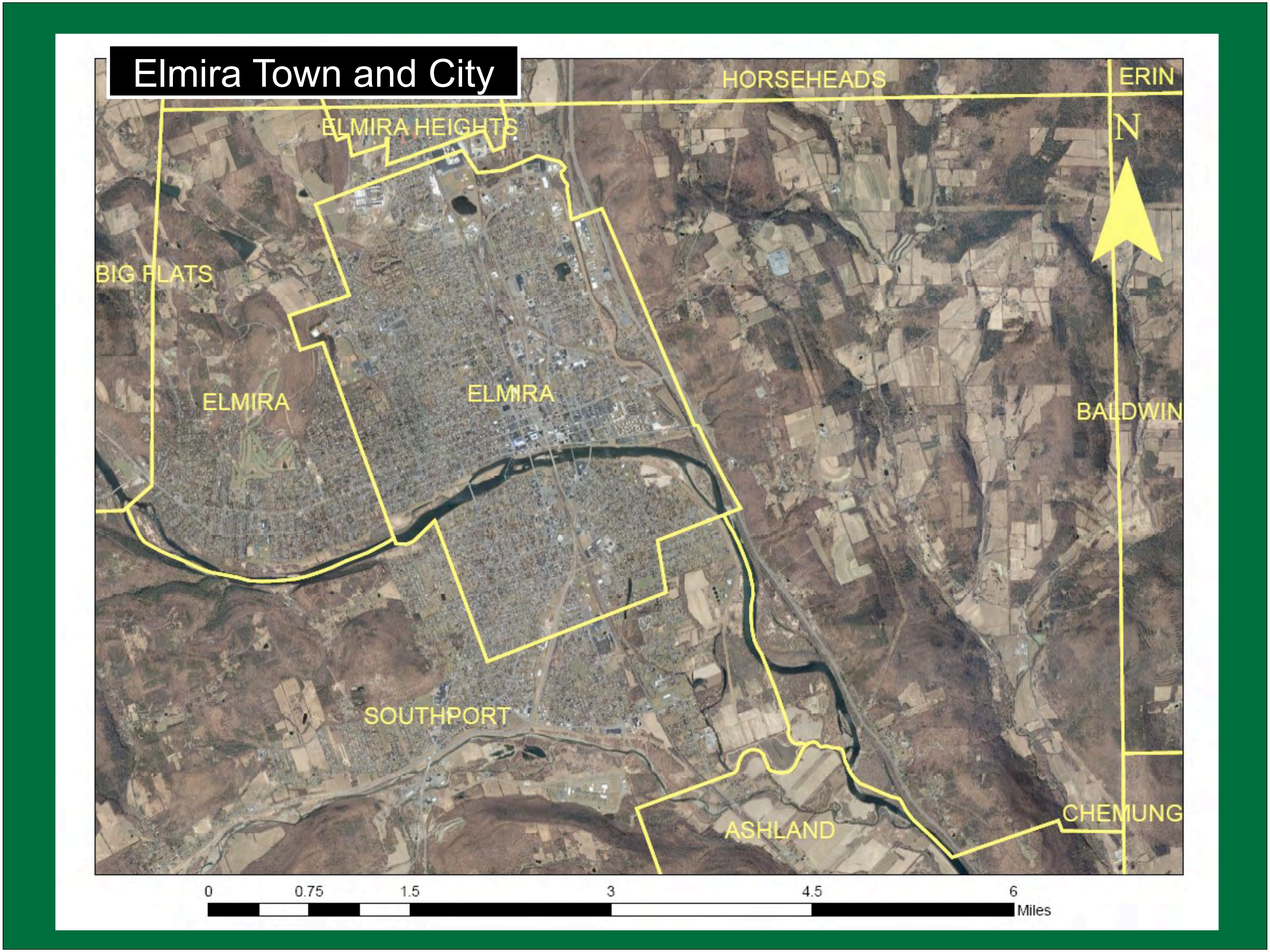
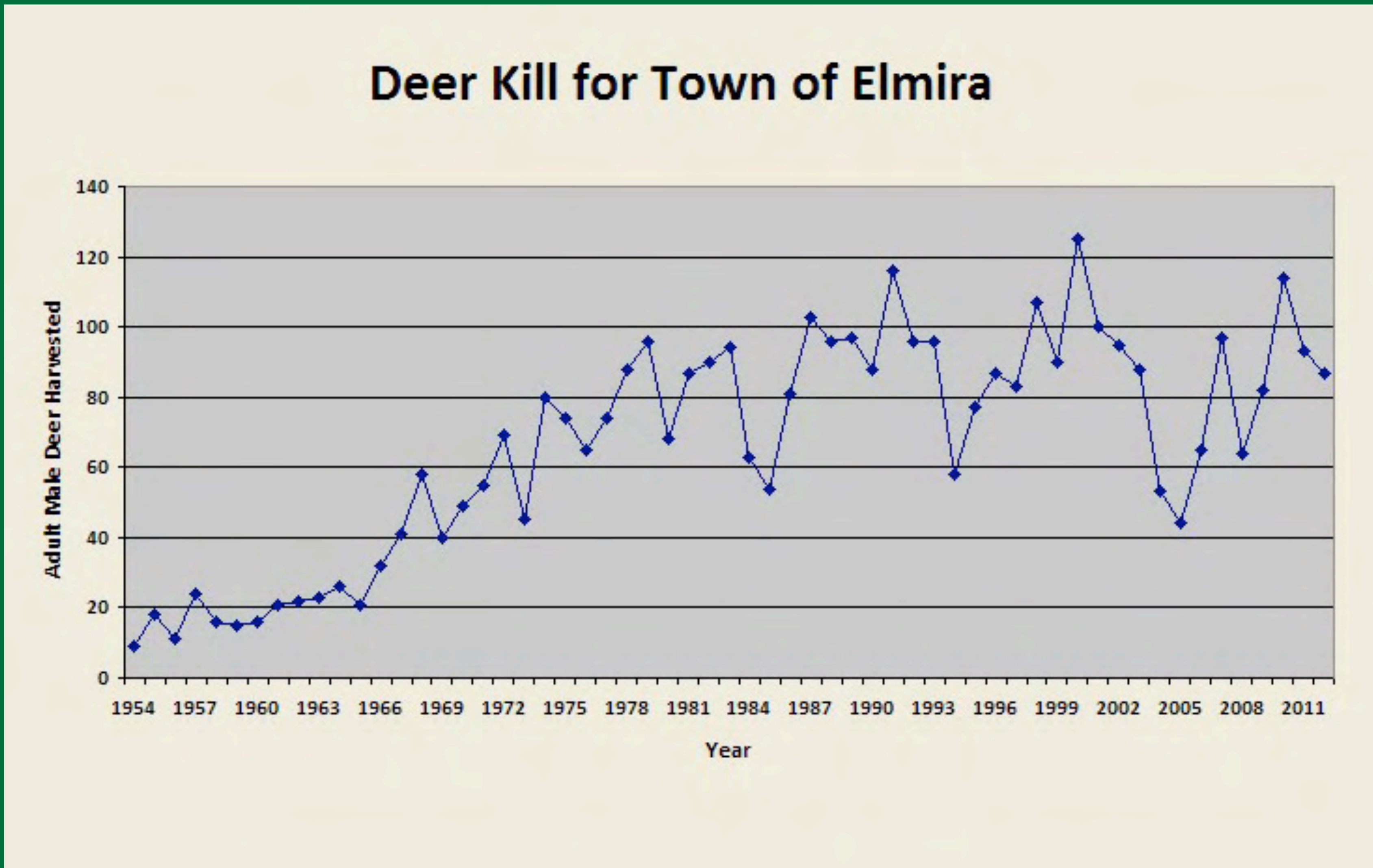
