



**Natural Resource
Consultants, Inc.**



DEER MANAGEMENT PLAN

for

**Hershey Trust
Company**



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Executive Summary

Historically, recreational hunting by full-time Milton Hershey School (MHS) employees or retirees has been permitted on School Trust lands for the purpose of “keeping wildlife populations under control.” In October 2007 the School Trust, in cooperation with the Milton Hershey School (MHS), decided to establish a moratorium on hunting based on safety concerns related to school expansion and the significant development that has and is occurring on and adjacent to School Trust lands. Natural Resource Consultants Inc. (NRC Inc.) was engaged by the School Trust in November 2007 to develop a deer management plan for the School Trust and MHS based on the goals outlined by the Master Plan and Environmental Programs Advisory Committee with instructions to evaluate all possible options.

NRC Inc. found, based on stakeholder interviews and field evaluation, that deer were negatively impacting agricultural crops, ornamental plantings and native plant communities on School Trust lands and that the current hunting program was not adequately resolving these issues. Lyme disease was not found to be a problem.

NRC Inc. recommends dividing School Trust lands into 19 deer management units and continuing the recreational hunting program but with greater supervision and control. In addition, in those areas such as the MHS main campus where hunting is not possible, it is recommended that deer be removed using sharpshooters under an agricultural damage permit. A detailed program for managing hunters and conducting compliance and effectiveness monitoring is provided with recommendations for assuring safety and achieve program goals.



The habitats that makes the campus a more livable and aesthetically pleasing environment for students also provides habitat for wildlife.

Major Recommendations

- An individual within the Hershey operation should be assigned the responsibility of managing and coordinating the hunting program on School Trust lands.
- Hunter participation in the School Trust hunting program should be based on cooperation and performance.
- Hunter numbers on any given day for the School Trust lands should not exceed one hunter per 15 acres of wooded/wetland or brush-covered habitat.
- Deer stand locations should be reviewed and approved by the hunt manager.
- Stands should be pulled from the field yearly by January 31.
- Firearm hunting should be permitted in units 1-Southern Farmlands, 2-Dearden Camus and Vian Parcels, 3-Redtail Ridge, 10-Springboard Academy, 12-Swatara Creek Corridor, 13-Venice Campus, 15-Manada Campus, 16-Swatara Campus, and 19-Green and Gravel Hill.
- Archery only hunting should be permitted in units 5-Cocoa Avenue Farmland, 6-Hershey Center for Applied Research and Farmland, 7-Hughey Tract, 9-Old Golf Course, 11-Hotel Hershey/Catherine Hall and 17-Hershey Foods Office Complex/State Police Academy/Hershey Cemetery and 18-Quarry Area/Farm 77.
- It is recommended that no hunting of any kind be permitted in Units: 4-Milton Hershey School-Main Campus, 8-Hershey Food Manufacturing/Hershey Park/Hershey Country Club, and 14-Wren Dale Golf Course.
- On the MHS Main Campus deer should be removed using sharpshooting under an agricultural crop damage permit.
- Additional restrictions will be required in the future as additional land development takes place.
- Only inline muzzleloaders with scopes and using pelletized powder and sabots should be permitted for use on the property during the October season.
- Only shotguns equipped with scopes, rifle barrels and sabots should be permitted for use on the property.
- All deer harvested by a property hunter should be checked by arrangements provided by the hunt manager.
- Compliance and Effectiveness Monitoring programs should be implemented to monitor deer/human conflicts, deer impacts on vegetation and if deemed necessary, tick abundance.

Introduction

The Milton Hershey School is a private philanthropic (pre-K through 12) boarding school in Hershey, Pennsylvania. Originally named the Hershey Industrial School, the institution was founded and funded by chocolate industrialist Milton S. Hershey and his wife Catherine Sweeney Hershey. The school was originally established for impoverished, male orphans, while today it serves underprivileged students of various backgrounds and is co-ed. The school currently serves over 1,300 students, and plans to grow to 2000 students by 2010. It is the largest residential education program in the nation.

The Hershey Trust Company was created in 1905, as Milton S. Hershey was organizing to create the Milton Hershey School. In 1909, when he founded the school, Hershey appointed the Hershey Trust Company as Trustee for the Milton Hershey School (School Trust). The School Trust, which funds the school, owns controlling interest in The Hershey Company and owns the Hershey Entertainment and Resorts Company (HERCO) which oversees many of the area hotels along with a theme park. Other Entities of the School Trust include the Hershey Museum, Hershey Gardens, Hershey Theatre, Hershey Community Archives, Hershey Nursery, Zoo America, Hershey Arena, Hershey Stadium, Giant Center and the Hershey Cemetery (Wikipedia 2008). (http://en.wikipedia.org/wiki/The_Hershey_Company) 2/.

The School Trust owns approximately 11,000 acres in and around Hershey Pennsylvania (Figure 1). Land use is diverse, ranging from residential school facilities, golf courses, hotels and entertainment operations to active farms, forests and wetlands.

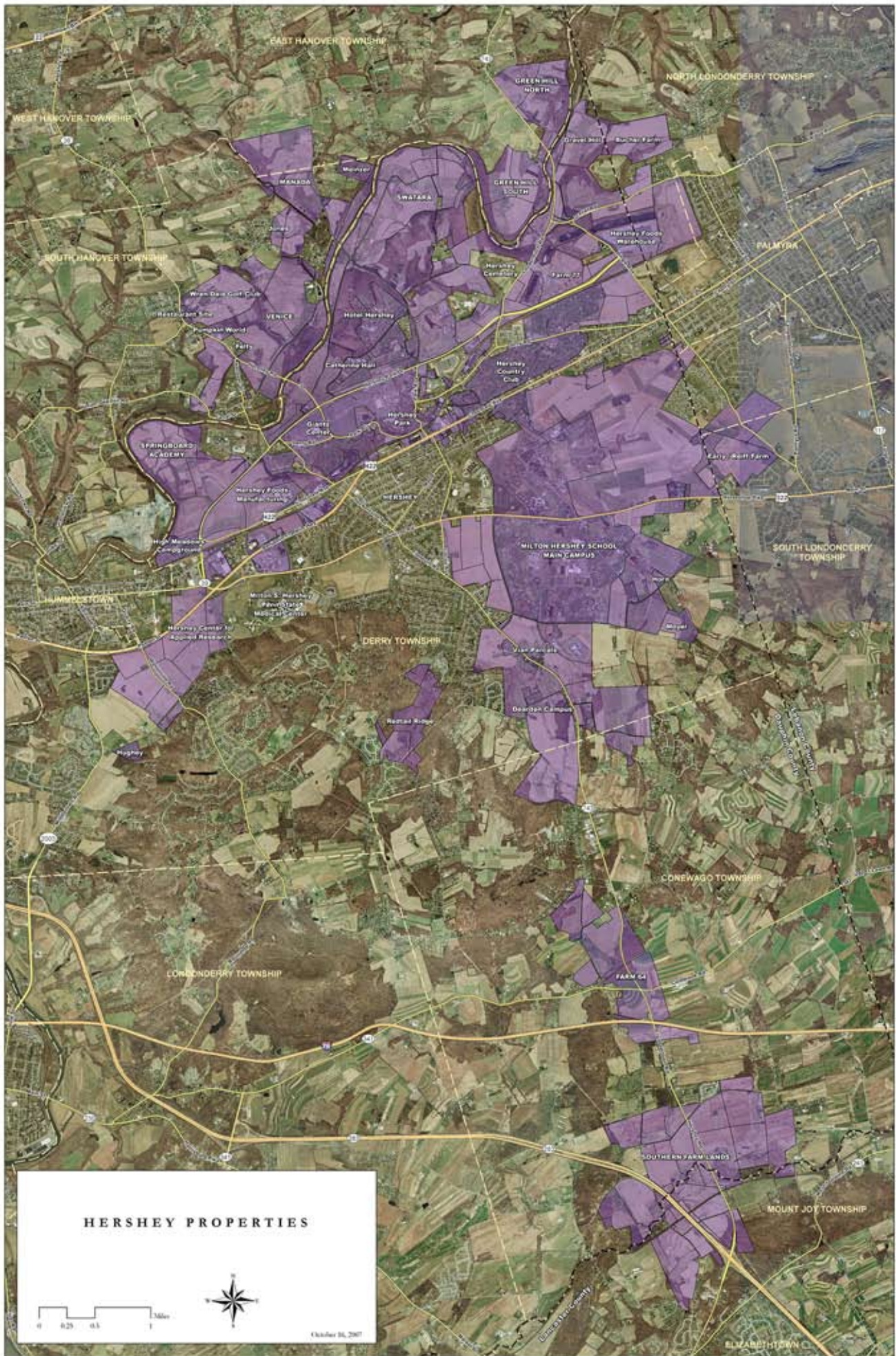


Figure 1

Background

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. 2004). 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). Further, current deer densities in the eastern United States may be affecting forest plant communities for future generations (Stromayer and Warren 1997). 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 (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. 2004). Deer may also depress reproductive success of native plants while simultaneously facilitating the spread of exotic species (Williams and Ward 2006). Deer/human conflicts such as deer/vehicle collisions, damage to agricultural, ornamental and garden plantings and the negative impacts that “overabundant” deer have on restoration plantings, wildlife populations, wildlife habitat, and forest ecology may result as deer numbers increase.

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 manage the impact of overabundant deer is a “value” decision. The Master Plan and Environmental Programs Advisory Committee was consulted as to the goals that should direct deer management on School Trust lands. They described the primary goal for deer management on Hershey Trust Company lands as maintaining white-tailed deer as a valued component of the property’s native fauna while minimizing deer/human conflicts and protecting and restoring the structure, diversity and function of the property’s ecosystems in a safe, humane, socially responsible manner.

Overabundant deer conflicts tend to increase as landscapes become more developed reducing the effectiveness of recreational hunting as a population control mechanism. Historically, recreational hunting by full-time Milton Hershey School (MHS) employees or retirees has been permitted on School Trust lands for the purpose of “keeping wildlife populations under control.”

Through the years some areas have been closed to hunting as development on Trust lands expanded and hunting was seen as incompatible with current land uses based on safety concerns. However, much of School Trust land remained open to hunting including deer, small game and waterfowl. In October 2007 the School Trust, in cooperation with the MHS, decided to establish a moratorium on recreational hunting on all School Trust lands citing serious safety concerns by the administration as a result of the significant development that had and was occurring on and adjacent to School Trust lands. Development projects including the goal of increasing the student population to 2,000. Notification of this decision was made in October 2007, just as hunting seasons were opening. The notification included an announcement that a long-term wildlife management plan would be developed and implemented in the coming months.

The central focus of the MHS regarding recreational hunting is the safety and welfare of its students, staff and the general public. Where recreational hunting by employees is determined to be safe, legal and compatible with other land uses it will be encouraged. (Personal communication Elliott Robinson, Vice President, Administration).

Deer cover adjacent to the Agricultural and Environmental Studies Center.



Deer Management Goals

for the School Trust Lands

- 1.** Maintain white-tailed deer as a valued component of the property'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 property's forests.
- 2.** Manage deer in a safe, humane, socially responsible manner using recreational hunters when and where it is safe, effective, legal and compatible with other land uses, adding additional tools only as needed.
- 3.** Reduce the probability of humans contracting Lyme disease while on the property.
- 4.** Reduce or eliminate deer/human conflicts regarding ornamental plantings, gardens and agricultural crops.
- 5.** Reduce the potential for exotic invasive plant expansion on trust lands by reducing deer herbivory on native species, thereby restoring community-level competition.

Hunters tend to judge deer abundance based on the number of deer they see while individuals focused on plants judge deer abundance based on deer impacts.



Deer damage on ornamental plantings

Stakeholder Consultations

In an effort to better define the issues related to deer and their management on School Trust lands NRC Inc. interviewed a variety of deer stakeholders including school instructors and administrators, School Trust administrators, property hunters, farmers, horticulturalists, nurserymen, ground and facility maintenance personnel, safety and security personnel and individuals or organizations outside the MHS and School Trust but with connections to School Trust properties. Personnel from the MHS, School Trust, Hershey Nursery, Hershey Cemetery, Hershey Gardens, Hershey Hotel, Hershey Golf Courses and others were consulted.

Interest in deer management on the properties was found to be high and sometimes intense. Farmers, horticulturalists, agricultural instructors, nurserymen and those who are in general responsible for grounds and landscape maintenance, felt deer numbers were high and impacts problematic. Concerns about deer damage ranged from moderate to severe. Damage was reported on the Main Campus, Hershey Cemetery, Hershey Gardens, Hershey Hotel, Wren Dale Golf Club and northern farmlands. Reports described severe damage to orchards, including the loss of the Johnny Apple Seed Orchard, and vegetable crops on the Main Campus, with more moderate damage to corn, soybean, hay crops and ornamental plantings. It was expressed that last year's damage seemed to be increased over previous years. Several individuals involved in agricultural enterprises would like to see less deer damage. One part-time lease farmer and hunter made the observation that deer are not nearly as bad now as they were a few years ago when he would routinely lose 25% of his crops to deer. The Hershey Gardens annually maintain deer fencing during the winter months in an effort to reduce deer damage. No farmers have applied for or used any of the Pennsylvania Game Commission programs to address crop damage including the Deer Management Assistance Program, Red Tag Program or crop damage permits.

