer challenges.

Measurable indicators are the basic tools required for monitoring the success of any deer removal program.

GOAL 5: Establish a permanent, quantitative monitoring program to assess deer impacts on forest vegetation.

Measurable indicators are the basic tools required for monitoring the success of any program to maintain or recover forest structure, diversity, and ecological processes. Morellet et al. (2001) found a browse index closely tracked deer population size although species-specific browsing rates differed widely. Vegetation assessments can utilize two methods: (1) comparing the overall influence of deer browsing on existing vegetation to an established index, such as SILVA for advanced forest regeneration (Marquis et al. 1992) or a browse survey as used the Pennsylvania Department of Conservation and Natural Resource (DCNR) (Benner 2006, Aldous 1944) and (2) quantitative sampling that includes measuring, cataloging and comparing vegetation within fixed plots that use deer exclosures as controls. DCNR is currently funding a Rapid Habitat Assessment Study by the Pennsylvania Cooperative Fish and Wildlife Research Unit which is specifically designed to identify a suite of possible indicators of forest recovery from deer overbrowsing (Benner 2006). The results from this study are not yet available but should be monitored for potential value in Lower Makefield.

NRC Inc. recommends maintaining the three current exclosures in Five Mile Woods but adding three additional exclosures there, in consultation with the manager and friends group. Three exclosures are recommended elsewhere in the township: one in woodlands in the southwest of the township, one in the northwest and one in the northeast pending landowner identification, permission and on-site analysis. Exclosures should measure 10 meters by 10 meters using 8' high-tensile, woven, wire designed for wildlife with 6" vertical wires and supported by wooden posts. Exclosure locations should be chosen based on practical issues such as topography, access, lack of previous disturbance, etc., but also on being representative of the most sensitive forest types on the property and overstory and understory. A paired unfenced plot for each exclosure will need to also be identified and permanently marked. Sites should have minimum disturbance when erecting the fences. General data recorded for each plot should include slope, aspect, topographic position, percent canopy cover and visible indications of natural disturbance history. Data collection in the fenced and paired unfenced plots should be as follows:

1. 4 m radius circular plot centered in each exclosure and paired control plot measuring:
 - trees (trees defined as >12 cm dbh) species and dbh of each tree.
 - shrubs (shrubs defined as <12 cm dbh and > 1 m tall) for each species, % cover and height of tallest individual.
2. Ten 1 m sq. plots
 - for each herbaceous species (herbaceous defined as < 1 m tall) record % cover
 - height of tallest individual, ground surface % cover of bare soil, leaf litter, rock, tree base, dead down woody material.
3. Cover board (record number of squares covered by vegetation) on assigned grid at 10 random intersections but recorded and using the same grid points year to year.

**Deer were largely
extirpated from southeastern
Pennsylvania by the 1860's
with no legal reported kills
until 1923.**

4. Total plot species list

Woody and herbaceous vegetative data should be collected in June. The herbaceous survey should include a “random walk” in March, June and August that identifies species that may be rare on the property. When species are found they should have an estimate of number, percent flowering, amount of ground coverage in square meters and height of the tallest plant and location record. Random walks should include a review of plot locations. Vegetation data should be compiled and submitted each September. Supervised volunteers from garden clubs, Friends of Five Mile Woods, naturalists etc. are more than capable of effective data collection. Analysis and monitoring trends may require outside assistance.

SILVA and DCNR data collection should follow their outlined protocols. Consultation with the Environmental Advisory Council is recommended.

HISTORIC BACKGROUND OF LYME DISEASE

Background

The “deer tick,” *Ixodes scapularis*, is the principal vector for Lyme disease bacteria, *Borrelia burgdorferi*. White-tailed deer, *Odocoileus virginianus*, are the principal host for the adult blacklegged tick and a key to its abundance, (Barbour and Fish 1993) resulting in the commonly used name, “deer tick.”

The blacklegged tick is believed to be a native species of arthropod that declined in the 19th century due to a dramatic reduction in deer numbers as the result of the unrestricted hunting and due to a landscape level conversion of eastern forests to the open habitats of agriculture thus removing both the adult ticks preferred host and its preferred habitat (Ginsberg 1993, Stafford 2004).