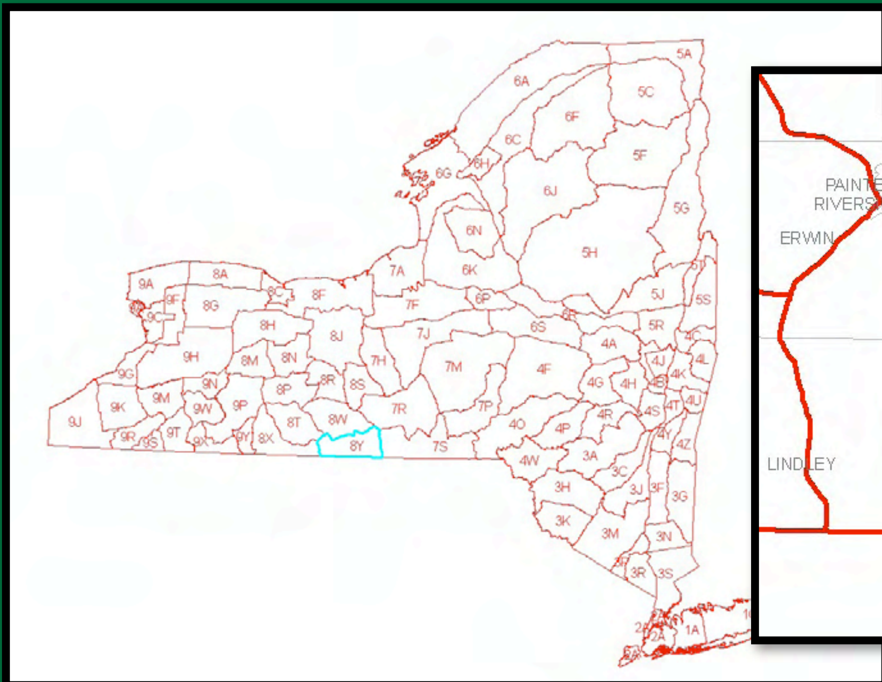
Community-Based Deer Management