Hunters in general expressed the belief that deer numbers had experienced a noticeable decline over recent years. Some suggested there were too few deer. Except for those areas where hunting was not permitted, some hunters felt deer populations had been successfully reduced to appropriate levels by the existing hunting program and reported seeing fewer deer. Several hunters articulated concerns that the current moratorium would result in significant deer population increases as a result of the removal of this year's hunter related mortality.

Who should be allowed to hunt was a subject eliciting strong opinions. Hunters who work for the MHS expressed the opinion that only MHS full-time employees and retirees should be allowed to hunt School Trust lands. This opinion seemed to be based on concerns that if all School Trust employees lease farmers and their relatives, as well as contractors, were allowed to hunt, there would be too many hunters for the area available. In addition, some hunters were of the opinion that the School Trust and the MHS owned the land they utilized. In reality, all the land is titled to the School Trust. Hunters and employees working on the ground for various School Trust enterprises expressed their frustration that they had been excluded from hunting on the very properties they are responsible for maintaining.

Where on School Trust lands, hunting should be permitted, also elicited strong opinions. Some hunters felt recreational hunting could be expanded to areas where it is currently excluded while some facility managers express concerns that recreational hunting was not a compatible use. Suggestions from hunters for increasing hunter access included allowing archery hunting on the Main Campus and elsewhere based on reduced safety zones; controlled firearm hunts with assigned and approved stand locations, archery hunting only areas and a lottery to decide who gets to hunt where on School Trust lands.

Other concerns expressed included the perception that the School Trust did not have a habitat or forest management program and was ignoring its responsibility to manage the land it owns. Particular frustration was expressed regarding the lack of timber sales in plantations and hardwood forests.

The draft deer management report was reviewed and commented on by the Sub-Committee of The Master Plan and Environmental Programs Advisory Committee. These comments were responded to by NRC Inc. and the report modified accordingly.

Observations

The disparity in observations regarding the number of deer and their impacts on School Trust lands by hunters versus farmers, landscapers and nurserymen is likely the result of two factors. First, some areas of School Trust property have been un hunted for many years, and as a result, have high numbers of deer and severe deer impacts. The most obvious example of this is the small deciduous woodland and white pine plantation behind the Hershey Food Manufacturing plant on Chocolate Avenue. This area has been closed to hunting for years and is severely overbrowsed and dominated by invasive exotic plants. Since hunters do not hunt nor frequent this area, deer numbers and their impacts may be unobserved by them. Second, hunters may use a different measure for judging deer numbers than farmers and landscapers. Hunters tend to judge deer abundance based on the number of deer they see. Individuals focused on plants, whether agricultural crops, horticultural

plantings or forest understories, tend to judge deer abundance based on deer impacts. This can result in both differing perceptions of abundance and the desired number of deer. Based on qualitative field observations, NRC Inc. concluded that deer impacts are above the desired level, based on School Trust goals, throughout much of the School Trust properties whether hunted or not.

One challenge on School Trust lands given the goals outlined is the relatively low deer densities required to achieve these goals.

Heavily browsed shrub near Hershey Food Manufacturing Plant



Current Hunting Program

The current hunting program on School Trust lands differs little from the general game law regulations established by the Pennsylvania Game Commission for hunting anywhere in Pennsylvania. MHS hunting restrictions do exclude the use of rifles and the forced movement of deer. Other rules and regulations involve identifying MHS hunters through arm bands, stand decals and parking tags or rules that restrict driving in fields, on dirt or tenants lanes, spotlighting on MHS private roads, parking inside chained off areas, and target shooting on Central Campus.

Hunter participation is not open to the public but restricted to MHS full-time employees and retirees with the exception of approximately 20 arm bands distributed by the School Trust to employees, contractors and lease farmers (personnel communication Kenneth Gall, Director of Real Estate, School Trust). Hunters are supplied with a numbered arm band which is to be visible on an arm or back while hunting. A vehicle tag supplied to MHS hunters is to be displayed on the front dash/window of the hunter's vehicle. Permanently fixed tree stands are required to have a MHS decal affixed in a location that is visible from the ground. MHS hunters are ask to sign an indemnity agreement where in the hunter agrees to indemnify the MHS for injury, damage or loss sustained by the hunter while hunting on the premises.

Hunters on School Trust properties are required to complete a MHS Deer Harvest Report if they are successful but no records are kept regarding com-

Landscapes are changing on and around HTC lands from rural agriculture to residential and scholastic.



Currently there is no reliable estimate of deer impacts or deer harvest numbers, trends, location or demographics on HTC lands.

pliance nor are there any penalties for noncompliance. Cooperation is reportedly low and no resulting records were made available to NRC Inc. The deer harvest report form requests only whether a hunter has taken a doe or buck and the number of points. Based on this loose, organizational structure which relies on voluntary cooperation by hunters, no reliable estimate of deer harvest numbers, harvest trends, sex or age ratios or location of deer kills exists. Similarly, it is unknown how many hunters use the property, where they hunt, how many days they hunt or what tackle they use. It was reported that there were approximately 140 hunters permitted to hunt on School Trust lands in 2007 prior to the moratorium. Of these, 35 to 40 were estimated to be archery hunters while 100 were shotgun/muzzleloader hunters. It has also been suggested that hunters annually take between 100 and 130 deer from the School Trust properties but no sex ratios or methodology was presented to confirm this estimate.

The hunting program is organized and supervised by a hunting committee who are employees of the MHS Safety and Security Department and hunters. These individuals are responsible for posting School Trust lands against trespass, enforcing trespass violations, distributing arm bans, hunting information and the collection of harvest data.

Observations

The current hunting program is a rather loose arrangement that allows for hunter recreation but no focus on managing deer to meet School Trust goals. This is best indicated by the fact that hunters are not required to have an antlerless deer license to hunt on School Trust land nor are deer impacts or antlerless deer harvest numbers or trends monitored. To successfully control deer numbers, and therefore deer impacts, hunters must take antlerless deer. Currently there is no reliable estimate of deer harvest numbers, harvest trends, sex or age ratios, location of deer kills or deer impacts. The deer questionnaire and accompanying letter sent out to program hunters in 2007 focused not on the primary goal outlined for School Trust lands, that of reduced deer impacts, but on the number of deer seen by hunters and the number they desire to observe.

Deer managers and hunters have a history of confusing management tools with the management goals. Providing hunting recreation is not the goal for deer management on School Trust lands. The goals are:

- to reduce or eliminate deer/human conflicts,
- to reduce the probability of humans contracting Lyme disease while on the property and,
- to protect, maintain and restore the structure, diversity and function of the property's forests in a safe, humane and socially responsible manner.

Recreational hunting is one tool for achieving these goals when and where it is safe, effective, legal and compatible with other land uses.

Recreation hunting can play a major role in meeting the deer management needs on School Trust lands, provided hunters and their regulatory agencies adapt and work together to provide effective population management programs for the landscapes involved. Where experience and evidence indicates traditional hunting methods will not work to meet School Trust deer management goals, hunters may still be able to participate, as skilled partners, using nontraditional techniques.

One challenge, however, is that recreational hunters do not view themselves as deer managers (Decker and Connelly 1990) but as recreationists. Hunters generally hunt for enjoyment not providing a management service to the landowner. Managers can achieve deer population control objectives using hunters if there are sufficient hunters who are:

- 1) motivated to comply with a particular set of regulations,
- 2) willing to participate under existing environmental and social conditions and,
- 3) willing to harvest antlerless deer at the needed rates (Brown et al. 2000).

A critical assumption of deer population control programs using recreational hunters is that sufficient numbers of obliging hunters will participate in the type of hunting necessary to control deer populations. This assumption was once safe, but may no longer be valid in many areas of the eastern United States where numbers of hunters are declining or hunters' willingness to kill multiple deer is limited (Curtis et al. 2000). Brown's et al. (2000) analysis in New York, suggested that even if landowners cooperated to eliminate refugia and hunters had unlimited antlerless tags, too few hunters exist, or their willingness to take antlerless deer is insufficient, to affect deer population control in their study areas. Nearly half the deer hunters in Pennsylvania hunt only antlered males. Archery hunters killed more antlered deer than antlerless deer in the 2006-2007 Pennsylvania seasons (Pennsylvania Game Commission 2007d).

Hunter motivations also range widely. Some hunters focus only on buck or large, trophy animals, while others are more utilitarian and 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. Holsman (2000) suggests that, though it is unrealistic to expect that all hunters will adopt Leopold's land ethic as their guiding worldview, we should be striving to initiate hunters who embrace a holistic view of the environment and their personal role in maintaining its quality. Hunter skill levels today, as in the past, vary widely. Some hunters, who have mastered the craft of hunting, are constantly successful, while others are not.

The primary deer management goal for School Trust lands is to mimic the population-stabilizing effects of natural predators on deer in order to protect, maintain, and restore the structure, diversity and function of the School Trust's forests and open space while reducing deer/human conflicts. Hunter selection for participating in a hunting program on School Trust lands should be based on their willingness and ability to work towards achieving that goal, not simply their full-time employment by the MHS.

Finally, the hunt management is currently handled by employees of the school's Safety and Security Department. These individuals are responsible for posting School Trust lands against trespass, enforcing trespass violations, distributing arm bands, providing hunting information and collecting harvest data. Some of these individuals are hunters on the property. This arrangement appears to have worked well but does create potential conflicts of interest. Security officers that enforce trespass for the school but who also hunt the property they are "protecting" have both a professional and personal interest. This potential conflict should be acknowledged and appropriate staff training implemented to avoid negative perceptions.

“The Deer Management Gradient is a concept that attempts to explain how factors that impact deer management change across landscapes.”

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 whose 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. This will allow deer populations on School Trust lands to be managed successfully. However, the efficiency and effectiveness of the population management will be influenced by the tackle and techniques used.

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 patterns and human population influence deer vulnerability to harvest by hunters. Deer vulnerability can influence what management tools are required to successfully manage deer numbers and therefore deer impacts.

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 caused mortality was insufficient to control deer populations in the study area. In

addition the study determined that hunter density was fewer than six hunters/square mile during 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 had a low hunter density 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. Deer movements become more predictable, requiring less skill and effort on the part of hunters to be successful in harvesting an animal.

In landscapes like those on the School Trust lands, forest covers are small and highly fragmented. If these forests and the areas around them are hunted, deer vulnerability will be high. Under such conditions recreational hunting can be very effective. However, if much of the landscape is not hunted due to safety zones or adjacent properties that are either closed to hunting or under-hunted, deer will use these areas as refugia to avoid hunters. 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 and deer impact 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 areas (legally defined as all areas within 150 yards of occupied buildings for firearm hunting and 50 yards for archery hunting) expanded due to development and exclude 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 now and in the future managers 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 can adapt to habitat changes caused by human development (Conover 1995). They habituate to human presence (Hansen and Berringer 1997) and do well in and around suburban and exurban neighborhoods because there is little hunting, abundant food and cover, and few remain-



Areas protected by safety zones include school athletic fields.

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.

ing predators (DeStefano and DeGraaf 2003). Residents of suburban and ex-urban neighborhoods often exhibit weak support for recreational hunting near their homes. Fragmentation of land ownership into smaller parcels and a lack of cooperation between neighbors and the various levels of government that must work together in suburban and exurban areas can also pose challenges to effective deer management through traditional recreational 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. In whatever huntable habitats that do exist, deer may recognize areas near human dwellings or un hunted properties 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 to archery equipment as safety issues are considered by local communities, landowners the Game Commission and hunters themselves. The use of rifles is prohibited by the Game Commission within all Special Regulation Zones (designated suburban/urban) 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 2006). 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 and property owners 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 disruption.

Hunting Safety Zones

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 2006). 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. A hunter may not violate a safety zone even when on neighboring property not owned by the occupant of the building. A hunter may hunt within a safety zone with the occupant’s permission. Safety zone size is reduced from 150 yards to 50 yards for archery hunting except in the case of schools, daycare facilities or playgrounds where it remains 150 yards. Safety zones do not apply to deer removals under a deer control permit or deer shot for crop damage.



Hershey Gardens annually has the existing fence modified to exclude deer in response to ongoing deer damage.

Public Access

The Milton Hershey School and Trust are supportive of community inclusion. They have intentionally avoided fences or walls that separate the School/Trust property from the community and encourage public access to campus walking paths for hiking and biking. Safety of the students, faculty and staff is a very high priority, with a focus on assurance that safety is preserved on campuses where students live and learn. Restrictions on camping, hunting and activities such as flying model airplanes and ATV/snowmobile use are enforced. In general the public is not prohibited from accessing School/Trust owned property. However, there are “No Trespassing” signs for hunting purposes.

NRC Inc. recommends that signage be modified from a “No Trespassing” message to “No Hunting” on the main campus and other locations where indeed no hunting by anyone at anytime is permitted. This signage should be designed to be more permanent than is currently used and on standards that meet general posting requirements for enforcement. The use of “Hunting by Written Permission Only” is recommended for areas open to MHS and Trust hunters but not the public. This will inform the public that hunting activity may be occurring, but let public hunters know that they may not access the property for hunting purposes. This approach to signage helps avoid mixed messages.