In pre-European Pennsylvania, and throughout much of the northeast, the land was primarily forested, broken only by rivers and lakes, and clearings associated with Indian villages (Cumplings 1810, Dudley 1886, Maxwell 1910, Day 1953). As European settlers claimed the land, trees were cut down to make room for farms and towns. Wood not needed for fuel or building material was often burned in the process of clearing land (Latham et al. 2003). By 1907, Penn’s Woods, which once covered 95% of the state, was reduced to less than 30% (deCoster 1995), creating an open sunny habitat inhospitable to the blacklegged tick. At the very same time deer populations were crashing as a result of over exploitation through unregulated hunting and habitat destruction (Rhoads 1903, Severinghaus and Brown 1956, Kosack 1995, Latham et al. 2005). Deer were rare throughout the eastern United States by 1900, but they were scarce in Pennsylvania by 1895 when the Pennsylvania Game Commission was formed, in part to restore deer numbers (Kosack 1995).

Deer were largely extirpated from southeastern Pennsylvania by the 1860’s with no legal reported kills until 1923 (Pennsylvania Game Commission 1995a). Deer densities remained low until the 1970’s when populations began to grow, increasing dramatically in the 1980’s and 90’s.

Increases in tick populations have been linked to changing landscape patterns and increasing populations of white-tailed deer, which is the primary host for the adult *I. scapularis* (Barbour and Fish 1993).

Today, Pennsylvania has regained much of its former forests but with a much higher deer density than the original 7-10 deer/square mile found in the pre-European landscape (McCabe and McCabe 1984).

It is believed that blacklegged ticks probably survived during the 19th and early 20th century on islands off the New England coast where they were documented in the 1920's. With the regrowth of forests and the explosion of deer numbers, the blacklegged ticks re-established their populations on the mainland (Stafford 2004). Lyme disease was first recognized in 1975 in Lyme, Connecticut and has spread south.

The geographic spread of Lyme disease and its rising number of cases is closely correlated with the distribution and abundance of the blacklegged tick, *Ixodes scapularis*, infected with the Lyme disease agent, *Borrelia burgdorferi* (Mather et al. 1996, Stafford et al. 1998). Increases in tick populations have been linked to changing landscape patterns and increasing populations of white-tailed deer, which is the primary host for the adult *I. scapularis* (Barbour and Fish 1993). The abundance and distribution of blacklegged ticks has been directly related to deer densities (Wilson, et al. 1990, Barbour and Fish 1993). Epidemic Lyme disease in the northeastern United States occurs only in areas where populations of white-tailed deer are dense (Spielman et al. 1985, Lastavica et al. 1989). Adult ticks will utilize other host animals but prefer white-tailed deer (Barbour and Fish 1993). It is estimated that over 90% of adult ticks feed on deer (Stafford 2004). Therefore, deer are key to the reproductive success of the blacklegged tick and the spread of Lyme disease (Barbour and Fish 1993, Stafford 2004).

LYME DISEASE MANAGEMENT OPTIONS

GOAL 2: Reduce the probability of contracting Lyme disease within Lower Makefield Township

Area Wide Applications of Acaricides – Not Recommended

Area wide applications of acaricides for controlling ticks (Curran et al. 1993 Allen and Patrican 1995) are possible. The use of such treatments may be unacceptable to some township residents and could be in conflict with existing township ordinances. Property owners wishing to explore these tools should check with the township and a licensed pesticide application company.

Vegetation Management and Landscape Modifications – Recommended

Vegetation management and landscape modifications to reduce the quality of habitat for ticks (White 1993, Schulze et al. 1995) can be used to treat individual lawns or outdoor activity areas. These techniques can be very effective at reducing tick exposure in more manicured, turf grass areas and may be quite useful to homeowners and park managers. A discussion and description of these techniques can be found in the *Tick Management Handbook* by Kirby Stafford and published by The Connecticut Agricultural Experimental Station, New Haven Connecticut. Electronic copies of the handbook are available at www.caes.state.ct.

Use of Rodent Bait Boxes with Fipronil – Not Recommended

The white-footed mouse, *Peromyscus leucopus*, is typically the most abundant and efficient reservoir animal for the bacteria, *Borrelia burgdorferi*, which causes Lyme disease. One approach to reducing Lyme disease has been to target rodents like white-footed mice with a controlled application of acaricide. This technique utilizes a box that restricts animal access based on the size of the opening and uses bait to lure rodents inside. To access the bait mice and/or chipmunks must pass over a wick treated with 0.70% fipronil, an effective acaricide that with one doze will kill existing ticks and protect the rodent from new ticks for 40 days. The box, once baited and charged with fipronil, will generally not need maintenance for 90 days. For greatest effect boxes should be maintained from April through October.

