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White-tailed Deer Management Plan, Robert B. Gordon Natural Area of West Chester University, Chester County, Pennsylvania

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Prepared by:

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

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BACKGROUND

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

Robert B. Gordon Natural Area (GNA) comprises approximately 150 acres of the campus of West Chester University. GNA is located in the southern portion of campus and is primarily composed of climax deciduous forest and floodplain. The area was preserved by provision of the West Chester University Board of Trustees in 1971. The mission of GNA is two-fold: 1) To preserve a natural area. All forms of human disturbance are to be minimized, thus limiting the types of activities that can be conducted in GNA. 2) To serve as a natural laboratory for environmental studies. The GNA is to be used for teaching and research in ecology and related environmental disciplines, not as a recreational facility.

Students, staff and faculty of the West Chester University Department of Biology work to maintain and improve the condition of the GNA ecosystem by promoting native vegetation and suppressing non-native exotic plants. To date, hunting has not been permitted on GNA. Consequently, white-tailed deer have grown overabundant and have remained at high densities for many years. Overbrowsing by deer has substantially reduced plant biodiversity and has severely limited natural regeneration in the forest understory as evidenced by a distinct browse line throughout GNA.

In February 2008, GNA requested the assistance of U.S. Department of Agriculture Wildlife Services (WS), and subsequently entered into a cooperative service agreement for WS to conduct deer density surveys and to develop a deer management plan. The following includes the methods used by WS to assess deer densities, results, analysis, and recommendations for managing deer according to the goals of GNA.

Deer Management Goals for the Robert B. Gordon Natural Area

The primary objective of Gordon Natural Area is to maintain a deer herd that will not adversely impact native plant biodiversity enabling the forest to regenerate itself if non-native invasive plants are intensively managed against.

INTRODUCTION

History of White-tailed Deer in Southeastern Pennsylvania

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

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

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

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

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

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

General Deer Biology

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

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

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

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

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

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

An Integrated Approach to Managing Damage by Deer

A well-designed deer damage management program is a progressive approach to wildlife management, which includes developing beneficial relationships among landowners, hunters, and wildlife professionals to reach and maintain deer densities at desirable levels; education about wildlife conservation and deer damage management; implementation of non-lethal deer damage management techniques where practical– fencing, repellents, deterrents; and monitoring the impacts of deer on the environment. WS recommends that our cooperators adopt an integrated approach to managing damage by white-tailed deer. WS provides leadership in the deer management process by conducting personal consultations with individuals and communities, educational programs, deer damage assessments, and direct management in the removal of overabundant deer.

Components of the Integrated Approach:

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

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

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

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

Options for Management

No Action. The "no action" alternative is appropriate if monitoring indicates that current management practices are maintaining deer densities in balance with program goals. For example, on some public lands, this means allowing the deer population to grow unrestricted. Often, deer numbers grows above levels which the habitat can support and above that which humans are willing to tolerate. In urban situations, deer densities may be maintained by a high rate of deer-vehicle collisions. In extreme cases, mortality may occur in the form of starvation. Alternatively, the "no action" alternative often means that sport hunting continues as the established management practice because hunters are achieving adequate harvests to meet program goals. In the case of GNA, the “no action” alternative would mean that no active management of deer occurs (i.e., hunting or other population reduction method). Deer that utilize GNA may be susceptible to mortality other than hunting (e.g., disease, accidents) while on the property and may be harvested by hunters while off of the property.

Non-lethal Damage Management. A myriad of non-lethal deer damage management techniques are available, and fall under three categories: exclusion, deterrents, and repellents. Research has demonstrated that some practices are effective while others appear to be marketing ploys. Properly installed and maintained fencing 10 feet in height and secured to the ground is the most effective exclusion tactic. Fencing can be cost prohibitive for large acreages, and many communities have ordinances limiting the use or height of fences. Deterrents use sound, visual, or tactile cues to frighten deer from areas where they are causing damage. Deterrents which are set off by the offending deer or those with irregular cues tend to be most effective since deer may easily become acclimated to deterrents. Repellents use taste or scent to discourage deer from eating treated plants or entering treated areas. A wide variety of commercially available repellents have been reported to be effective in independent research. Repellents require reapplication after rain events and may lose effectiveness at temperatures below freezing. GNA has utilized fencing and tree protection tubes in attempts to reduce damage by deer to natural regeneration and planted tree seedlings. However, these methods have proven ineffective at sufficiently reducing deer damage to vegetation. Non-lethal management methods will not reduce risk of Lyme disease or deer-vehicle collisions.