Landscape Analysis

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

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). Exurbia is a residential land use that occurs outside city limits and is situated among working farms or undeveloped land where human population density and average property size are intermediate between the suburbs and rural areas (Nelson 1992). All these landscape types, urban, suburban and exurban in addition to rural farmland, are represented on and around School Trust properties. The Southern Farm Lands and Green Hill areas are examples of rural, the Dearden Campus and Vian Parcels are examples of exurban, the golf courses and the Main Campus resemble suburban landscapes while facilities like Hershey Stadium, Giant Center, Hershey Park and Hershey Lodge and more “downtown” properties resemble urban landscapes.

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 forested 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. Most of the Trust's lands are dominated by open fields, lawns, development or wetlands rather than forests. It is unlikely that any single forested tract on School Trust lands encompasses the complete home range for any individual deer. The forests on School Trust properties are comprised of relatively small, fragmented, wooded patches, many with linear configurations and surrounded or perforated by roads, fields, utility right-of-ways, residential development, backyards or non-forested wetlands. It is nearly a certainty that all deer on Trust land includes as part of their home range agricultural fields, wetlands, lawns or landscaped areas with ornamental plantings, gardens, golf courses, and the odd habitat areas common within the matrix of the landscape.

Human-built environments create uninhabitable areas for deer as well as barriers to movement between habitat islands. Such barriers exist to some degree in the expanses of parking lots and human dominated facilities like Hershey Stadium, Giant Center, Hershey Park and Hershey Lodge. However, in most of the landscapes in which Trust properties are located there are no real barriers, allowing unhindered daily movement by deer within their home range as well as dispersal or immigration between habitat within and beyond the property's boundaries. The Swatara Creek and its side drainages and wetlands serve as an important corridor that links much of the Trusts lands. For deer much of the conductivity exists within the matrix of farm fields, large lot residential buildings, wetland areas and open space where they may move with ease particularly at night. Home range size of deer on Trust lands likely varies within these landscapes being larger in the more fragmented rural landscapes and smaller in the more suburban.

In some areas, the majority of Trust land 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 (PGC 2006). 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. For archery hunters the safety zone is reduced to 50 yards except for schools, playground and daycare centers. School safety zones extend to resident halls, athletic facilities, and instructional or recreation areas used regularly by students.

Safety zones can be waived by the occupants of a building to allow hunting. Facilities used by employees or tenants are also protected by safety zones and require the permission of those occupants to allow hunting within the buildings safety zone. Safety zones extend across property lines in Pennsylvania. As a result significant acres of Trust land falls within the safety zones of neighbors. These neighbors must be consulted and must grant a waiver to hunters in order to legally hunt on Trust lands within the neighbor's safety zone. It is the policy of the MHS and the School Trust not to waive safety zones for any facility including rental properties. In areas like the Main Campus safety zones encompass nearly the entire area for both firearm and archery hunting (Figure 2 and 3).



Deer cover is absent on the Wren Dale Golf Course.

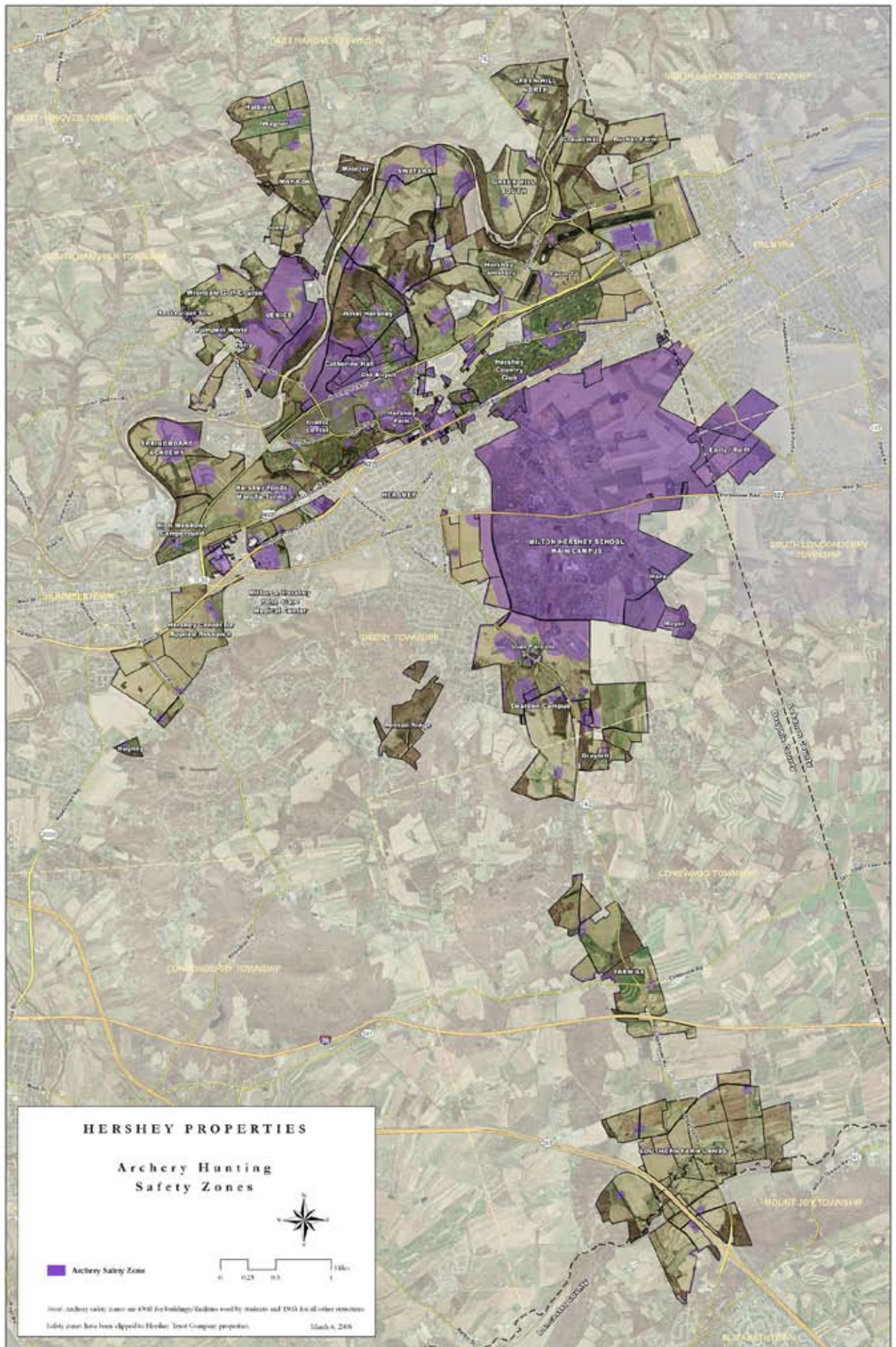


Figure 3

For an increasing number of people, hunting is not a familiar or comfortable concept. Nor is the use of firearms and archery equipment within their community or 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. However, surveys 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 had an 86% and 71% respectively.

A homeowner may waive their legal right to the safety zone surrounding their home. However, for many families this is not an acceptable option. The result can be a mosaic of huntable and unhuntable habitat within a landscape that provides deer with refugia into which they can escape hunting pressure during daylight hours when hunting is permitted. Deer can also find refugia in dense cover thereby avoiding hunters. When evaluating management options NRC Inc. ranks cover potential for deer in one of four categories; 1) poor – areas with little cover in which deer can conceal themselves, 2) adequate – sufficient cover to allow deer to seek it out as diurnal cover but where deer remain easily observed and vulnerable, 3) good – cover in which deer are concealed from hunters but can be driven out of the cover and, 4) excellent – cover that is dense enough and large enough that deer cannot be driven from the cover or adequately observed by hunters to allow for their harvest. In these covers deer vulnerability is low and hunters’ success at harvesting deer poor.

NRC Inc. reviewed School Trust lands at the stand and landscape level evaluating deer vulnerability using the following criteria:

- 1) amount and distribution of safety zones on School Trust lands for both firearms and archery,
- 2) amount and distribution of safety zones adjacent to School Trust lands,
- 3) amount and distribution of safety zones on School Trust lands for facilities being built or planned to accommodate growth,
- 4) amount and quality of deer cover on or adjacent to School Trust lands,
- 5) mast producing potential of forest stands and,
- 6) amount and type of agricultural use.

As a result of this review NRC Inc. separated School Trust lands into 19 potential deer management units (Figure 4).

Unit 1 Southern Farmlands

Safety zones in this unit cover only a small portion of the landscape but impact important areas of deer cover. Safety zone concerns are primarily the result of buildings on adjacent properties rather than School Trust buildings. Deer cover in this unit is good but primarily in the form of primarily forest stands which are small and highly fragmented. Currently the majority of cover used by deer is on adjacent properties and in the form of larger forest stands. As wet meadow and pastures once grazed but now fallow, move through succession, cover quality and quantity will increase significantly. Mast producing potential for this area is low. Agricultural crops dominate the landscape and include corn, soybeans, small grains, alfalfa and other hay crops.



Much of the deer cover on HTC lands is in the form of linear forest stands.

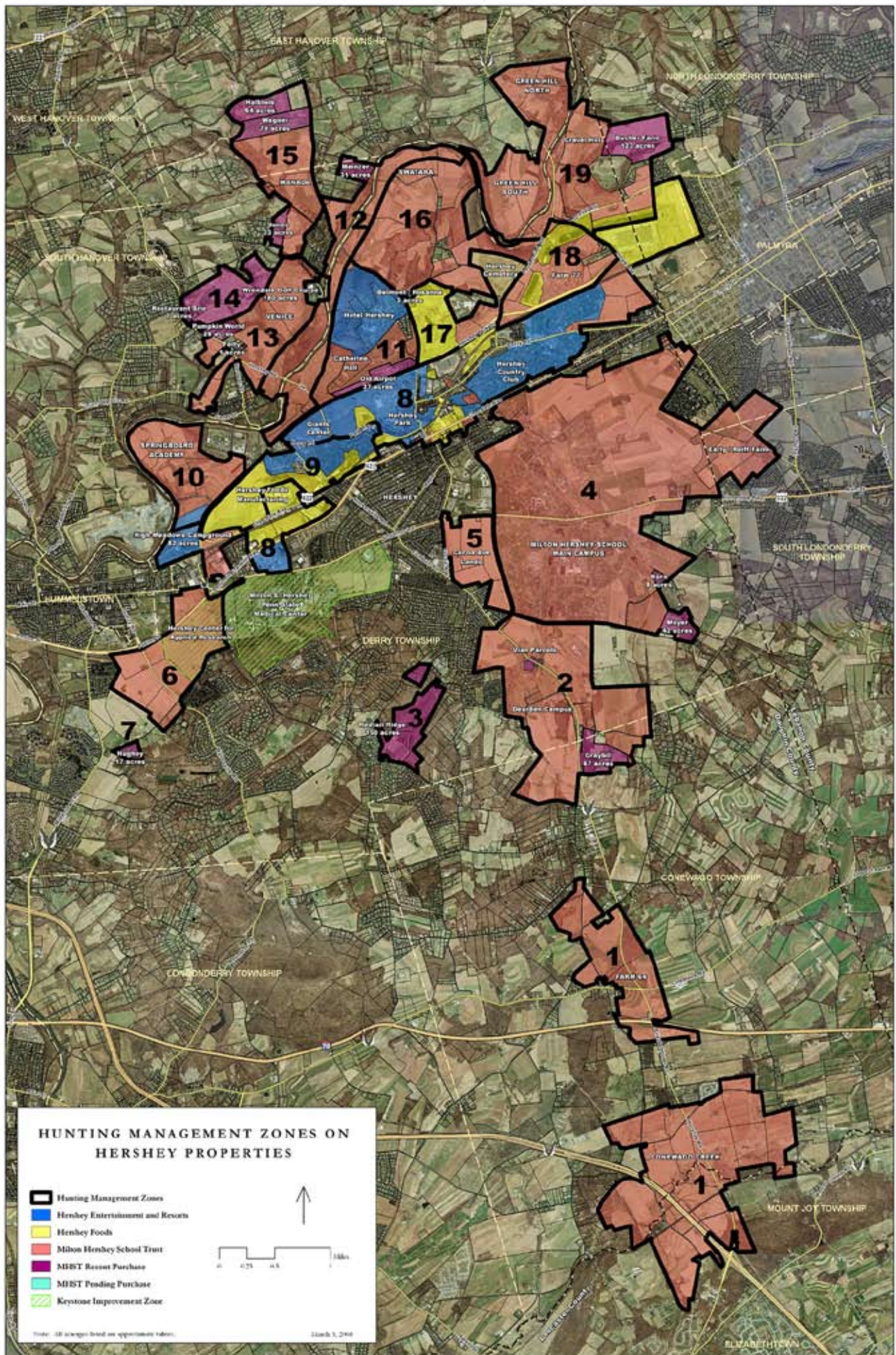


Figure 4



Unit 2 Dearden Campus and Vian Parcels

This unit is exurban in nature but surrounded increasingly by suburban development. Safety zones in this unit cover a significant portion of the landscape and impact important deer cover areas. One area of particular concern is abandoned pasture along the western property line and just east of the Jacob's Creek development. This area is rapidly becoming good deer cover yet falls within the safety zones of the adjacent homes. Other than this location, safety zone concerns are primarily the result of buildings on School Trust property and areas used by students. Deer cover in this unit is limited, of poor to good quality, fragmented in small patches and primarily consisting of forest stands. Currently the majority of cover used by deer is on adjacent properties. Mast producing potential for this area is good. Agricultural crops dominate the landscape and include corn, soybeans, alfalfa and other hay crops.