Field trials have shown a high acceptance of the boxes by mice and a dramatic reduction in the total number of ticks in the areas treated after only one year and even higher after two years. The technique also showed positive results in decreasing the abundance of ticks infected with *Borrelia burgdorferi* (Dolan et al. 2004).

Down sides of the technique include the intensity of treatment, an average of 10 bait boxes per 1/2 to 1 acre habitat and high cost. Compounding these challenges is the withdrawal in 2006, of the modified commercial bait boxes registered by the Environmental Protection Agency in 2003. Bayer Environmental Science, the manufacture of Maxforce Tick Management System, explains the decision as based on challenges with squirrels chewing open the boxes to access the bait resulting in the potential exposure of nontarget wildlife and children to the fipronil inside. EPA has required that Bayer Environmental Science develop a shield to prevent uncontrolled access and the re-registering the product. The manufacturer would not provide an estimate of when the product would again be available but was not encouraging. They do recommend as a replacement, area wide spray applications of acaricides.

Considering the withdrawal by the Environmental Protection Agency of the Maxforce Tick Management System, it seems imprudent to use bait boxes with fipronil unless an EPA registered product becomes available.

Use of 4-Poster Feeder – Not Recommended at this time

The use of 4-poster feeders to treat deer with topical acaricides was developed in Texas (Pound et al 2000a). Computer models indicate that if 90% of a local deer population could be treated by 4-posters and have 95% control of *I. scapularis* on treated animals, that local tick populations could be reduced dramatically over several years (Stafford 2004). The 4-poster feeders rely on a central bin containing clean whole corn as bait to lure deer into placing their heads in such a way as to rub against pesticide-impregnated applicator rollers that apply acaricide to their ears, head, neck and shoulders. In restricted populations, 4-poster technology has resulted in the control of 92 to 98% of free-living ticks (lone star ticks, *Amblyomma americanum*) in the area around the devices after three years of use (Pound et al. 2000b, American Lyme Disease Foundation 2006). The use of 10% permethrin, resulted in a 91-100% reduction of larval, nymphal, and adult questing ticks in sampled plots (Stafford 2004) under controlled conditions. In a Maryland study at three locations with free ranging deer population Carroll et al. (2003) reduced *I. scapularis* nymphs by 69%, 76% and 80%.



4-poster feeders are not recommended at this time.

Failure to properly maintain 4-posters can be an obstacle to an effective program.

One challenge at Lower Makefield may be that while 4-poster use is generally high, utilization by deer is extremely low when other attractive food resources are available (Stafford 2004). Attractive food resources could be recreational feeding of deer, incidental feeding at bird feeding stations, or naturally occurring mast such as acorns or beechnuts. Forests with significant oak composition can produce hundreds of pounds of high quality acorns per acre as can yard trees that receive the benefits of lawn fertilizer, lime and watering. Acorns are preferred by deer over corn. In years of significant acorn crops, corn consumption is likely to decline independent of deer numbers. The major environmental factor that interferes with feeder use by deer and thus temporarily reduces efficacy, is the occurrence of heavy acorn crops (personal communication J. Mathews Pound, USDA-ARS Knipling-Bushland U.S. Livestock Insect Research Laboratory, Kerrville, TX).

A negative result of 4-posters would be to increase deer concentrations in the immediate area of their placement, increasing potential impacts on vegetation, which could be of concern to nearby residents. In addition the corn used to bait deer will increase the nutritional carrying capacity of the habitat. Provided the townships deer reduction program is implemented, neither of these issues should be of concern

An important issue regarding 4-poster effectiveness is feeder maintenance. Failure to properly maintain 4-posters can be an obstacle to an effective program. One serious challenge is habitat type and the presence of squirrels. When possible, 4-posters should be placed in clearings where they are not available to squirrels. Where squirrels do have access they will feed on the shell corn but focus primarily on the seeds embryo leaving much of the endosperm behind. The result is exposed, partially eaten kernels which quickly mold clogging the corn flow within the 4-poster and resulting in only moldy corn being available to deer and deer avoidance of the bait. In areas where feeders are exposed to squirrels it is recommended that feeders be checked and cleaned daily (Personal Communication Andy Szulinski, C.R. Daniels, Inc. Ellicott City, Maryland). In Lower Makefield Township a 4-posted distribution plan will allow for most areas to have minimum squirrel conflicts.