Population Management. When deer become overabundant, a rapid reduction in deer density is necessary to suppress annual population growth and reduce damages. Once management goals are reached, annual deer harvests must be conducted to maintain acceptable population levels. The methods used to remove deer will depend on safety, legal restrictions, financial constraints, timing of the management action, and effectiveness of the removal methods employed (Appendix A). In many deer management situations, using a combination of deer removal methods is necessary to achieve management goals. To date, population management has not been used on GNA since its establishment as a natural area.

Types of Population Management

Sport Hunting. Sport hunting should be encouraged whenever possible as it is generally the most economically feasible strategy to manage deer. However, legal restrictions (e.g., safety zones, timing of hunting activity) and other limitations (e.g., hunters resistant to harvesting adequate numbers of does) may limit the effectiveness of sport hunting in some situations. In recent years, the Pennsylvania Game Commission has provided for additional deer harvest opportunities under depredation permits outside of the normal hunting seasons. Additional information about hunting seasons, bag limits, and depredation permits may be found online at www.pgc.state.pa.us or by contacting the Pennsylvania Game Commission headquarters in Harrisburg by phone at 717-787-5529.

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

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

Relocation. Capturing deer and relocating them to another location is not an option in Pennsylvania because this practice is not legal. Legal considerations not withstanding, trap and transfer of deer is expensive, ideal relocation sites are limited, and relocated deer suffer greater than 50% mortality. Relocating deer may also transfer diseases to areas where they did not previously occur.

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

METHODS

Establishing regular monitoring of the deer population is an important initial step toward long-term management. Baited camera surveys were conducted to obtain estimates of the number of deer utilizing GNA prior to the 2009 fawning season. The surveys were conducted according to previous research by Jacobson et al. (1997). These researchers demonstrated that the abundance of deer in an area could be determined using baited surveys, where bucks could be uniquely identified by antler characteristics (Figures 1, 2) and their number used to infer the number of does and fawns (Figure 3) visiting repeatedly the bait site.

Three bait sites were surveyed in this manner: Camera 1) north of the access road for the “Big Woods” area of GNA in a stand of mature white pine trees in the early succession field west of South High Street; Camera 2) in the flood plain area three tenths of a mile southwest of the intersection of South New Street and Tigue Road; and Camera 3) in the wooded corridor on Plum Run Creek west of South Campus Drive and East of Lenape Road.

Criteria for the bait sites included: 1) regular utilization of the area by deer before bait was placed, 2) uncommon use by humans in the immediate area of the camera to avoid disturbance of deer, and 3) adequate distance from other bait sites to maximize capture of different deer by photograph. During a 7-day pre-baiting period, whole kernel corn was placed at each bait site in a quantity sufficient to maintain consistent access by deer 24 hours a day. Following this acclimatization period, an infrared camera was installed in a stationary position and was set to record still photographs of deer 24 hours a day during survey period of at least 14 days. As in the pre-baiting period, whole kernel corn was provided ad libitum. The infrared cameras were triggered to photograph by movement and/or changes in heat within a sensing cone, which was 50-feet long and 30-feet wide at the placement of the bait station.

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

To establish an estimator of deer abundance the following analysis was conducted. The number of bucks uniquely identified was divided by the total number of bucks photographed to calculate a *population factor*. Jacobson et al. (1997) established *extrapolation factors* for baited cameras set to service particular land areas during differing survey lengths. The extrapolation factor adjusts the estimator to account for the percentage of the total deer population likely to be photographed during the survey based on the density of cameras and the length of the survey period. The extrapolation factor used for this study assumed that 90% of the total deer population utilizing GNA was photographed. The estimate of the total number of bucks was calculated by multiplying the total number of bucks times the extrapolation factor. The total number of does was calculated by multiplying the number of does counted in the photographs times the population factor, and times the extrapolation factor. The total number of fawns was calculated by multiplying the number of fawns counted in the photographs times the population factor, and times the extrapolation factor. The total deer abundance in the area of each bait site was calculated by adding the total number of bucks, the total number of does, and the total number of fawns.