Currently, all areas of this unit south of Route 322 to Gates Road and/or McCorkle Road off Route 743, between east and west property lines is closed to hunting as are lands between Gates Road and Route 743 with the exception of archery hunting for deer in the woods on the east side of Gates Road. As a result, the only deer cover open to firearm hunting is the area known as the Knob and the small wooded areas along the southern most boundary.

Unit 3 Redtail Ridge

Firearm safety zones in this unit cover nearly the entire northern parcel but only a small portion of the primary tract. Archery hunting safety zones impact only a small portion of either parcel. There are no existing School Trust facilities or buildings on the property so all safety zone issues result from structures on neighboring lands. As with the Dearden Campus, suburban development on surrounding land is increasing and appears inevitable along all boundaries. Most of the surrounding land has already been subdivided in relatively small parcels for single family dwellings. As houses are built, more and more of this tract will fall within safety zones. Deer cover in this unit is good in the old field areas that are converting to early successional forests and/or invasive exotic shrub lands but poor in much of the forested areas which for the most part have open understories. With the exception of the two fallow agricultural fields and the powerline right-of-way the entire tract is forested and represents the most intact forest on School Trust lands. There is abundant deer cover on adjacent properties. There are no agricultural crops within this unit. Mast producing potential for this area is good.

Unit 4 Milton Hershey School - Main Campus

Safety zones in this unit for both firearms and archery cover nearly the entire landscape with the exception of areas on the Early/Reiff tracts which are flat, open crop fields with practically no deer cover. This entire unit, with the exception of one flat, open field east of Lingle Road has been closed to hunting due to safety zones and use by the majority of the property by students and staff. Safety zone concerns are primarily the result of Milton Hershey School facilities on site with some impacts from the adjacent Derry Township School complex and the burgeoning, high density suburban development north,



Deer Management Unit 5 Cocoa Avenue Farmland contains no significant deer cover.



Deer Management Unit 8 contains little deer habitat.

east and east-southeast of the campus. Deer cover in this unit is primarily in the form of linear plantings of warm-season grasses and landscape plantings on campus. Adjacent cover is limited to suburban development and corridors leading to larger wooded stands in the southeastern corner. Mast producing potential for this area is low. Agricultural crops dominate the northeast area of the campus and to a lesser degree the southeast.

Unit 5 Cocoa Avenue Farmland

Safety zones in this unit cover all the available deer cover and result from off site structures. Deer cover in this unit is poor and very limited. Mast producing potential for this area is poor. Agricultural fields dominate the landscape and include corn and soybeans. The area is dominated by open, production agriculture fields.

Unit 6 Hershey Center for Applied Research and Farmland

This area is open farm fields and institutional facilities. It contains very little deer cover and that which does exist, is either in the form of isolated woody patches on rock outcrops or falls within safety zones. A small area of woodland does fall outside the archery hunting safety zones. The tract borders the Lower Dauphin School Campus, Milton S. Hershey Penn State Medical Center, Route 322 and high density suburban development. Mast producing potential for this area is poor. Agricultural fields dominate the landscape and include corn and soybeans.

Unit 7 Hughey Tract

This small tract has nearly half its acreage within the firearm safety zone of the onsite residence. However, the wooded portion of the tract which provides good deer cover is largely outside the safety zone. Mast producing potential for this stand is high. No agricultural crops appear to be grown on the site but a hayfield dominated by broomsedge and fescue appears to be cut annually but not removed.

Unit 8 Hershey Foods Manufacturing/ Hershey Park/Hershey Country Club

This unit includes all the School Trust properties between Hershey Park Drive and Governor Road east to the Main Campus and Lingle Road including the High Meadows Campground and the distribution center east of Lingle Road and north of Hershey Park Drive but excluding the old golf course and wooded/field area above and west of the waste water treatment facility. Safety zone regulations impact much of this area and nearly every deer cover area. Safety zone concerns are the result of buildings on and off School Trust lands. Deer cover in this unit is nearly nonexistent with little adjacent cover with the exception of the old golf course, quarry area and woodland above the sewage treatment plant. Mast producing potential for this area is low. The agricultural fields near the Hershey Foods Manufacturing Plant and the fields east of the Hershey Country Club are planted to corn and soybean.

Unit 9 Old Golf Course

This area includes the old golf course, quarry/reservoir, woodland south of the sewage treatment plant and conifer plantations north and down slope of the Hershey Manufacturing Facility and farmland north of Chocolate Avenue and south of Rt. 39. Safety zones in this unit exclude significant acreage from recreational hunting but important deer cover are largely unaffected. Safety zone concerns are the result of buildings on and off School Trust lands. Deer cover in this unit is poor and represented by forest stands with open understories and small areas of dense invasive exotic shrubs. Surrounding cover is limited. Mast producing potential for this area is low. Agricultural crops dominate the landscape to the west with little deer cover. Crops include corn, fescue and mowed but ungrazed pasture.

Unit 10 Springboard Academy

This unit is bordered by the Swatara Creek and Derry Township Water Treatment Plant to the north, Swatara Creek to the west, Route 39 to the east and High Meadow Campgrounds to the south with the Springboard Academy and Camp Milton located in the north-central area. The school safety zone and that of the property's other structures cover a relatively small portion of the property and its deer cover. Offsite safety zones have little impact. Deer cover in this unit is good and takes the form of wetlands, old fields, orchards and woodlands that have well structured understories dominated by invasive exotics. Nearly all cover areas are linear. Good cover also exists on adjacent properties across the Swatara Creek. Mast producing potential for this area is good. Agricultural crops dominate the landscape and include corn and soybeans.

Unit 11 Hotel Hershey/Catherine Hall

Safety zones cover much of the landscape in this unit but significant deer cover remains outside these zones. Safety zone concerns are primarily the result of buildings on School Trust property including the Catherine Hall Middle School, Hershey Hotel and Hershey Gardens but also include adjacent residential properties. Deer cover in this unit is generally poor and in the form of primarily forest stands but does include some dense understory areas dominated primarily by invasive exotic shrubs. Significant deer cover lies to the northeast and northwest. Mast producing potential for this area is high. No agricultural fields are in the unit, but extensive open fields maintained by mowing are present.

Unit 12 Swatara Creek Corridor

This unit extends along Swatara Creek from Hanover Street to the south, Route 39 and Swatara Road to the east curving around to Camp Catherine and extending across the Swatara Creek from the Meinzer tract south to include the School Trust lands east of Sand Beech Road, Canal Road and Canal Street south to the Derry Township water treatment plant. This long linear unit includes open agricultural fields, dense successional shrub and woodland communities, wetland complexes of palustrine emergent, scrub/shrub and forested floodplain forests and the Swatara Creek. It is an important



Catherine Hall and the Hershey Hotel facilities and outdoor activity areas dominate Deer Management Unit 11.



Well-stocked conifer plantations provide good thermal habitat for deer but poor cover due to open understories.

wildlife corridor that snakes through what is and will increasingly become landscape dominated by intense human development that will include the Venice, Swatara and Catherine Hall Campuses, Camp Catherine, Hershey Hotel, Swatara Creek Water Trail, Horseshoe Trail, Boat House Road Park, Swatara Park and Union Deposit ball fields and the towns of Union Deposit and Sand Beach.

Safety zones cover significant areas of this unit, but much of the important deer cover is not included. Safety zone concerns are primarily the result of HMS facilities but also include buildings on adjacent properties. Deer cover in this unit is some of the best on School Trust lands. Some deer cover is on adjacent properties. Most producing potential for this area is low. Agricultural crops include corn, soybeans, small grains and hay crops but will disappear in the unit as the Venice and Swatara Campuses are developed.

Unit 13 Venice Campus

This unit includes the Venice Campus which is currently under construction, the Pumpkin World property and the land south of Hershey Road and west of the town of Union Deposit. Safety zones in this unit cover most of the landscape but some areas of deer cover are not included. Safety zone concerns are the result of both buildings on adjacent properties and the school facilities on site. Deer cover in this unit is primarily successional woodlands many of which were pastured in the past and have understories dominated by invasive, exotic shrubs. All woodlands are narrow, linear stands which mostly occupy drainages with steep slopes. There is limited cover on adjacent properties. Most producing potential for this area is low. Agricultural crops have been eliminated from most of the unit as it is converted into a school campus. Cropland for corn, soybeans and small grains remain south of Hershey Road.

Unit 14 Wren Dale Golf Course

This unit is made up in its entirety by a golf course and its supporting facilities. Most of the property falls outside of safety zones. Deer cover is nearly non-existent onsite but available on adjacent properties. Most producing potential for this area is low. No agricultural crops are grown onsite and are becoming increasingly less available in the immediate area as suburban development surrounding the golf course converts land use. The golf course has not been open to hunting in recent years.

Unit 15 Manada Campus

This unit includes the Manada and Jones properties as well as the tract located between the Jones tract and the American Water Company land. Currently, safety zones in this unit cover only a small portion of the landscape with most of the important deer cover areas unaffected. Safety zone concerns are primarily the result of buildings on adjacent properties rather than School Trust buildings. Safety zones will increase dramatically when the MHS Manada Campus is completed. No construction has begun to date. Deer cover in this unit is good, represented by a mosaic of forest types and successional stages including areas of dense multiflora rose, old pastures reverting to deciduous forests, decadent conifer plantations and deciduous woodlots. Deer



Hershey Cemetery



The majority of deer cover within Deer Management Unit 17 is in proximity to occupied buildings.

cover exists on adjacent properties. Mast producing potential for this area is low. Agricultural crops currently dominate the landscape and include corn, soybeans, small grains and hay crops. The availability of agricultural crops on site will end once the campus construction begins. Adjacent agricultural areas have and will likely continue to decline as housing development continues to expand.

Unit 16 Swatara Campus

This unit is enclosed by Sandy Beach Road, Swatara Road, the western access road to the Hershey Foods Office Complex, the State Police Academy, Hershey Cemetery and Swatara Creek. Safety zones in this unit currently cover a relatively small portion of the landscape with much of the important areas of deer cover unaffected. Safety zone concerns are the result primarily of adjacent properties but also School Trust buildings. Safety zones will increase dramatically when the MHS Swatara Campus is completed. No construction has begun to date. Deer cover in this unit is poor to good and covers a significant part of the unit. Cover is represented by a mosaic of forest types and successional stages including areas of dense exotic invasive shrubs, old pastures reverting to deciduous forests, decadent conifer plantations and large deciduous forest stands. Deer cover exists on adjacent properties, particularly the Lentz tract, Hershey Hotel and across the Swatara Creek. Mast producing potential for this area is good. Agricultural crops currently dominate much of the landscape and include corn, soybeans, small grains and hay. The availability of agricultural crops on site will end once the campus construction begins. Adjacent agricultural areas are likely to continue for some time.

Unit 17 Hershey Foods Office Complex/State Police Academy/ Hershey Cemetery

This area is north of Hershey Park Drive and Route 743, east of Sandy Beach Road and south of the western drive into Hershey Food Office Complex. It does not include the wooded hillside north of the Hershey Cemetery. Safety zones in this unit cover only a small portion of the landscape but much of the available deer cover. Safety zone concerns are the result of buildings on adjacent properties, School Trust buildings and the Hershey Cemetery. Deer cover in this unit is very limited and poor. Most of the area is open grass, hay or landscaped. The majority of cover used by deer is on adjacent properties. Agricultural land is limited but an area planted to corn, soybeans or small grains does continue to be farmed. Mast producing potential for this area is low.

Unit 18 Quarry Area/Farm 77

This unit is bound by Hershey Park Drive, Route 743 and Lingle Avenue. Safety zones in this unit cover only a small portion of the landscape however fencing around old quarries exclude deer and hunters from significant areas. Safety zone concerns are primarily the result of buildings on site. Deer cover in this unit is poor. Currently the majority of cover used by deer is on adjacent properties to the north and west. Mast producing potential for this area is low. Agricultural crops dominate the landscape and include corn, soybeans and small grains. This area has been closed to hunting for sometime.



Decedent conifer plantations invaded by hardwoods and invasive exotic shrubs can provide good deer cover such as this one near the Hershey Hotel.

Unit 19 Green and Gravel Hill

This unit includes the School Trust properties known as Green Hill North, Green Hill South, Gravel Hill, and Bucher Farm. It includes the wetland complex west of Route 743, east of the Swatara Creek and north of the wooded hillside north of Hershey Cemetery and the area north of the fence along the northern edge of the eastern most quarry but south of Gravel Road. Safety zones in this unit cover only a small portion of the landscape and have little impact on important areas of deer cover. Safety zone concerns are primarily the result of buildings on School Trust land but do include buildings from adjacent properties. Deer cover in this unit is good. There is significant deer cover on adjacent properties. Agricultural crops dominate the landscape and include corn, soybeans, small grains, alfalfa and other hay crops.