The use of 4-posters is labor intensive and requires multiple years to show efficacy. The estimated cost of a 4-poster program the initial year when purchasing feeders is approximately \$22/acre. In subsequent years the cost is approximately \$11/acre/yr. In Lower Makefield the acres requiring treatment would be reduced dramatically by targeting diurnal deer cover areas not the township as a whole. However, because of the exposed class 4 pesticide on the application rollers, 4-poster technology may not be appropriate in some settings near homes or high use recreation areas. Feeders must be posted with warning signs.

Properly maintained and positioned 4-poster feeders may, in and of themselves, reduce tick numbers to levels acceptable to the community.

Deer Reduction – Recommended

The exclusion, elimination, or reduction of deer has been shown to substantially reduce tick abundance (Rand et al. 2004, Stafford et al. 2003, Stafford 1993, Daniels et al. 1993, Wilson et al. 1988). However, to interrupt the transmission of Lyme disease with deer reductions alone, deer densities may need to be reduced to densities similar to pre-European development, perhaps 8

deer per square mile (Stafford 2004). Kilpatrick and LaBonte (2003) reported that incidents of Lyme disease decreased by 83% in a residential community following a 92% reduction in deer.

Given the primary deer management goal of reducing deer impacts to levels that protect and restore the structure, diversity and function of Lower Makefield Township, deer densities may well be reduced to levels that interrupt the enzootic cycle and transmission of Lyme disease. It is suggested that the incidence of Lyme disease and baseline tick abundance be estimated and monitored. If tick populations and or incidence of Lyme disease remain above acceptable levels the use of 4-posters may be considered.

Monitor trends in the abundance of ticks on the property using standardize tick drags.

Managing Lyme disease means managing tick bites which means reducing tick numbers. Therefore one method by which to judge the success of a Lyme disease management program is to have good data on trends in relative tick abundance. Estimates of absolute tick density are unnecessary. Should the township wish to track tick abundance two techniques are recommended, tick drags and tick flagging. Both are manpower-intensive and tedious but valuable in tracking population change and program effectiveness.

It should be recognized that tick abundance can vary dramatically from one year to the next (Daniels et al. 2000) even in the absence of any tick control program. The reasons for these changes are unknown. Daniels et al. (2000) showed a fourfold range in nymph population size over a five year study. Nymphs prefer woodland habitats. It has been suggested that local environmental conditions over relatively small areas have a role in shaping the distribution of tick abundance year to year (Daniels et al. 2000). McEnroe (1985) recorded an exceedingly high density of adult ticks along roadside drag courses, indicating the impact that landscape features may play in the distribution of ticks. Tick infestations tend to occur in clumps with many drags producing few or no ticks while others have high tick counts. Immigration and emigration of host-seeking ticks is negligible in all life stages (Daniels and Fish 1990, Falco and Fish 1992, Curran et al. 1993) so difference in local abundance on a property cannot be explained by tick movement.

Tick drag sampling efficiency, that is the number of ticks picked up by a single drag, compared to the actual number of ticks present, is low. Daniels et al. (2000) reported a drag efficiency average of 8.6% for larvae, 6.7% for nymphs and 3.6% for adults. Tick dragging involves pulling a 1-meter square panel of flannel, muslin or corduroy fabric along the ground and over vegetation (Falco and Fish 1992) for a given distance and then removing ticks using an adhesive tape lint roller, placing the tapes in a plastic bag which is then sealed, and marked with the date and plot number (Daniels et al. 2000). Ticks are later identified and counted by species and life stage using magnification. The result is a relative tick abundance estimate for that sample and site, by tick stage, based on the number picked up per square meter dragged (Fish 1993).

Tick abundance for all stages increases to a peak and then decreases over several weeks during the season in which a particular stage is active (Daniels et al. 1989, Fish 1993). Larval abundance tends to decline rapidly after reaching its peak (Daniels and Fish 1990). Nymph sampling in Lower Makefield

Managing Lyme disease means managing tick bites which means reducing tick numbers.