RESULTS

The pre-baiting period for the baited infrared camera surveys was started on 22 September 2008. Infrared cameras were installed and the survey period began on 29 September 2008. The surveys were concluded on 21 October 2008. Deer acclimated well to the bait sites and were photographed throughout the day and night (Table 1).

A total of 28 unique bucks were identified. Although baited cameras were in relatively close proximity, no individual buck was photographed on two different cameras. This suggests that the data from each camera represents an independent sample of the deer population on GNA. Therefore, data were pooled for all three cameras to calculate the total abundance of deer utilizing GNA.

The total abundance of deer determined to be utilizing GNA was 83 deer, including 31 bucks, 28 does, and 24 fawns. The buck to doe ratio was approximately 1:1 and the fawn to doe ratio was approximately 0.87:1.

Table 1. Data collected by USDA APHIS Wildlife Services during baited infrared camera surveys to estimate white-tailed deer abundance on the Gordon Natural Area at West Chester University, Chester County, PA during September and October 2008.

Survey location	Total photos with deer	# unique bucks	# buck photos	# doe photos	# fawn photos
Camera 1, Big Woods	223	9	69	48	35
Camera 2, Floodplain	220	8	57	64	35
Camera 3, Old Field	276	11	65	62	76

DISCUSSION

Home ranges of female white-tailed deer may vary in different habitats, latitudes, and deer population densities (Appendix B). However, data from previous studies suggested that home ranges for female white-tailed deer in suburban habitats range between approximately 50-1,974 acres with most averaging less than 640 acres (1 square mile). In general, the home ranges of adult males are twice that of adult females. Baited surveys are designed to develop an index of deer abundance for a particular area rather than a deer density or exact population estimate. However, given knowledge of the home range size of deer in suburban habitats and the capability of the baited survey technique for capturing by photograph a high percentage of deer in an area, it is likely that these estimates of deer abundance approximate deer density per square mile. Therefore, the home ranges of the 83 deer utilizing GNA encompass an area beyond the borders of the property. Deer traverse their home ranges to fulfill their life requisites of food, water, and cover during different times of the year, including breeding and the birth of fawns.

Based on the relatively high number of bucks, including multiple mature males, photographed on GNA during the survey it appears that sport hunting has had a negligible impact on the deer population. Bucks are naturally pre-disposed to greater mortality than does because they range farther, are more sought after by hunters, and are more susceptible to deer-vehicle collisions when searching for mates during the fall breeding season. Many deer populations regulated by sport hunting display buck to doe ratios in excess of 1:10. The buck to doe ratio of 1:1 observed on GNA is more typical of populations regulated by natural mortality other than hunting (e.g., predation, disease, starvation).

The deer densities derived during this study may be considered a conservative estimate of deer abundance on GNA since over 5 weeks of archery hunting for deer had occurred by the conclusion of the surveys and the majority of deer-vehicle collisions had already occurred for the 2008 calendar year. Also, the productivity of the deer population appears to be relatively low since adult does were photographed with an average of less than one fawn each. Recruitment of fawns into the population may be limited by typical mortality factors including deer-vehicle collisions or predation. Reduced fawn survival may also be due to degraded habitat conditions, which increases internal parasite loads and malnutrition. Despite being a low-productivity herd, deer density estimates for GNA were a minimum 8 times greater than recommendations by WS for minimization of deer-human conflicts in suburban habitats (10 deer per square mile). Likewise, the density of deer observed in GNA was high relative to deer densities recommended for maintaining plant diversity in forested areas (5 deer per square mile).

Recommendations

To reduce damage to native plant biodiversity, deer abundance on GNA should be reduced to a point where the level of damage by deer is acceptable. Damage to vegetation will never be eliminated, but maintaining lower deer densities for several years will allow regeneration to advance beyond its susceptibility to deer browsing. Since deer home ranges are greater than the size of GNA, deer will continue to infiltrate GNA from adjacent properties. For suburban habitats such as the area surrounding GNA, deer densities less than 10 deer per square mile are appropriate but rarely achieved due to safety zone restrictions for hunters. To promote regeneration of the forest understory and to improve native plant biodiversity, deer densities must be maintained at levels less than 5 deer per square mile. Seedling regeneration in mature forested stands like the Big Woods section of GNA may be compromised by only a few deer since regeneration is often limited to small gaps where the canopy has been opened.