Observations

The amount and distribution of safety zones on School Trust lands for both firearms and archery varies widely, ranging from the entire unit (Unit 4-Milton Hershey School- Main Campus) to being inconsequential (Unit 1- Southern Farmland). The same is true for the amount and distribution of safety zones adjacent to School Trust lands. Unit 5-Cocoa Avenue has no internal safety zones but is significantly impacted by buildings on adjacent properties while Unit 10-Springboard Academy, has almost no external safety zones. The amount and quality of deer cover on or adjacent to School Trust lands also varies greatly. Units like 5-Cocoa Avenue, 6-Hershey Center for Applied Research, 8-Hershey Foods Manufacturing/Hershey Park/Hershey Country Club, and 14-Wren Dale Golf Course have virtually no significant deer cover while Unit 3- Redtail Ridge is entirely composed of cover. Unit 1-Southern Farmlands has relatively little cover onsite but abundant off site cover. At the stand level no School Trust property has excellent deer cover that could be classified as escape cover with the exception of the Meinzer property. However, functional refugia created by safety zones does exist in all management units and impacts deer vulnerability to varying degrees. Deer vulnerability to hunters ranging from High in Unit 1-Southern Farmlands, to moderate in 3- Redtail Ridge, 10- Springboard Academy, 15-Manada Campus, 16-Swatara Campus, and 19-Green and Gravel Hill to low Units 2-Dearden Campus and Vian Parcels, 7-Hughey Tract, 12-Swatara Creek Corridor, 13-Venice Campus and 18-Quarry Area/Farm 77 and very low in 5-Cocoa Avenue, 6-Hershey Center for Applied Research, 9-Old Golf Course, 11-Hershey Hotel/Catherine Hall, 14-Wren Dale Golf Course, 17-Hershey Food Office Complex/State Police Academy/Hershey Cemetery to none in Units 4-Milton Hershey School-Main Campus and 8-Hershey Foods Manufacturing/Hershey Park/Hershey Country Club.

Only Unit 3- Redtail Ridge has excellent mast producing potential. All other units have poor potential even though some stands within units have good to excellent potential. Only four units, 3- Redtail Ridge, 7-Hughey Tract, 11-Hershey Hotel/Catherine Hall and 14-Wren Dale Golf Course lack active agricultural land used to grow corn.

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).



Recreational hunting in landscape mosaics dominated by open crop fields and residential development is often ineffective since deer use residential areas as refugia to avoid hunters.

Deer Management Options

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."

Recreational Hunting – Recommended with modifications

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). Where recreational hunting by employees is determined to be safe, legal and compatible with other land uses it will be encouraged on School Trust lands. (Personal communication Elliott Robinson, Vice President, Administration). 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, despite the good intentions, confidence and optimism of many hunters and wildlife agencies, the available published literature does not support the conclusion that traditional recreational hunting can be effective everywhere in realizing the deer management goals outlined for the School Trust properties. The limited effectiveness of recreational hunting can result from challenges regarding the recreational threshold of hunters and deer vulnerability.

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). A deer hunter hunts 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 often 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, reduce deer/human conflict or 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 reduce deer/human conflict and 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 landowner or community to meet their goals can be difficult.

In addition, hunting activities cause deer to be increasingly wary, nocturnal and use un hunted refugia, reducing their visibility and vulnerability to hunters. Consequently, hunters who see few deer may be tempted to declare the management program a success, even though deer numbers and impacts remain above the landowner's goals. Maintaining hunter effectiveness under such conditions is challenging, particularly given the widespread overabundance of deer in southeastern Pennsylvania where a hunter may find another location where deer are dramatically more abundant, vulnerable and easy to observe. To address this issue, NRC Inc. will recommend techniques that increase deer vulnerability even at low deer densities thereby reducing hunter effort per harvest while increasing deer sighting. We will also recommend selecting hunters that are well matched to the deer management needs and conditions of School Trust properties.

Deer Vulnerability

Deer vulnerability is defined as the effort required to harvest a deer, independent of the hunter's skill level. In suburban and exurban landscapes deer are less vulnerable due to nocturnal behavior and the abundant deer refugia where hunters cannot responsibly pursue them. These refugia include safety zones around schools, homes, neighboring properties where hunting is prohibited, properties where deer are under-hunted, and dense thick covers like multiflora rose thickets where hunters either cannot or chose not to pursue deer. 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 significant un huntable 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. Deer most easily removed by hunters tend to be those that are less cautious while those that remain have the advantage of 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.

Deer vulnerability varies dramatically between different properties and landscapes based on topography, amount and juxtaposition of deer habitat and deer refugia, cover type, size of huntable areas, density of housing and community values. Based on these variables, recreational hunting can play an important role in meeting deer management goals in some situations but not in others. On School Trust properties, there is a range of deer vulnerability from high in places like the southern farmlands to none in places like the Main Campus where the entire area falls within a safety zone. As a result, on some School Trust lands a well-designed and executed recreational hunting



Deer cover interspersed with campus buildings

program should be effective in achieving deer management goals while on others recreational hunting will not be effective.

Regulating Hunting and Hunters

The current hunting program on School Trust lands differs little from the general game law regulations established by the Pennsylvania Game Commission for hunting anywhere in Pennsylvania. The strong safety record by hunters on the School Trust lands is a testament to the good judgment and behavior used by the property's hunters. However, as the MHS campuses expand into more traditional hunting habitats such as the Venice, Manada and Swatara areas and development continues to encompass Trust lands in general, it is recommended that hunting and hunters have increased levels of management. This recommendation is made with a full appreciation of the independent, private and solitary nature of the deer hunting experience. Yet, if hunting is to continue in this rapidly changing landscape, program changes will be necessary to assure safety and compatibility. Hunt and hunter management must involve hunter input, participation and support if it is to be effective.

Hunt Manager

An individual within the Hershey operation should be assigned the responsibility of managing and coordinating the hunting program on School Trust lands. Ideally this individual should be a hunter but not an individual who hunts on School Trust lands. This person should be supplied with clerical and administrative support and have access to hunter volunteers to assist in managing the program.

Who Should Hunt?

The goals for deer management on School Trust lands require that the focus of any recreational hunting program be to use hunters to manage deer. Yet, as discussed previously, hunters do not view themselves as deer managers (Decker and Connelly 1990) but, instead, as recreationists. Managers can achieve deer population control objectives using hunters if there are sufficient hunters who are 1) motivated to comply with a particular set of regulations, 2) willing to participate under existing environmental and social conditions, and 3) willing to harvest antlerless deer at the needed rates (Brown et al. 2000).

Hunting is a skill and a craft involving woodsmanship, marksmanship, stealth, an understanding of animal behaviors and how animals use habitats. To be consistently successful, individuals must commit both time and work to master these skills. Hunter skill levels vary widely. Some, who have mastered the craft of hunting, are constantly successful, while others are not. The primary deer management goal for School Trust lands are to reduce deer/human conflicts, maintain and restore the structure, diversity and function of School Trust forests and open space and to reduce the probability of humans contracting Lyme disease while on the property. Hunter selection for participating in a hunting program at the School Trust should therefore be based on their willingness and ability to work towards achieving these goals.



Heavily browsed forest now dominated by invasive exotic plants.

It is fully recognized that many individuals enjoy hunting as a recreation activity in a fairly casual way, hunting only a few days a year while placing little emphasis on improving their skill at the craft or harvesting deer. This is true of many recreationists who pursue and enjoy a variety of activities such as golf, ice skating or pinochle without ever mastering the skill. This does not mean that hunters or pinochle players who never become highly skilled should discontinue their pursuit of the activity they enjoy. We would, however, suggest they pursue it somewhere other than within the School Trust hunting program. If hunters are challenged to remove enough deer to meet the property's deer management goals, a hunter cull may be required. This entails asking hunters who fail to harvest adequate antlerless deer to find another place to hunt while inviting more skilled hunters to replace them. One option for developing more skilled hunters is to use hunters who have mastered the craft of hunting to mentor individuals who have not. Encourage them to hunt together, teaching and learning skills.

We suggest the following application procedure and that the opportunity to apply is open to all full-time employees of the MHS, School Trust and the various School Trust interests who, as part of their jobs, maintain Trust owned land. We suggest that contractors and lease farmers not be included at this time. Farmers experiencing crop damage should be encouraged to contact the hunt manager to coordinate a response that addresses their challenges. If the problem cannot be successfully resolved using recreational hunting, alternative management tools for removing deer should be applied. Farmers should not be required to use non-lethal mitigation techniques.

Minimum hunter requirements recommended are:

- signed copy of hunt regulations and agreement
- minimum of one valid antlerless license for PGC Wildlife Management Unit (WMU) 5B. If antlerless tag availability becomes limited or the time-frame for application and receipt from the PGC becomes problematic, School Trust should apply to the PGC for entry into their Deer Management Assistance Program.
- possession of tackle that meets the minimum requirements for the property
- be willing to hunt deer on the property a minimum of 5 full days or equivalent or harvest at least one female deer
- harvest at least one female deer, one every three years, or be dropped from the property's list of hunters (The minimum number of deer required will need to be adjusted based on harvest numbers, number of hunters, and the monitoring of deer impacts)
- develop a running average of antlered buck to antlerless deer accountable every three years that may not exceed a 1:1 ratio of buck to antlerless deer.
- maintain a deer hunting log
- archery hunters should be required to harvest two antlerless deer for every antler buck.
- attend annual pre-hunt workshop
- no blemishes on hunter's record of cooperation with hunting regulations and agreement

Hunter numbers on any given day for the School Trust lands should not exceed one hunter per 15 acres of wooded/wetland or brush covered habitat. Depending on the number of hunters who apply, the hunt manager may need to use a lottery system to control hunter numbers. Currently, there

is little information on the number of hunters who use or may wish to use School Trust lands, how often and for what days they have or would hunt, the level of hunter commitment to School Trust deer management goals, or the number of deer killed. Therefore, at least one year of hunter management data may be required before designing a hunter lottery system. NRC Inc. recommends that if a lottery to select hunters from a pool is required, that the system be used to identify a given group of hunters who have access for as long as they meet the hunt behavior and performance guidelines. As individuals leave the program and openings become available additional hunters may be added. This will allow a core group of hunters who return year after year to learn the property, deer behaviors on the property and how to hunt cooperatively, thereby increasing hunter success rates, hunter satisfaction and program efficiency.

Stand Management

Stand selection has by tradition, been at the discretion of the individual hunter relying on courtesy and “traditional use” to avoid conflicts. Currently, deer stands are allowed to be placed in the field and remain there year-to-year with no records of where stands are located or who is hunting from them. Individual hunters may have multiple stands at multiple locations. This policy has resulted in some tension between hunters as stands are perceived to be used to “stake out” territories year-to-year.

It is recommended that stands be pulled from the field yearly by January 31. Stand site selection requests should be proposed to the hunt manager on a property map by the first Monday in August each year when resident antlerless applications are also due to the PGC. If two or more hunters are proposing stands closer than 100 yards to each other, unless separated by appropriate topography or mutual consent, a lottery should determine who gets the stand location. Hunters may apply for a second stand once all hunters requesting their first stand have received one. All stand locations should be recorded on a map with the hunter or hunter’s using them identified. Hunters may share stands by mutual agreement. Multiple stands and stand sharing should be encouraged because it allows hunters to adjust to conditions and deer behavior. Stands selected for archery hunting, except in those units open only to archery hunting, must be hunted with a shotgun by their owner during at least the first day and both Saturdays of firearm seasons, or by a mutually-agreed upon firearm hunter or be open to use by any firearm hunter on the property unless inside a safety zone. Based on the hunt manager’s judgment and harvest needs, it may be necessary to require archery hunters to hunt archery only units, with archery equipment, during key firearm season days in order to deny deer key refugia.

All stand location proposals submitted to the hunt manager would require the manager’s review and approval. Archery hunting stands in those units limited to archery hunting only can be reviewed on paper without field review unless determined to be necessary by the hunt manager except within Units 9-Old Golf Course, 11-Hotel Hershey/Catherine Hall and 17-Hershey Foods Office Complex/State Police Academy/Hershey Cemetery. In these units the hunter, hunt manager and onsite facilities staff will need to review and approve each stand location. All firearm and archery stands in those units open to firearms will need to have an initial onsite visit and approval of the hunt manager. The hunter may accompany the hunt manager in the field or mark the proposed stand site in the field using an agreed-upon tagging protocol along with the map identifying its location. The current use of decals to mark approved stands should be modified by using numbered

plastic tags that provide a unique number to each stand. Archery stands that are located within the 150 yard safety zone but outside a 50 yard safety zone should be marked with an additional tag identifying it as a non-firearm stand. It is suggested that firearm hunting be permitted in units 1-Southern Farmlands, 2-Dearden Camus and Vian Parcels, 3-Redtail Ridge, 10-Springboard Academy, 12-Swatara Creek Corridor, 13-Venice Campus, 15-Manada Campus, 16-Swatara Campus, and 19-Green and Gravel Hill. Archery only hunting be permitted in units 5-Cocoa Avenue Farmland, 6-Hershey Center for Applied Research and Farmland, 7-Hughey Tract, 9-Old Golf Course, 11-Hotel Hershey/Catherine Hall and 17-Hershey Foods Office Complex/State Police Academy/Hershey Cemetery and 18-Quarry Area/Farm 77. It is recommended that no hunting of any kind be permitted in units 4-Milton Hershey School-Main Campus, 8-Hershey Food Manufacturing/Hershey Park/Hershey Country Club, and 14-Wren Dale Golf Course. Additional restrictions may be required in the future as additional land development takes place.