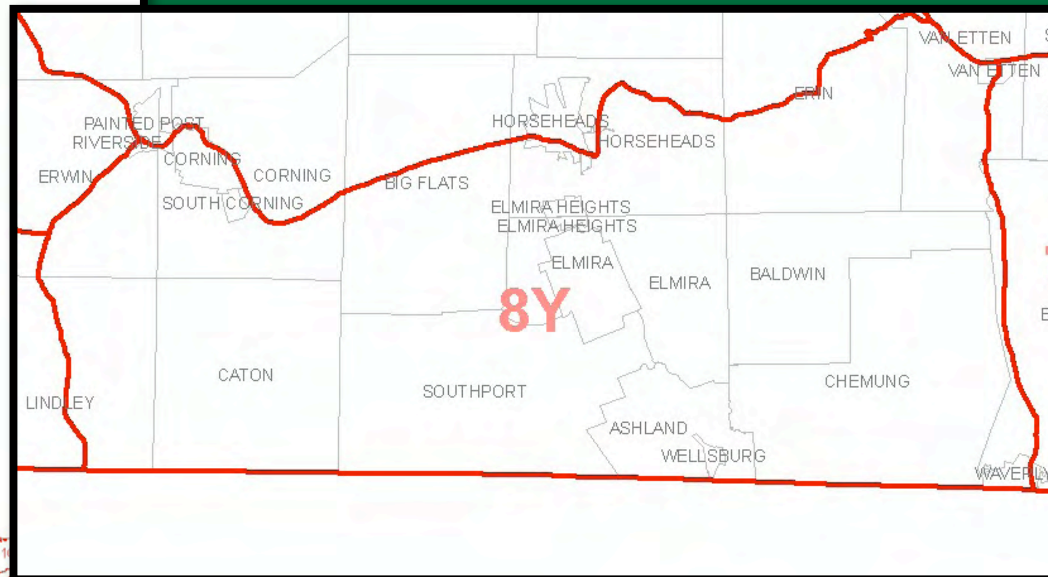
Art Kirsch
NYSDEC Region 8


Elmira Town and City
HORSEHEADS
ERIN
ELMIRA HEIGHTS
N
BIG FLATS
ELMIRA
ELMIRA
BALDWIN
SOUTHPORT
ASHLAND
CHEMUNG
0
0.75
1.5
3
4.5
6
Miles