WS recommends implementation of an aggressive deer reduction program in which as many deer as possible are harvested on the property. Sport hunting should be utilized to the greatest extent possible. Reduction to less than 20 deer on GNA would greatly enhance the ability of the forest to regenerate and maintain native plant biodiversity. Not all deer will be available for harvest during the timing of management activities since deer use properties outside of GNA. Also, annual immigration onto GNA from the high density deer populations in the local area will likely occur. Therefore, no matter how intense the population management activity, deer will continue to be a component of the GNA ecosystem, and probably at levels higher than desired. However, any reduction in deer abundance will assist in reducing conflicts.

Due to the high number of deer utilizing GNA, WS would normally recommend a rapid population reduction via firearms. However, in discussions with WS, GNA administration raised concerns about utilizing firearms to reduce the deer population. Research has demonstrated that using archery sport hunting as a sole method to reduce deer densities may limit success on small parcels since deer tend to become nocturnal in response to intense hunting pressure. Therefore, management goals may not be met in a reasonable timeframe. This is not consistent with the mission of GNA to minimize human disturbance and to protect plant biodiversity. WS recommends that GNA explore the possibility of allowing use of firearms to cull deer in a more efficient manner.

Once any management action is undertaken, maintenance of the deer population must be maintained through persistent annual harvest. On average, deer populations grow 30% annually without harvest. Therefore, after the population is reduced to appropriate levels, annual culling should be used maintain the population. Monitoring of the deer population must be continued to ensure that deer densities are kept in check. If post-hunting season surveys indicate that greater than 20 deer are utilizing GNA, management actions should be adapted to increase harvest of deer.

The methods by which the deer population is reduced and maintained are at the discretion of GNA within the guidelines set forth by the Pennsylvania Game Commission. GNA should apply for a permit from the Pennsylvania Game Commission through the Deer Management Assistance Program (DMAP) to obtain permits for hunters to take additional antlerless deer. Typically, applications must be postmarked on or before July 1 prior to the hunting season. GNA should request more than the standard number of coupons (standard = one per 50 acres for non-agricultural land) given the specialized goals of GNA to improve forest regeneration. WS recommends that for the first year of sport hunting, GNA request 50 DMAP coupons. Although harvest of 50 antlerless deer utilizing archery sport hunting alone would be exceptional, this level of population reduction should be attempted.

Likewise, to conduct a population reduction via the professional deer removal option, GNA would be required to apply to the Pennsylvania Game Commission for a municipal deer control permit. This report serves as the majority of documentation required by the Pennsylvania Game Commission in the DMAP and municipal deer control permit applications. WS can further assist in preparation of a permit application at the request of GNA.

GNA should consult with WS and the district Wildlife Conservation Officer from the Pennsylvania Game Commission in designing a controlled archery hunting program within the guidelines set forth by the Pennsylvania Game Commission Wildlife Code. WS recommends that GNA allow no more than 5 archery hunters access to the property during an individual hunting session (e.g., 3 hours before dusk on Mondays). Public access should be restricted to established trails or totally restricted during controlled archery hunts. Archery hunters should be given as much opportunity as possible to harvest deer during established seasons (usually mid-September to late January), especially near dawn and dusk. However, the specific timing and restrictions of the hunting activity should be clearly defined in writing by GNA and provided to participating hunters. For example, GNA may require hunters to pass an archery proficiency exam and agree to report all deer harvested on the property. Hunters should be encouraged to harvest as many antlerless deer (female and antlerless juvenile males) as possible. GNA should also request that hunters involved in the controlled hunting program use their antlered deer tag on GNA to help reduce the overall population. GNA should develop cooperative relationships with neighboring properties owners and encourage them to allow hunting on their land to accelerate and maintain reduction in deer densities.

Desirable conditions resulting from lowered deer densities would likely include: 1) reduced damage to native vegetation, 2) a healthy deer population well below biological carrying capacity, 3) a reduction in deer-vehicle collisions and other human health and safety risks (e.g., Lyme disease), and 4) a positive relationship with the surrounding community by responsibly managing damage by white-tailed deer. Deer population densities relative to the goals of GNA should continue to be monitored. Deer densities should be managed appropriately to satisfy these goals.