Hunting Within Safety Zones

The policy of the School Trust and MHS is not to waive safety zones for any building or rented property. The entire main campus is closed to hunting. Hunters hunting on School Trust properties who wish to hunt or move through a safety zone for the purpose of moving game within a neighboring property's safety zone must provide on a form designated by the hunt manager that name of the resident whose safety zone is involved, its location, affirmation that the hunter received expressed permission to hunt within the safety zone, the date on which permission was granted and the person who was contacted. The form should be signed by the hunter. Annual permission is required.

Hunting 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 the goals outlined for School Trust lands where significant deer refugia exist.

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 close 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, but 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 groups of deer.

Archery hunting should be permitted and encouraged on the property, but should not be allowed to interfere with or reduce the effectiveness of firearm hunting such as in stand placement or use. Beginning the second year of the program, archery hunters should be required to harvest two antlerless deer for every antlered buck. Antlerless deer harvested the first year and every subsequent year should be counted towards the following year's antlerless kill. This will allow archery hunters to "bank" antlerless kills and thereby harvest antlered buck anytime during the season. If archery hunters fail to meet this antlerless/antlered ratio they should lose their hunting privileges on School Trust properties. It is recommended that Units 5-Cocoa Avenue Farmland, 6-Hershey Center for Applied Research and Farmland, 7-Hughey Tract, 9-Old Golf Course, 11-Hotel Hershey/Catherine Hall and 17-Hershey Foods Office Complex/State Police Academy/Hershey Cemetery and 18-Quarry Area/Farm 77 be limited to archery hunting only in order to remove deer and to discourage the use of these areas as deer refugia.

In-line muzzleloading rifles of .44 caliber or larger are permitted as legal tackle for recreational hunting in Wildlife Management Unit 5B by the Pennsylvania Game Commission in the early, antlerless muzzleloader season. Similar to archery tackle, muzzleloaders have limitations that do not lend themselves 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. However, in-line muzzleloaders fitted with scopes and using pelletized powder can provide a very accurate one-shot rifle capability. Muzzleloader hunting should be permitted and encouraged during the October antlerless muzzleloader season. Only inline muzzleloaders with scopes and using pelletized powder and sabots should be permitted for use on the property during the October season. Hunters without this equipment should either upgrade or be excluded from the hunting program. Flintlocks should not be permitted during the October season but should be encouraged during the late flintlock season

Shotguns, .410 or larger with all-lead bullets are permitted as legal tackle for recreational hunting in Wildlife Management Unit 5B by the Pennsylvania Game Commission. 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. However, unlike archery and muzzleloading rifles, well-equipped shotguns allow for multiple shots in quick succession and potential multiple deer harvests per encounter. Only shotguns equipped with scopes, rifle barrels and sabots should be permitted for use on the property.

Rifles provide the most effective and efficient tackle for managing deer populations. Rifles are legal tackle for recreational hunters in Wildlife Management Unit 5B but have not been traditionally permitted on School Trust lands because of safety concerns. A study requested by Pennsylvania House Resolution 61 and supported by the PGC reports, however, that rifles are no safer than shotguns with slugs for hunting in suburban environments (Ba-



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.

castow and Kevenk 2007). Other than tradition and perception, there is no reason to exclude rifles as tackle on School Trust lands.

Guidelines for Moving Deer by Hunters

Deer drives where hunters line up and attempt to move deer to waiting hunters on stand should not be permitted on the School Trust property. The liability risk of a deer being driven across the path of a car and causing an accident is reason enough to discourage deer drives. However, the technique has several other significant disadvantages. Deer drives are designed to “run” deer past hunters, often resulting in scenarios where hunters must take shots at running deer. This type of hunting may increase deer wounding rates while forcing hunters to make quick decisions under intense circumstances jeopardizing safety. In addition, no other deer hunting technique is more effective at moving deer into refugia. In landscapes where refugia are an issue, as they are on School Trust lands, deer drives can be counterproductive.

Deer stalking differs from deer drives in several ways. During a deer stalk, a single hunter moves into cover in an effort to sneak up on deer and harvest it. The hunter’s goal is to find and take the deer before the deer discovers him and flees. Hunter movements during stalks are not fast or linear but very slow and circuitous as they use wind, elevation, habitat features and stealth in an attempt to see the deer before the deer sees them. Stalkers will move deer when hunting; however, typical movements by deer are not to run but rather to attempt to “sneak” away undetected through travel lanes or between woodlots or cover in proximity to one another. Therefore, the placement of standers at possible escape routes around covers being stalked can be a very effective hunting technique.

To produce maximum results, the stalker and standers must be hunting descended with standers elevated either by topography or a stand paying close attention to wind direction and noise. The effort is often more effective if the stalker randomly “goes on stand” for five to ten minutes staying still, allowing deer to sneak out of the cover and past standers.

Deer stalking is perhaps the ultimate deer hunting skill. It requires a great deal of practice, self-control and good judgment for a hunter to become proficient. Hunters must constantly be thinking about backstops and hunt safety. Because deer stalking can move deer into refugia it should not be permitted during the first three days of either the early muzzleloader or shotgun seasons. It is recommended that stalk hunting not be permitted by firearm hunters in Units 2-Dearden Camus and Vian Parcels, 10-Springboard Academy, 12-Swatara Creek Corridor and 13-Venice Campus.

Monitoring Hunter Performance

Every hunter in the hunting program should be required to keep a hunting log in a form determined by the hunt manager that records the days hunted, including start-stop times, stands used by number, number of deer observed by day, any shots taken, deer hit but not recovered and deer taken. The hunting log would be given to the hunt manager by January 31 each year. Hunters not providing an adequate log to the hunt manager would be dropped from the hunting program. All deer harvested by a property hunter should be checked by arrangements provided by the hunt manager. This may involve

the use of maintenance facilities and personnel, MHS Safety and Security Department personnel or others. All harvested deer should have the following information recorded, PGC license number, sex, antlered or antlerless, age (fawn, yearling, adult), date and time harvested, location on property, tackle used, and hunting method (stand, stalking, stalking-stand, other).

Many hunters are interested in biological data such as body weights/sex and age class, antler beam diameters, beam length, inside/outside antler spread, raw Boone and Crockett scores, evidence of lactation and photographs. These data will provide little useful information for managing the deer herd but may be useful for motivating hunters. If hunters wish to have such information collected and the effort and cost can be justified, it is recommended such information be included.

Antler Restrictions

Current PGC mandated antler restrictions for WMU 5B require legal bucks to have at least one antler with three points or more. On the School Trust properties where nutrition is excellent this restriction probably protects less than half the yearling males and allows hunters to harvest mostly immature bucks. If producing larger racks is a goal for property hunters and poaching is not an issue in the area, an additional property antler restriction is possible.

Mature bucks are a powerful motivator for many hunters but also a potential liability to successfully managing deer populations to meet property goals. Some hunters will pass up opportunities to harvest antlerless deer in order to avoid the down time and disturbance created when harvesting an antlerless deer. This behavior should be minimized by the antlerless harvest requirements for the property.

Special Regulation Hunting

The Pennsylvania Game Commission has recognized the challenge of managing deer populations in suburban environments using recreational hunting and is developing an urban deer management program. Part of that program involves the establishment of Special Regulation Areas for deer hunting in Allegheny, Bucks, Chester, Delaware, Montgomery and Philadelphia counties in which additional tackle restrictions, longer seasons and nearly unlimited antlerless tags are available. Wildlife Management Units 2B, and 5C and 5D, which surround the city of Pittsburgh and Philadelphia and much of their suburbs, have firearm antlerless seasons that extend well into January. In addition, the PGC has legalized the use of bait to lure deer to areas where they may be safely and legally removed by hunters in Bucks, Chester, Delaware, Montgomery and Philadelphia counties (PGC 2007b). PGC biologists hope these tool will allow hunters to be more effective at controlling deer populations in these challenging landscapes by increasing deer vulnerability while lowering the recreational threshold for hunters. 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). The PGC is also considering removing

the current requirement that a harvested deer be tagged by a hunter before harvesting a second thereby allowing firearm hunters to be more effective at controlling deer numbers in these areas.

NRC Inc. met with the PGC deer management biologists on February 7, 2008 to discuss the possibility of having the School Trust lands treated as a pilot area for exploring the extension of Special Regulation Areas to islands of suburban/urban areas within the Commonwealth beyond just the Pittsburgh and Philadelphia areas. Nearly every WMU in the state has cities and towns where, due to highly developed landscapes, deer populations cannot be effectively managed using the same tools and methods that may be appropriate and effective in the more rural areas of the WMU. If the PGC were to agree to work with the School Trust in allowing the longer antlerless seasons, use of bait and other management modifications designed for suburban/exurban landscapes, then those areas of School Trust lands where deer vulnerability to recreational hunting is currently low or nonexistent could potentially be successfully managed by hunters. In addition, as development continues and recreational hunting becomes more limited on School Trust lands, these tools could extend the areas hunters could play an effective role.

Regulated baiting can increase deer vulnerability if done properly. It will move the core area of deer (area of highest use within a deer's home range closer to bait sites (Darrow 1993, Kilpatrick and Stober 2002), thus allowing for their more efficient and safe removal. Baiting also may be used to shift deer activity away from residential areas to enhance shooting safety (Kilpatrick and Stober 2002).

Even though baiting has been legal for use in many states for decades, some studies suggest a negative or relatively neutral relationship between hunting over bait and overall efficiency of harvesting deer, particularly among gun hunters (Sonant and Maestro 2006). This failure of bait to increase deer vulnerability is a result of its improper use. If deer have been provided with unrestricted access to bait and disturbed by hunting activity, they quickly adapt by approaching bait sites warily, using bait sites only at night, and using unharmed alternative feeding sites. Hunter disturbance at bait sites can take the form of bumping deer off the site when approaching the stand, harvesting a deer while other deer are present or having deer scent a hunter while at a bait site. It is very difficult for hunters to use bait effectively if it is placed in a ground feeder.

For baiting to be consistently effective, hunters must regulate the availability of the bait and avoid educating deer. NRC Inc. recommends bait only to be used in elevated, time dispensed feeders, using shell corn. We prefer hanging feeders with an approximately 200 lb. feed capacity and equipped with a battery and timer. The timer on the feeder should be set to dispense corn daily approximately 60 to 90 minutes after the time the hunter will be in his stand. The amount of bait dispensed should be regulated by observation of its use. Only the amount of corn that will be completely consumed before the following morning should be dispensed. This will entail some trial-and-error, but the general pattern is to begin with about one gallon of shell corn until the bait site is discovered by deer, then increase the amount to several gallons. Never allow more than five-gallons to be placed on the ground at any one time. Different bait sites will have varying amounts of bait removed and should be treated accordingly.



Hunting is a skill and a craft involving woodsmanship, marksmanship, stealth, an understanding of animal behaviors and how animals use habitats.

Approximately three weeks are required for deer to pattern well on a bait site. Initially, deer will arrive intermittently at a new bait site and at all times of the day. As time passes, deer will arrive closer to the programmed dispensing time until finally they will come approximately 30 minutes prior to corn distribution. We suggest baiting begin three weeks prior to the site being hunted. Baiting material should be bagged shell corn. Recharging feeders should only occur four hours before or eight hours after the normal corn dispensing time.

No deer feeding, other than that which happens in the feeders, should occur anywhere on the property. As much as is appropriate, neighbors should be discouraged from feeding deer except for hunting purposes. Year round or winter feeding should be discouraged.

It is strongly suggested that each feeder be placed with a 16-foot or higher ladder stand. Ladder stands provide a safe and comfortable shooting position, but more importantly they allow hunters to slip into the site without the noise of a climber. It is wise to cut, clear and rake a trail to allow quiet access to and up the stand by the hunter with an absolute minimum amount of noise and movement. Stands should be positioned in the most common downwind direction from the feeder and placed to conceal the hunter's outline while allowing for a clear shot with a muzzleloader or shotgun. Deer will often bed near feeders and be alerted to a hunter's presence by his or her entry.

No bait site should be hunted more than once every four days. To do so will increase deer wariness and reduce their vulnerability. Hunters should have multiple bait and stand sites, if they are going to hunt several days in succession as discussed previously. Hunters are also strongly encouraged to hunt de-scented. The most pragmatic approach to hunting scent-free is to wash your hunting clothes using a box of baking soda. Place washed and dried cloths in a sealed plastic storage container with either a few white pine boughs and/or oak leaves along with rubber hunting boots used only for hunting. It is advisable to take your clothes and boots to the property in a plastic container and dress on site. Hunters should take care to substitute rubbing alcohol for deodorant and use unscented bath soap and shampoo one or two days before each hunt. Avoid pumping gas or handling any petroleum products on the way to the site.

Once in the stand, limit your search area so as to minimize body and head movements. Head turns should be very slow. If deer approach the site cautiously, are apprehensive or alert, rest the site and discuss with other hunters on the property what they are observing. Deer killed at bait sites should be removed to another location for field dressing.

The effectiveness of baiting will vary within a year and between years. Deer prefer acorns, particularly white oak, over corn. When acorns fall, deer may abandon bait sites for mast as long as it is available. Most years acorns begin falling in late August and remain on the ground through November. In years of bumper acorn crops, mast may be available throughout the winter, making deer difficult to bait. However, with the exception of Unit 3-Redtail Ridge, this is not a serious issue on School Trust properties which overall have poor mast potential.