Deer Kill for Town of Elmira
Adult Male Deer Harvested
0
20
40
60
80
100
120
140
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
Year



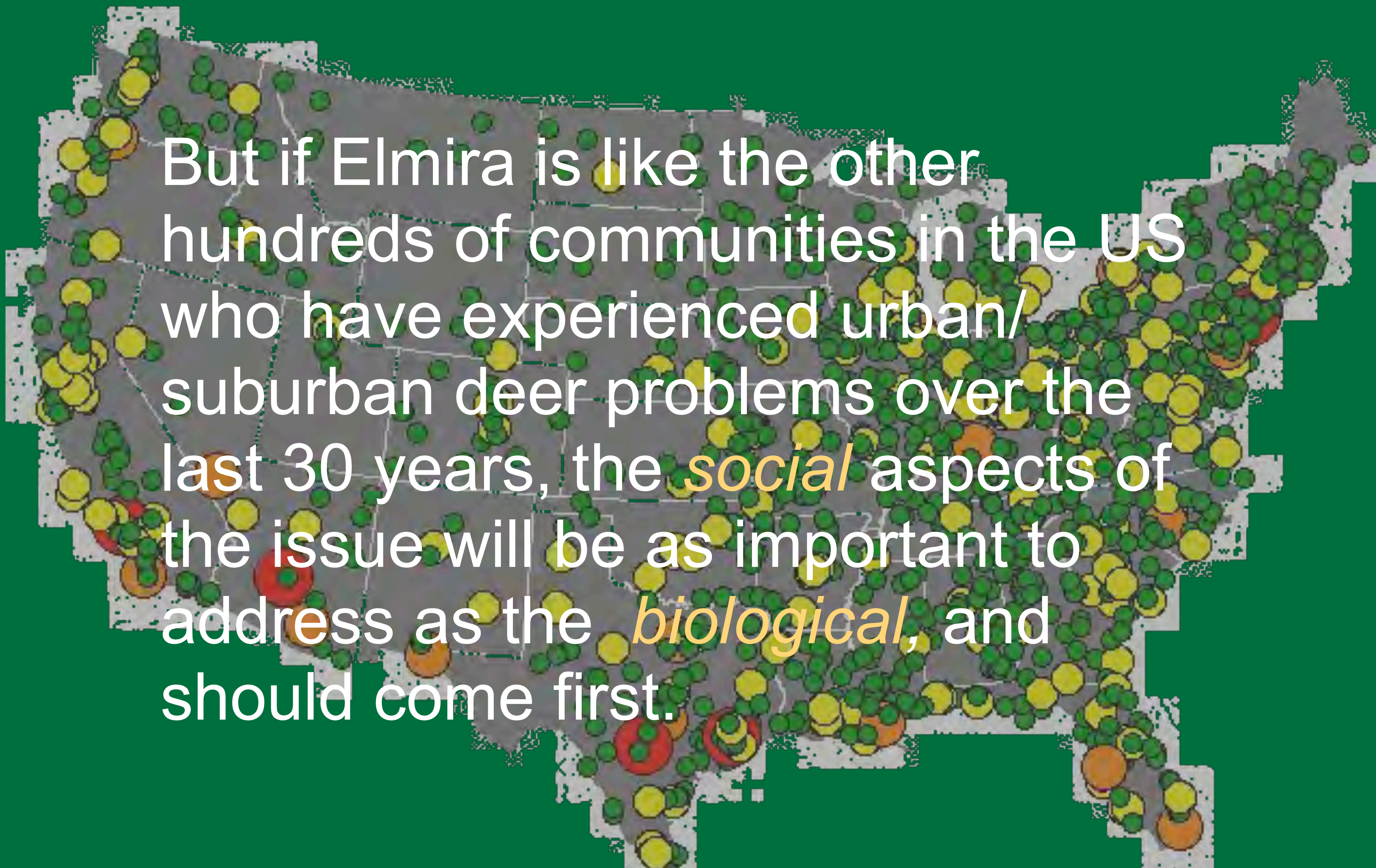


WMU 8Y	2008	2009	2010	2011	2012	2013
DMP Quota	7,400	5,400	3,400	4,900	5,400	4,900
DMPs Issued	7,535	5,426	3,578	4,897	8,245	?