Given the primary deer management goal of reducing deer impacts to levels that protect and restore the structure, diversity and function of Lower Makefield Township forests, deer densities may well be reduced to levels that interrupt the enzootic cycle and transmission of Lyme disease.

should occur from June 15 through August 31. Nymphs normally have only one peak abundance period per year. Larval abundance should show a peak in July and August and a second smaller peak in May. Sampling is recommended during July through the end of August.

In the initial years of the Lyme disease management program tick surveillance should be rigorous in order to provide effectiveness monitoring that can be used to track program success. If the program demonstrates effectiveness, tick monitoring efforts can be reduced as determined by the community. One option for low density tick monitoring would be to conduct tick drags on a number of ticks per time of effort as a standard measure of relative tick abundance.

It is recommended that a field data sheet for tick drags be developed with a township/community map on the back and all tick drag transects marked and numbered. The data sheet should have a field for recording the observer name, date, transect number, transect length in meters, time of day, temperature, humidity, cloud condition, general level of soil moisture (e.g. dry, normal, above normal), number of nymphs, larva, and adults by species and the resulting calculated tick density for nymphs, larva, and adults. Approximately 40-ten meter sample transects should be established within township problem areas focusing on high quality tick habitats like forest understories and grassy areas such as lawns where forests open into fields. Transects should be permanently marked in the field so they can be located and identified from year to year. NRC Inc. recommends drag equipment as described by Carroll and Schmidtman (1992) using PVC pipe and flannel-sided rubberized laminate cloth. Personal precautions in dress and tick management should be taken before and after conducting tick drags and flagging. However, surveyors should not avoid tick areas in order to avoid walking where ticks may be. Conduct tick drags weekly between June 15 and August 31 sampling each transect twice during each four week period doing each at two different times of the day. Ideally, one late morning after the dew has dried and during the late afternoon as temperatures cool. Do not sample if the leaf litter or grass is wet.

Monitor trends in the number of cases of Lyme disease in humans within the community.

The primary goal regarding Lyme disease in Lower Makefield is to reduce the incidence of the disease within the community. Therefore the best indicator of program success would be a downward trend in the cases of Lyme disease within the township. To accomplish this, an annual survey of Lyme disease cases within the township is recommended.

One challenge of monitoring Lyme disease within a mobile and transitory community is differentiating between cases that result from ticks picked up in township habitats verses those encountered while township residence are afield elsewhere. Trend data can also be confounded by changes in personal behavior as attitudes towards the threat of the disease change. This might mean increased outdoor activity with less personal protection as individuals perceive the problem as having been addressed or a decrease in exposure resulting from increased awareness and individuals becoming more cautious. To address these issues it is suggested that any survey process include follow-up questions, for individual's reporting positive for the disease. The

Compliance monitoring is simply a formalized process of documenting that the treatments agreed to within a management/monitoring program are being applied as designed and the data properly recorded.

survey would seek information about the person's outdoor activities both in and out of the township.

Deer Presence and Reproduction Monitored.

The use of remotely placed digital cameras for studying, surveying and observing wildlife has become a common practice. Today there are dozens of manufactured units designed for this purpose on the market. They are relatively inexpensive and easy to mount and maintain. These cameras will provide images of those animals utilizing deer removal bait sites and, if desired, provide a record that can be presented to the community. It is possible to estimate deer populations using these cameras (Jacobson et al. 1997, Koerth et al. 1997) however their purpose at Lower Makefield will be to simply monitor the minimum presence of deer, fawns (reproduction) and the pattern of deer use of bait sites, if desired.

Should monitoring be desired NRC Inc. recommends the Cuddleback Digital Scouting Camera with the Compact Flash memory cards which costs approximately \$400 per unit. Other less expensive models are available. Units that use film or flashes are not recommended. Cameras should be downloaded onto a memory card once every week. Each photo will have recorded on it the date, camera location, and time and should be archived.

Compliance Monitoring

Compliance monitoring is simply a formalized process of documenting that the treatments agreed to within a management/monitoring program are being applied as designed and the data properly recorded. It is suggested that once a course of action is decided upon, Lower Makefield Township identify a compliance monitoring coordinator. This individual should develop compliance monitoring protocol and forms for each aspect of the management program that is adopted and annually review monitoring and deer removal activities for completeness and conformity to the agreed design. Data sheets should be checked for completeness and field work occasionally observed to assure proper techniques are being followed. The compliance monitoring coordinator would be responsible for pulling together an annual report.