“The concept of sport allows many hunters to enjoy the experience of hunting and the chase without overly depleting wildlife populations.”

“However, where hunters are being used to control wildlife populations issues of sport should be secondary to effective management goals.”

Baiting is currently illegal in WMU 5B. The PGC biologists acknowledge that the School Trust lands do represent those conditions present in the special regulation areas and the challenge faced there by deer hunters and managers but declined to make the HTL a pilot area. NRC Inc. recommends that School Trust staff and hunters continue to explore this issue with the Pennsylvania Game Commission.

Ethics of Hunting Over Bait

As one moves along the deer management gradient toward exurban landscapes, traditional recreational deer hunting as a management tool becomes less effective. If hunters want to remain relevant in such situations they will need to adapt.

Brown et al. (2000) suggests that if deer populations are to be controlled, wildlife agencies and hunters will need to recognize the increasing importance of exurban and suburban areas as elements of deer range while adopting hunting regulations that can address the expansion of deer refugia associated with development that limits 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 suggests 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 organizations” Holsman (2000:814).

The hunting tradition in North America has its roots in a utilitarian value system (Organ and Fritzell 2000) that recognizes 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 and staying warm or going without clothing or blanket skins.

The concept of sport hunting was first advanced in America in the mid-19th 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 19th century and was led by wealthy elites, primarily from urban areas, concerned about the dramatic decline in game populations as a result of over-exploitation 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.



Deer cover exists throughout the MHS Main Campus but within legal safety zones, thereby preventing recreational hunting.

The concept of sport allows many hunters to enjoy the experience of hunting and the chase without overly depleting wildlife populations much as catch and release facilitates trout fishing enjoyment and opportunities. However, where hunters are being used to control wildlife populations, issues of sport should be secondary to effective management goals.

Today, most Americans support legal hunting, but the perceived motivations of the hunter appears 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, to manage game populations, and for animal population control are acceptable activities, whereas hunting strictly for recreation and to acquire trophy animals are less acceptable.

As deer become less vulnerable to hunters in exurban and suburban landscapes, hunters and wildlife agencies will need to remove many of the self-imposed restrictions designed to limit their effectiveness as predators if they are to be effective, relevant deer managers.

The deer management goals on School Trust lands are to reduce or eliminate deer/human conflicts, reduce the probability of humans contracting Lyme disease while on the property and to protect, maintain and restore the structure, diversity and function of the property's forests in a safe, humane and socially responsible manner. Based on management experience and published evidence, traditional recreational hunting cannot achieve these goals in at least one area but hunters could use nontraditional techniques like baiting. Being able to hunt deer and reduce their impacts to meet property owner goals under these conditions is a skill and a challenge.

Hunt Cycle

Deer vulnerability varies dramatically between different properties and landscapes based on topography, amount and juxtaposition of deer habitat and deer refugia, cover type, size of huntable areas, density of housing and community value. Based on these variables, recreational hunting can play an important role in meeting deer management goals in some situations but not in others. When hunting activities are initiated, deer will quickly move to unhunted properties or safety zones if they are within their home range and remain there during daylight hours until hunting pressure declines or the deer are disturbed. On School Trust lands deer refugia are common and increasing as development on and adjacent to Trust lands continues. The abundance of deer refugia and their ability to increasingly compromise recreational hunting as a management tool for achieving School Trust deer management goals is a reality that should be recognized.

A powerful tool for dealing with this challenge would be the application of Special Regulation Area rules to the School Trust lands as a pilot by the PGC as previously discussed. This would allow for several important tools to make hunters more effective including more opportunities for hunters to harvest antlerless deer. The longer seasons in Special Regulation Areas allow for three separate firearm seasons for a total of 42 days spanning October, November, December and January. This increased opportunity allows managers to take advantage of deer behavior to increase their vulnerability.

Under hunting disturbance deer move to refugia where hunters cannot follow, and the deer do not leave except at night. Nocturnal deer behavior in landscapes with abundant refugia reduces deer vulnerability to recreational hunter mortality to near zero. It usually requires approximately five days following the cessation of hunting activity for deer to return to their more normal behaviors and increased vulnerability. Managers can use this behavior to establish hunting cycles that allow hunting for two to four days followed by no hunting for five to seven day. This allows deer to come out of refugia, return to normal behaviors, increase their vulnerability to hunters while creating multiple opening days and increased deer sighting/unit of effort for hunters. The use of hunting cycles will maximize deer vulnerability while lowering the recreational threshold for hunters. It is only possible, however, if long antlerless seasons are available. NRC Inc. encourages School Trust to work with the PGC to include their lands in the Special Regulation Area.

Sharpshoot Deer Under a PGC Deer Removal Permit– Not 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). 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. Deer are humanly 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, 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 naive to gunshots, and are reluctant to flee a bait site once shooting is initiated (DeNicola et al. In Press). To prevent "educating" deer and maintaining their naive 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, MHS employees.

There is some confusion within and without of the PGC as to who may apply for a Deer Control Permit. The most generous interpretation would allow the MHS to apply directly to the PGC. The most restrictive would require the MHS to request that Derry Township apply and obtain a Deer Control Permit on the school's behalf. Regardless of whoever applies the PGC will require the applicant 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 landuse

within the area, cover types, huntable areas, damage areas, deer concentration areas, safety zones and proposed control areas will need to be provided. In addition, a deer management plan will 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.

Sharpshoot Deer Under a Crop Damage Permit – Recommended

Without the use of tools like baiting, designed to make hunters more effective in suburban/exurban environments, there is no opportunity for recreational hunting to address the overabundant deer concerns in Unit 4-Milton Hershey School-Main Campus. However, deer removals by sharpshooting based on crop damage is an option. Safety zone regulations do not apply to deer removals for crop damage.

There is considerable disagreement between the agricultural community and the PGC about the laws regarding agriculture's right to remove deer. What is clear is that agriculturalists may remove deer for crop damage at any time of day or night with tackle that includes suppressed small caliber rifles. What is less clear are issues regarding who qualifies as an agriculturalist, who decides if agricultural damage is occurring, and whether a permit is required.

Under the current law, NRC Inc. believes that Hershey employees could be trained by a contractor to annually remove deer for crop damage at night at the Milton Hershey School-Main Campus using a suppressed small caliber rifle, provided the employees or school either acquired the appropriate permits for owning and using a suppressor from the Bureau of Alcohol, Tobacco, Firearms and Explosives or operate under the supervision of a permit holder. Deer could be removed using these techniques safely, efficiently and unobtrusively anytime during the winter. We recommend contacting the PGC southeast regional office to explore this option.

No Action – Recommended for Units 8 and 14

No action could be considered as one deer management option. The result of inaction for School Trust properties in general would be increasing deer numbers, increased negative impacts by overabundant deer and a widening area of overabundant deer challenges on School Trust lands. The recreational hunting program may have failed to reduce deer impacts to the desired level, but it has played an important role in limiting deer numbers. Inaction across School Trust lands will assure failure in the achievement of School Trust deer management goals and a dramatic increase in deer/human conflict.

NRC Inc. does recommend no active deer management be pursued in Unit 8-Hershey Foods Manufacturing/ Hershey Park/Hershey Country Club and Unit 14-Wren Dale Golf Course. These areas contain intensely-developed environments such as the expansive paved parking lots, downtown properties, Hershey Country Club, High Meadows Campground and landscapes with no

diurnal deer cover such as open agricultural fields and golf courses. NRC Inc. does not anticipate a deer problem in these units. Any deer problems that may occur can be addressed through actions in adjoining units.

Mitigation Techniques - Not Recommended

Mitigation techniques such as fencing, repellents, feeding and establishing landscape plantings resistant to deer browsing have value in addressing individual problems but not larger functioning landscapes. It is neither practical nor effective to use deer repellents to protect forest ecosystems. Fencing, although costly, could be used to exclude deer from some select areas such as a garden but not forest stands 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 unprotected landscape had deer numbers, and thus impacts, been reduced.

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 homeowner’s property are on the market today. Deer can hear outside the range of human hearing (D’Angelo et al. 2007), but no science-based literature supports the effectiveness of ultrasonic devices at deterring deer.

Restoration of Predators - Not Recommended

Predation controlled and limited both deer numbers and deer impacts through the millennia. The current overabundance of white-tailed deer and their pervasive effects on ecosystems are 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 but not on School Trust lands.

Predators capable of limiting deer populations are also animals that see humans and their 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/agricultural landscapes 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/agricultural 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 for meat or recreational “hunting.” In nearly all cases trapping and moving deer simply involved transferring them to 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 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 suggests that localized management using immunocontraception is theoretically possible in exurban/suburban communities. Immunocontraceptive vaccines offer significant promise for wildlife management (Turner and Kirkpatrick 1991, Kilpatrick 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 Agency (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 what its policy will be on the use of contraception in the state.

The specific application of any form of contraception at the School Trust properties has several challenges:

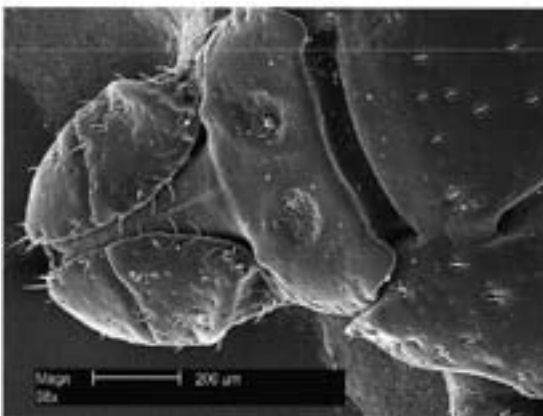
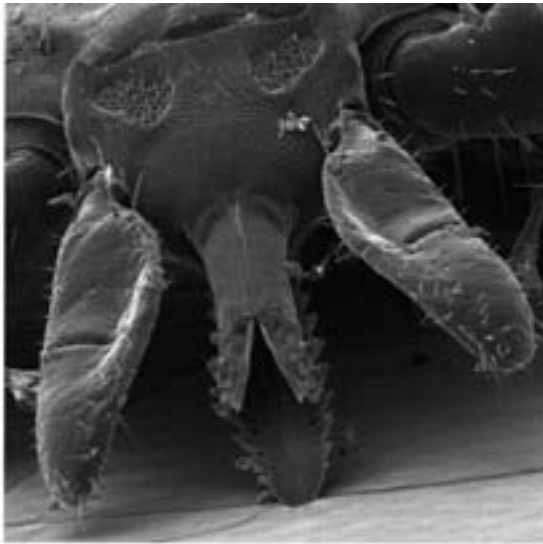
- Contraception is experimental and has not been shown to be an effective management tool for free ranging deer populations in situations like those at the School Trust properties. Any use of contraception would need to be viewed as research and experimental, not as a management solution.
- Contraception by design requires time and nondirected 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 the property.
- No experimental applications of these drugs have targeted the low deer densities required to achieve the goal 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 School Trust.
- If localized management of deer in exurban/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. Exurban and 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.
- 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 the School Trust properties. In addition, contraception is in conflict with the goal of providing recreational deer hunting opportunities to employees where it is determined to be safe, legal and compatible with other land uses (personnel communication Elliott Robinson, Vice President, Administration).

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 goes to the trap and 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 onsite to activate the net then euthanize the animals either

White-tailed deer, *Odocoileus virginianus*, are the principal host for the adult blacklegged tick and a key to its abundance...



with a gunshot to the brain or a bolt gun such as is used in slaughterhouses. Trapping and euthanizing using drop nets may not be viewed as humane because of the interval between capture and euthanization. Neither technique is recommended as a single treatment approach due to the fact that deer eventually learn to avoid traps, reducing program effectiveness.

Historic Background of Lyme disease

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 unrestricted hunting and due to a landscape level conversion of eastern forests to the open habitats of agriculture, thus removing both the adult tick’s 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 (Cummings 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. 2004). 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 1860s with no legal reported kills until 1923 (Pennsylvania Game Commission 1995). Deer densities remained low until the 1970s when populations began to grow, increasing dramatically in the 1980s and 1990s.

Today Pennsylvania has regained much of its former forests but with a much higher deer density than the original seven to ten deer per 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 centuries on islands off the New England coast where they were documented in the 1920s. 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 are 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 have 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

Area-Wide Applications of Acaricides – Not Recommended

Area-wide applications of acaricides for controlling ticks (Curran et al. 199, Allen and Patrican 1995) are possible but not recommended.

Vegetation Management and Landscape Modifications – Not Recommended at this time

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. A discussion and description of these techniques can be found in the Tick Management Handbook by Kirby Stafford, 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 dose will kill existing ticks and protect the rodent from new ticks for 40 days. Once baited and charged with fipronil, the box 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 numbers after two years. The technique also showed positive results in decreasing the abundance of ticks infected with *Borrelia burgdorferi* (Dolan et al. 2004).

Downsides of the technique include the intensity of treatment--an average of ten bait boxes per half to one acre of 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 manufacturer 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 non-target 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 of the product. The manufacturer would not provide an estimate of when the product would again be available which was not encouraging. They do recommend area-wide spray applications of acaricides as a replacement.

Considering the withdrawal of the Maxforce Tick Management System by the Environmental Protection Agency, 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, 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 populations, Carroll et al. (2003) reduced *I. scapularis* nymphs by 69%, 76% and 80%.