The Traditional Concerns

- Ornamental damage
- Deer-related vehicle accidents
- Ecological damage
- Aggressive deer (rarely)
- Disease transmission

If everyone agrees there is a problem, and also agrees on what to do about it, then by all means, round up the posse!



But if Elmira is like the other hundreds of communities in the US who have experienced urban/ suburban deer problems over the last 30 years, the *social* aspects of the issue will be as important to address as the *biological*, and should come first.

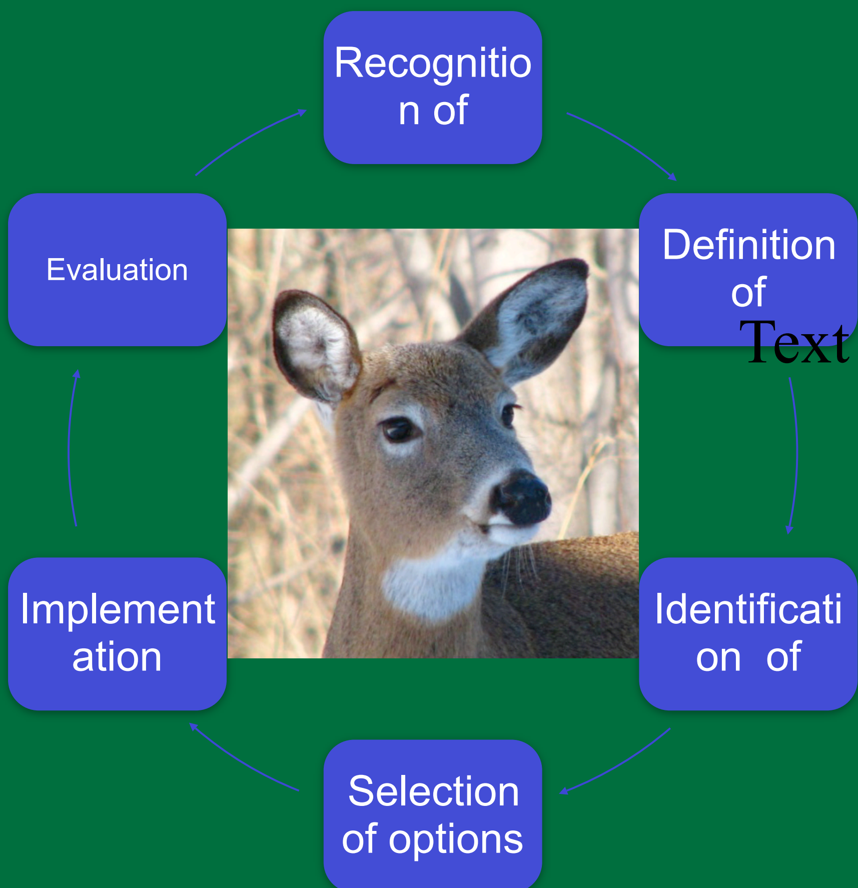
How to Guarantee That Efforts to Solve a Community Deer Issue Will Fail

- Include only one or two perspectives
- Have no structured decision-making process
- Skip right to the action phase
- Ignore people’s opinions
- Have no real ground rules
- Don’t consider who your stakeholders are
- Keep information to yourself
- Ignore pertinent information
- Harbor hidden agendas
- Give up when the going gets a little tough
- Expect a “magic bullet” that you only need to take once
- Don’t learn from your successes and failures, or those of others

Essential Elements for Success

- Include multiple perspectives
- Create a structured decision-making process
- Form universally accepted ground rules
- Identify your stakeholders
- Share understandings among stakeholders
- Build a shared, comprehensive information base
- Foster full disclosure of stakeholder goals
- Believe that acceptable solutions are worth seeking
- Understand that community-based deer management is an ongoing process, not a one-time event
- Commit to systematic evaluation of the decision-making process and subsequent management program

The Community-Based Deer Management Process



- High awareness of the issue within the community
- Consensus within the community that a problem exists and something should be done
- Clarification of just what the problem is

- Must be acceptable to the community
- Must be affordable
- How long will it take?
- What is the potential for success?