Monitoring compliance for a deer removal program will depend on whether the removal is done by trained township staff, contractor or trained local hunters. It should include data sheets for baiting and removal activity. Baiting data sheets should record site, date, bait volume placed out per treatment, amount remaining, deer use, deer observed, etc. Removal data sheets should record every removal attempt, whether successful or not, by date and time, weather conditions, location, deer observed, deer group size, deer passed, the number of deer within a group when a removal occurs, when one is passed, description of any deer that escape, deer use of baited sites, deer behavior when approach, deer behavior within the group during shooting, shooters position (which pre-established shooting site) tackle, shots taken, deer killed by age, sex, site, body weight, PGC tag number, etc.

If tick drags are implemented for tracking relative tick abundance, the compliance monitoring coordinator should make sure those conducting the drags are familiar with and using the proper sampling protocols, are on the desired transects at the appropriate times and accurately and completely

The best indicator of program success would be a downward trend in the cases of Lyme disease within the township.

filling out data sheets. Similar approaches should be taken to monitor forest regeneration, browse utilization, fenced plots, 4-poster program, etc.

Effectiveness Monitoring

Effectiveness monitoring involves using a group of indicators to quantitatively measure whether your management program is successfully accomplishing the goals and objectives it was designed to do. The focus of effectiveness monitoring will be primarily the vegetation trend data from the paired exclosure plots, SILVA advanced regeneration plots, DCNR browse utilization transects, measurements of relative tick abundance and the number of cases of Lyme disease within the township. Compliance monitoring will track how well treatments are being applied and allow for adjustment. Effectiveness monitoring will track whether the overall deer management program is resulting in the abatement of the problems for which it was implemented. If community goals are achieved some treatments maybe modified, gradually reduced or dropped to maximize cost effectiveness both in dollars and effort without compromising the success of the program. Effectiveness monitoring and compliance monitoring are most critical in initial years of a new program.

Regulation Review

RECREATIONAL HUNTING SEASONS AND BAG LIMITS

Recreational hunters in Wildlife Management Unit 5D may hunt with muzzleloading long guns 44-caliber or longer, bows and arrows, manual or autoloading shotguns .410 or larger using slugs and 20-gauge or larger using buckshot. Crossbows with a draw weight of at least 125 pounds, but not more than 200 pounds, may be used during the regular firearms deer seasons, including the antlerless deer season Dec. 10-22 and Dec. 26-Jan. 26 (Pennsylvania Game Commission, 2006b and Pennsylvania Game Commission 2007a). Recreation hunting seasons and bag limits for deer in WMU 5D are;

- **DEER, ARCHERY (Antlered and Antlerless)** Sept. 15-28, and Nov. 12-24. One antlered deer per hunting license year. One antlerless deer with each required antlerless license.
- **DEER, ARCHERY (Antlered and Antlerless)** Sept. 29-Nov. 10 and Dec. 26-Jan. 12. One antlered deer per hunting license year. One antlerless deer with each required antlerless license.
- **DEER (Antlered and Antlerless)** Statewide Nov. 26-Dec. 8. One antlered deer per hunting license year. An antlerless deer with each required antlerless license.
- **ANTLERLESS DEER (Statewide):** Oct. 18-20. Junior and Senior License Holders, Disabled Person Permit (to use a vehicle) Holders, and Pennsylvania residents serving on active duty in the U.S. Armed Services or in the U.S. Coast Guard only, with required antlerless license. Also included are persons who have reached or will reach their 65th birthday in the year of the application for a license and hold a valid adult license, or qualify for license and fee exemptions under section 2706. One antlerless deer with each required antlerless license.

A deer control permit from the Pennsylvania Game Commission would allow deer to be removed safely, humanly, efficiently and discreetly from Lower Makefield Township.

- **DEER, ANTLERLESS MUZZLELOADER (Statewide):** Oct. 13-20. An antlerless deer with each required antlerless license.
- **DEER, ANTLERED OR ANTLERLESS FLINTLOCK (Statewide):** Dec. 26-Jan. 12. One antlered per hunting license year, or one antlerless deer and an additional antlerless deer with each required antlerless license.
- **DEER, Antlerless (WMUs 5C and 5D):** Dec. 10-22 and Dec. 26-Jan. 26. An antlerless deer with each required antlerless license (Pennsylvania Game Commission 2007a).