One challenge on School Trust property 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 agricultural crops and waste grain, recreational feeding of deer, incidental feeding at bird feeding stations, or naturally-occurring mast such as acorns or beechnuts. Corn and soybean crops are readily available on much of the School Trust lands. How this might impact feeder use is unknown. 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 Knippling-Bushland U.S. Livestock Insect Research Laboratory, Kerrville, TX). Due to the limited amount of oak forests on School Trust lands NRC Inc. does not see this as a significant issue.

Negative aspects of 4-posters would be cost, labor, and increased deer concentrations in the immediate area of their placement. To be effective, 4-posters would need to be in operation during the fall hunting season.

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 seed's embryo, leaving much of the endosperm behind. The result is exposed, partially eaten kernels which quickly mold and clog the corn flow within the 4-poster, resulting in only moldy corn being available to deer. This leads to 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). On all MHS campuses adequate open areas exist to avoid squirrel damage issues if feeders are placed properly.

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/year. At the School Trust properties costs could be reduced dramatically by simply targeting the campus areas and not the farmland property as a whole. However, because of the exposed Class 4 pesticide on the application rollers, 4-poster technology should not be placed within 100 yards of occupied buildings without the knowledge and permission of the occupants, particularly if small children are present.

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 eight 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 the property's forests, deer densities on campuses 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 to determine if they are above acceptable levels before use of 4-posters.

Measurable indicators are the basic tools required for monitoring the success of any program to maintain or recover forest structure, diversity and ecological processes.



Deer damaged agricultural and ornamental plantings.

Monitoring Program to Guide Deer Management

If desired, it is possible to measure, with statistical confidence, deer densities on the Trust lands using distance sampling. However, Natural Resource Consultants Inc. does not recommend expending resources on counting deer. The goal for the School Trust lands is not a particular deer number per se but rather a reduction in deer impacts and the balancing of those impacts with Trust goals. Therefore, NRC Inc. recommends effectiveness monitoring programs that focus on the abatement of those conflicts for which the deer reduction are proposed, not an arbitrary deer density. Secondly, in the diverse landscapes that make up agricultural and exurban environments (Nelson 1992), there is very little science-based data that relates deer density to the abatement of a range of deer conflicts making deer density goals somewhat speculative and arbitrary. Finally, as deer numbers are reduced, population surveys become increasingly unreliable. Effectiveness monitoring programs that focus on quantitative measures of those challenges for which a deer reduction are initiated are more meaningful, more reliable and less controversial.

NRC Inc. recommends that the hunt manager working with the MHS staff monitor both deer/human conflicts, deer impacts on vegetation and if deemed necessary, tick abundance.

Deer/Human Conflict

The deer management goals for School Trust lands include both goals related to deer impacts on society (e.g., number of deer vehicle collisions, number of crop damage complaints, ornamental/landscape planting complaints, Lyme disease) and the environment (negative effects deer have on ecosystems and other wildlife). It should be noted that deer impacts on forest ecosystems occur at much lower deer densities than densities associated with noticeable deer health indicators (Stout et al. 1997) and most deer/human conflicts. Societal goals for School Trust lands include the following: 1) reduce or eliminate deer/human conflicts regarding ornamental plantings, gardens and agricultural crops, 2) reduce the probability of humans contracting Lyme disease while on the property and 3) manage deer in a safe, humane, socially responsible manner using recreational hunters when and where it is safe, effective, legal and compatible with other land uses, adding additional tools only as needed.

Agricultural, Horticultural and Restoration Plantings

During the month of August the hunt manager should contact Michael Benner, Ph.D., Director, Agricultural & Environmental Education Program for an annual update on deer impacts to vegetable, row, and orchard crops as well as native plantings on MHS school campuses. These reports should, as much as possible, be both qualitative (e.g. unable to grow sweet corn beyond silk stage, unable to grow red beets, maple-leaved viburnum plantings

severely browsed, apple trees damaged by antler rubbing, plastic ground covers damaged by deer foot traffic) and quantitative (e.g. less than 50% of the sweet corn reached the silk stage, 100% of red beet plantings destroyed, many of the maple-leaved viburnum plantings had 50% or more of their stems browsed, 30% of orchard trees were damaged by antler rubbing, 60% of plastic ground covers damaged by deer) regarding within-year damage. Similarly, Phillip Shirk, Manager, Grounds & Landscaping with MHS should be contacted as should Jamie Shiffer, Grounds Manager, Hershey Gardens and Art Shiavo, Hershey Nursery for similar annual input on deer impacts. All full-time farmers that lease farmland from School Trust should be contacted and queried, in a supportive way, about any damages or challenges they are facing with deer damage.

Trends in Tick Abundance

Managing Lyme disease means managing tick bites which means reducing tick numbers. One method by which to judge the need or 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 there be a desire to track tick abundance on the Trust properties two techniques are recommended: tick drags and tick flagging. Both are manpower-intensive and tedious but effective 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 differences 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. The ticks are removed from the fabric using an adhesive tape lint roller. The tapes are placed 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 reach-

ing its peak (Daniels and Fish 1990). Nymph sampling on the property, if desired, 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.

If tick sampling is to occur, it is recommended that a field data sheet for tick drags be developed. 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. This is tedious work and careful records are required to assure consistent data collections so the analysis of trends provides good information.

Approximately four 10-meter sample transects should be established within each campus area of concern focusing on high quality tick habitats like forest understories and grassy areas such as lawns and roadsides 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, that would be one late in the morning after the dew has dried and again during the late afternoon as temperatures cool. Do not sample if the leaf litter or grass is wet.

Cases of Lyme disease

The primary goal of Lyme disease management is to reduce the incidence of the disease in people who live, work and visit School Trust lands. Therefore, the best indicator of the need for tick control or program success would be to track the trend in the cases of Lyme disease among students and employees. If no problems currently exist than obviously, no control is necessary. MHS has only one documented case of Lyme disease among its students in the past two years. The attending Doctor felt these cases were likely contracted at the student's home over the summer.

One challenge of monitoring Lyme disease is differentiating between cases that result from ticks picked up from on site habitats versus those encountered while elsewhere. Trend data can also be confounded by changes in personal behavior as attitudes towards the threat of the disease change. This might mean there is increased outdoor activity with less personal protection as individuals perceive the problem to have been addressed, or a decrease in exposure resulting from increased awareness and individuals becoming more cautious.

Ecosystem Impacts

Ecological goals for the School Trust properties are:

- 1) Maintain white-tailed deer as a valued component of the property'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 property's forests.
- 2) Reduce the potential for exotic invasive plant expansion on Trust lands by reducing deer herbivory on native species, thereby restoring community-level competition.

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). Further, current deer densities in the eastern United States may be affecting forest plant communities for future generations (Stromayer and Warren 1997). In Pennsylvania, there is nearly unanimous agreement within the scientific community that much of the state's forest is in a seriously degraded ecological condition as a result of high deer densities and impacts (Latham et al. 2004). Much of this challenge results from a history of managing deer from an "agricultural paradigm" where the foundation of the program is based on determining the number of animals that exist within herds (population density goals) and estimating yields for harvest (harvest objectives) with the goal of maximizing deer numbers based on nutritional carrying capacity.

Managing deer to meet School Trust goals will require a major shift in the philosophical approach from an agricultural paradigm to one with an ecosystem perspective. This approach will require a focus on vegetation data to assess levels of herbivory on the trophic level (Latham et al. 2004) rather than deer numbers. One of the basic tenets of ecosystem management is that forests, instead of being viewed as containing a set of resources, be considered as more than the sum of their parts. Forests are comprised of many quantifiable components with systems performing various functions and processes. Ecosystem management is the implementation of practices that promote the long-term health of the forest ecosystem as measured by important ecological indicators. The monitoring of these indicators is the means by which successful management is measured. The challenge is to pick those few components whose changes most fully reflect the processes, functions, and diversity trends of the entire ecosystem. Many monitoring protocols use indices of forest regeneration as a primary measure of forest habitat health. Tree seedling size, abundance, and species diversity, may work well as a short-term surrogate for recovery of the entire vascular plant species community.

One challenge for meeting School Trust goals and for monitoring deer impacts is the nearly ubiquitous abundance of exotic invasive plants. Species such as multiflora rose, Asiatic bittersweet, Japanese stiltgrass, privet spp. and exotic honeysuckles are common on the property and compete directly with native species for space, moisture, nutrients and light. This competition is intensified through the enemy release principle, whereby deer preferen-

tially feed on the more palatable native plants giving non-natives a competitive advantage and increasing their dominance. This shift from native to nonnative shrubs was apparent in every woodland landscape surveyed on Trust property as well as most wetlands and warm-season grass plantings. To be successful in reducing the potential for exotic invasive plant expansion on Trust lands, deer impacts and therefore densities, will need to be low.

NRC Inc. recommends effectiveness monitoring programs that focus on measurable indicators of deer impacts on vegetation. 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 by the Pennsylvania Department of Conservation and Natural Resources (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.

Exclosures with Paired Plots

NRC Inc. recommends eight exclosures on the School Trust properties in the mixed hardwood forest stands. Two should be placed in Redtail Ridge, one on the knob on the Dearden Campus, one north of Camp Milton, two northwest of Hotel Hershey, one along the western edge of Manada and one south of Camp Catherine. Exclosures should measure 10 meters by 10 meters using 8-foot high-tensile; woven wire designed for wildlife with 6-inch vertical wires and supported by wooden posts. A paired unfenced plot for each exclosure should 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:
 - tree (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.
4. Total plot species list

Woody and herbaceous vegetative data should be collected in June.

Managing deer to meet HTC goals will require a shift in the philosophical approach from an agricultural paradigm to one with an ecosystem perspective.

Advanced Regeneration and Browse Utilization Survey

Advanced regeneration surveys using SILVA and browse utilization surveys using DCNR data collection protocol should be collected in the same stands as exclosures. Browse utilization data should be collected in April. Regeneration data should be collected in late June/July.

Random Walk Survey

A “random walk” survey is suggested to identify herbaceous species that may be rare on the property and vulnerable to deer impacts. This survey, if desired should occur in March, June and August. When species are found, they should have an estimate of number, percent flowering, amount of ground coverage in square meters, height of the tallest plant, and location recorded. Random walks should include a review of plot locations. Vegetation data should be compiled and reviewed each September. Analysis and monitoring trends may require outside assistance.

Camera Monitoring

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 habitats and, if desired, provide a record that can be presented to the staff, students and/or hunters. It is possible to estimate deer populations using these cameras (Jacobson et al. 1997, Koerth et al. 1997). However, their purpose on School Trust lands will be to provide information about deer use of habitats to students, document deer presence, fawns (reproduction) and deer behavioral patterns. Camera monitoring can also be used to pattern deer use of bait sites if this technique is employed, motivate hunters, and/or monitor deer learned behavior at individual stand sites.

Should monitoring be desired, NRC Inc. recommends cameras with the Compact Flash memory cards and the silent infra-red feature. Units that use film or flashes are not recommended. Each photo will have recorded on it the date, camera location, and time and should be archived.

Effectiveness monitoring will track whether the overall deer management program is resulting in the abatement of the problems for which it was implemented.

Compliance Monitoring

Compliance monitoring is simply a formalized process of documenting that the agreed to treatments 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, the School Trust identify a compliance monitoring coordinator. This individual should annually reviewed deer removal activities and harvest records for completeness and conformity to the agreed design. Data sheets used by the Hunt Manager and hunters should be checked for completeness. Field checks of stand locations, posting and data collection techniques should be made. 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 fill out data sheets. Similar approaches should be taken to monitor forest regeneration, browse utilization, fenced plots, ornamental and plant specimen deer damage and 4-poster program. The compliance monitoring coordinator would be responsible for preparing an annual report.

Effectiveness Monitoring

Effectiveness monitoring uses a group of indicators to quantitatively measure whether a management program is successfully accomplishing the goals and objectives it was designed to accomplish. The focus of effectiveness monitoring on School Trust lands will be the abatement of deer/human conflicts and vegetation trend data from the paired exclosure and control plots, advanced regeneration plots, browse utilization transects, measurements of relative tick abundance and the number of cases of Lyme disease on campus. 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 School Trust goals are achieved, some treatments may be modified, gradually reduced or dropped to maximize cost effectiveness both in dollars and effort without compromising the success of the program.



Educational Opportunities

Student and teacher involvement in deer management could provide a range of hands on learning opportunities tied to critical thinking, values clarification, conservation biology, botany, plant ecology, human ecology and quantitative math and science. For example students could examine questions such as:

- What is humane treatment of animals and how does it relate to natural systems?
- Can deer populations be managed on School Trust lands in a way that sustains deer, humans and ecosystems?
- How does the use of fertility control fit into a model of sustainability?
- How might deer impact water quality on MHS lands?
- What are the cultural values of words like sport, livestock, wildlife, hunting, meat, human ecology, and humane?
- What are the impacts of exotic, invasive plants on native ecosystems and wildlife?
- Can deer be defined as invasive and if so, under what circumstances?
- What role do deer play in native and invasive plant interactions?

All these questions provide for the opportunity for field data collection, community interaction, internet research, and the use of the literature and analysis. In addition, students could be involved in the monitoring programs by conducting browse utilization transects, using SILVA to explore advance regeneration, comparing fenced plots and controls, conducting tick drags and participating in the processing of transferring deer from the field to the table.

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