In conjunction with reduction of the deer population, GNA may be required to increase the area of fenced deer exclosures (Appendix C). Mature forests are sensitive to even low levels of deer browsing. Fencing 10 feet in height and secured to the ground is the only complete method for controlling deer browsing. With reduced browsing by deer, non-native exotics will proliferate. GNA should be prepared to bolster efforts to control these plants utilizing an adaptive approach, which may include methods not previously employed (e.g., controlled burns, herbicides, mechanical manipulation).

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Figure 1. Photograph of a uniquely antlered buck captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on the Robert B. Gordon Natural Area at West Chester University, Chester County, PA during September and October 2008.

Figure 2. Photograph of three uniquely antlered bucks captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on the Robert B. Gordon Natural Area at West Chester University, Chester County, PA during September and October 2008.

Figure 3. Photograph of an adult doe, a yearling doe and a fawn captured by an infrared-triggered camera during baited infrared camera surveys conducted by USDA APHIS Wildlife Services to estimate white-tailed deer abundance on the Robert B. Gordon Natural Area at West Chester University, Chester County, PA during September and October 2008.

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

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

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

Appendix A. Continued.

[b] Doerr, M. L., J. B. McAninch, and E. P. Wiggers. 2001. Comparison of 4 methods to reduce white-tailed deer abundance in an urban community. Wildlife Society Bulletin 29:1105-1113. Note: Data averaged for 3 years of study. Sharpshooting from a stand over bait includes sharpshooting effort by police and park rangers.

[c] DeNicola, A. J., S. J. Weber, C. A. Bridges, and J. L. Stokes. 1997. Nontraditional techniques for management of overabundant deer populations. Wildlife Society Bulletin 25:496-499.

[d] Kilpatrick, H. J., and W. D. Walter. 1999. A controlled archery deer hunt in a residential community: cost, effectiveness, and deer recovery rates. Note: Based on total effort of 1,848 person-hours by archery hunters and 19 deer recovered.

[e] Kilpatrick, H. J., A. M. LaBonte, and J. T. Seymour. 2002. A shotgun-archery hunt in a residential community: evaluation of hunt strategies and effectiveness. Wildlife Society Bulletin 30:478-486. Note: Actual hours hunted per day were not reported. Data presented were based on assumption of 5 hours hunted per individual hunter per day.

[f] Kilpatrick, H. J., S. M. Spohr, and G. G. Chasko. 1997. A controlled deer hunt on a state-owned coastal reserve in Connecticut: controversies, strategies, and results. Wildlife Society Bulletin 25:451-456.

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

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

Foreword on Deer Spatial Dynamics:

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

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

Please Note: Comparative table on following page.

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

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

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

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

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

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

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

Appendix B. Continued.

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

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

Appendix C. United States Department of Agriculture Animal and Plant Health Inspection Service guidance on the design of exclosures to reduce browsing by deer (on following page).