BAITING FOR RECREATIONAL HUNTING

Hunters are permitted to use bait only on private lands. Bait may be placed or distributed two weeks prior to the opening of the first deer season and continued until the deer seasons conclude. Bait accumulation in any one location will not be permitted to exceed five gallons at any given time (Pennsylvania Game Commission 2006a).

DEER CONTROL PERMIT

A deer control permit from the Pennsylvania Game Commission would allow deer to be removed safely, humanly, efficiently and discreetly from Lower Makefield Township. Current PGC policy requires communities to include traditional regulated hunting and controlled hunts within their management plans in order to receive a Deer Control Permit (Pennsylvania Game Commission 2007e). Deer control permits as allowed by Section 147.321-329, Subchapter R of Title 58 Pennsylvania Code 2.3.2 has no such requirement.

Current regulations are as follows:

§ 147.322. Application for deer control permit.

- (a) An application for a deer control permit shall be completed in conjunction with the Commission and submitted by an authorized officer or employee of the political subdivision in the form required by the Director and contains the information requested by the Director.
- (b) An application for a deer control permit shall contain the following information:
 - (1) A complete map showing the boundaries of the area being considered and indicating the land use within the area, cover types, hunt-able areas, damage areas, deer concentration areas, safety zones and proposed control areas within the municipal boundary.
 - (2) A deer management plan shall be submitted with each application which provides deer density estimates and requesting the number of animals to be removed.
 - (3) Each application shall substantiate the background and scope of the deer problem and include alternative approaches to the problem and propose what action is recommended to be taken under the permit.

Source The provisions of this § 147.322 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

 **Effectiveness monitoring involves using a group of indicators to quantitatively measure whether your management program is successfully accomplishing the goals and objectives it was designed to do.** 

§ 147.323. Permit.

An application shall show the name, address, date of birth and telephone number for each permittee and subpermittee.

Source The provisions of this § 147.323 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.324. Privileges authorized under the permit.

Deer may be taken:

- (1) Outside the established hunting seasons as set by the Commission in § 139.4 (relating to seasons and bag limits for the license year).
- (2) Regardless of age or sex.
- (3) From February 1 to September 30, unless otherwise authorized by the Director and listed on the permit.
- (4) At any hour, day or night, and with or without an artificial light.
- (5) With any lawful firearm for big game as described in section 2322(a) of the act (relating to prohibited devices and methods).
- (6) Only in areas designated by the political subdivision.

Source The provisions of this § 147.324 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.325. Special conditions of permit.

- (a) Special conditions specific to the applicant's area will be listed on the permit.
- (b) Permits shall list the applicant's name, who shall be an authorized officer or employee of the political subdivision responsible for the activities conducted under this permit and list not more than five subpermittees who shall be licensed hunters or law enforcement officers, or both.
- (c) A copy of the permit shall be carried by the permittee and subpermittees when engaged in activities granted by the permit. The permit shall be shown to any officer of the Commission or person empowered to enforce the act or this part.

Source The provisions of this § 147.325 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.326. Carcass handling.

- (a) Each deer harvested shall have the entrails removed at a suitable location away from where the animal was taken.
- (b) Each deer shall be tagged or marked with a tag supplied by the Commission.
- (c) Due care shall be taken with each carcass to preserve the meat for human consumption.
- (d) Deer suitable for human consumption shall be utilized through a food bank or needy family or as otherwise determined by the Director.
- (e) Antlers from deer taken under the authority of this permit shall be submitted to the Commission for disposal by the Director.

Source The provisions of this § 147.326 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.327. Reports.

- (a) Deer taken under the authority of this permit shall be reported to the Director on forms supplied by the Commission.
- (b) Reports shall be submitted on a monthly basis when deer are taken.

Source The provisions of this § 147.327 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.328. Permit renewal.

- (a) Permits will be issued on a fiscal basis of July 1 to June 30 next following.
- (b) Renewal of the permit will be subject to the review of progress towards deer management plan objectives.

Source The provisions of this § 147.328 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.

§ 147.329. Violations.

The Director may revoke a permit for a violation of this subchapter, conditions of a permit, or if a report is not received, as required, upon written notice to the permittee.

Source The provisions of this § 147.329 adopted July 29, 1994, effective July 30, 1994, 24 Pa.B. 3716.



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