- Did actions address and improve original problem?
- To what extent?
- Were costs on target?
- Is community happy?
- Any unforeseen neg. consequences?
- Can process be made better or more efficient?

- Community notification
- Who?
- When?
- Time frame
- Who pays?
- Safety addressed?
- Venison disposition (if deer killed)
- Reporting of results

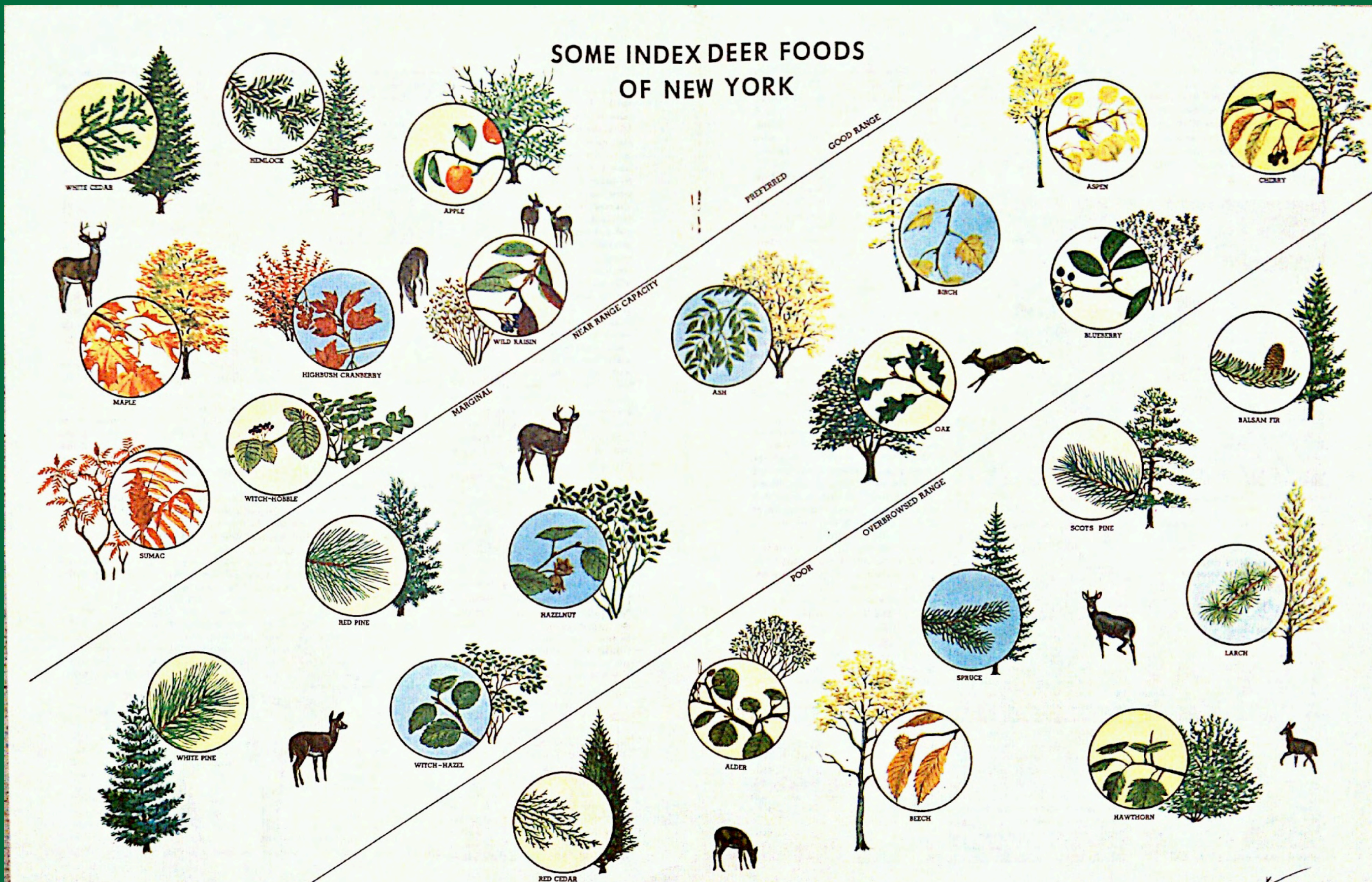
- Fencing
- Repellents
- Planting recommendations
- Fertility control (experimental)
- Managed hunting
- Damage permits
- Bait and Shoot
- Trap and transfer
- Other