United States Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services

Plans for Construction of Exclosures to Demonstrate the Effects of Deer Browsing

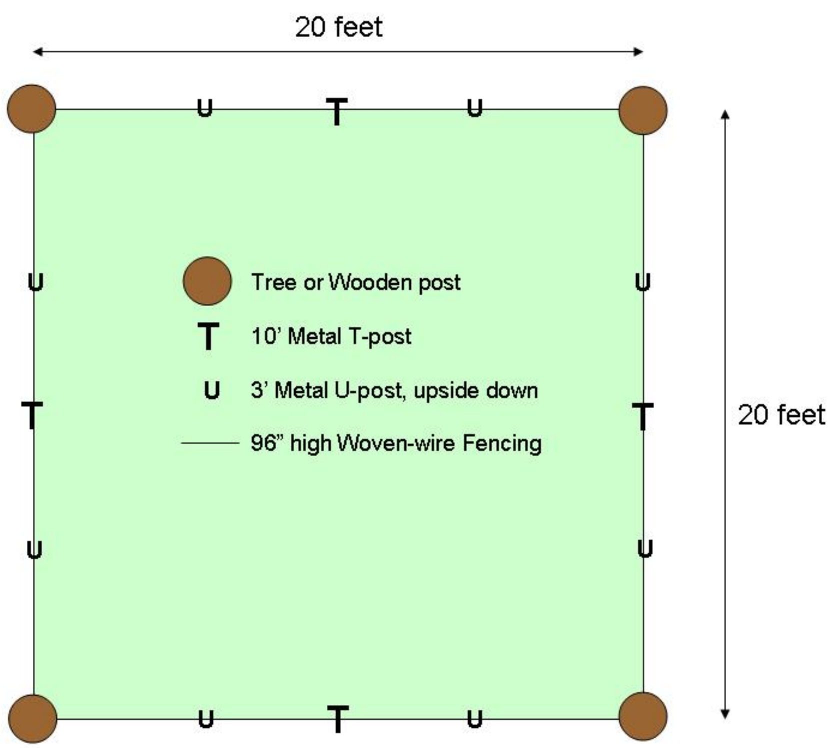

Figure 1. Typical layout of an exclosure to demonstrate the effects of deer browsing.

Supplies

Please note: All prices are approximate and shipping is not included. USDA Wildlife Services can provide technical advice on supplies; a list of suppliers can be provided upon request.

330' roll of 96" high woven-wire fencing
(1 roll may be used for 4 exclosures)..….$630

10' metal T-posts, each……..……………………………………………..…………..$12

3' metal U-posts, each……………………………..……………………………...$3

8' round wooden fence posts, each……………………………………………….$20

Wire clips for fence attachment to T-posts, per 50………………...……………..$5

Galvanized fence staples for attachment
to wooden posts or trees, per 25 lbs……………………………………………..….$30

Recommendations for Constructing Exclosures

Buying supplies in bulk to construct four or more exclosures will provide a savings. Using these recommendations, supplies for a single exclosure may cost less than $300. A 4-sided exclosure with sides of 20 feet in length is more than adequate to demonstrate the effects of deer browsing in forested environments. These dimensions enable the installer to have enough fencing in one standard 330-foot roll to construct four exclosures (approximately 80 feet of fence each).

Although deer can jump vertical barriers greater than 10 feet in height, the vegetation contained in small exclosures generally does not provide enough enticement for them to attempt to jump the fence. Deer prefer to go through or under a barrier rather than jump whenever possible. Use galvanized woven-wire fencing made for deer and exotic animal farms. This type of fencing is more durable in forested settings and stands up better to deer and other wildlife than plastic fencing. Most woven-wire fences have larger holes on one side. The side with larger holes should be installed on the top of the fence. Installing the smaller holes near the ground makes it less likely that deer or other animals will become caught in the fence.

Where possible, consider using existing trees as corner posts since commercially available wooden posts greater than 8 feet in length can be difficult to find and trees provide a much stronger anchor point. However, trees with timber value should be avoided since fence installation may damage the wood. Metal T-posts placed between wooden posts or trees are necessary to add rigidity to the fence, are easy to install, and are relatively inexpensive.

To deter deer from entering the exclosure by going under the fence, pound upside down metal U-posts into the ground through the bottom row of holes in the fence between the upright posts. You may also consider adding a gate or other entry to the exclosure to more closely examine regeneration and for maintenance purposes.

Exclosures may serve as important data collection points for monitoring deer densities relative to your goals. But more importantly, in just a few years, exclosures act as stark examples of the tremendous impact deer may have on the ecosystem. Installing at least four exclosures in separate locations is a good starting point. However, adding more exclosures throughout an area where visitors will encounter them regularly increases the ability to demonstrate the effects of browsing in different habitat types through a range of environmental conditions (e.g., differing levels of sunlight, moisture, soil types). Informational displays placed near each exclosure will also enhance the educational effect.

We recommend taking photographs in a standardized fashion to document changes in the habitat over time. This can pay dividends when conducting long-term monitoring. For example, photograph each exclosure from a certain distance and also take photographs in the four cardinal directions with your back to the sides of the exclosure. Such photographic evidence may also be collected at additional points where exclosures were not installed to increase sampling with limited cost. For questions about designing deer exclosures or for additional advice on monitoring the effects of deer, contact USDA Wildlife Services Biologist, Gino D’Angelo by phone at 267-864-6768, or by Email at Gino.J.Dangelo@aphis.usda.gov.