- Should relate to the problem
- Should be easily measured
- Does not necessarily require knowing how many deer live in the community

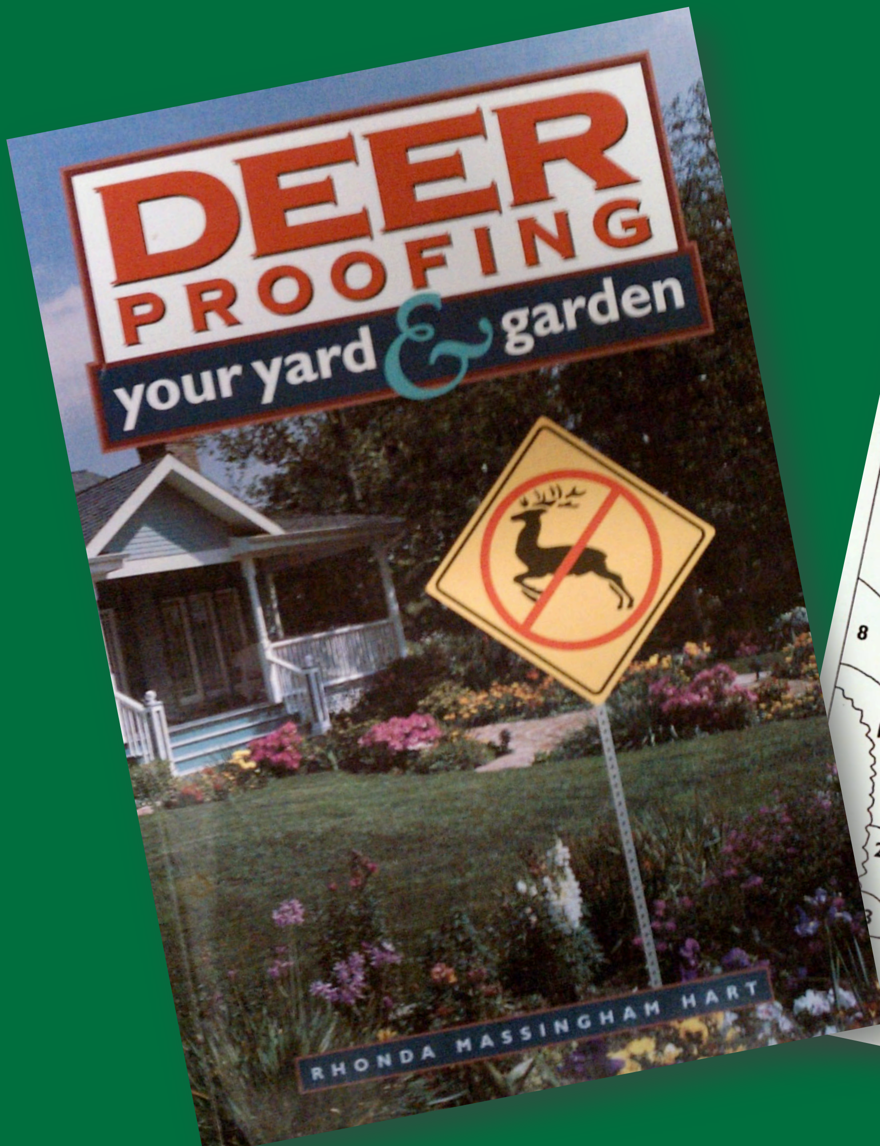
Reducing Plant Damage

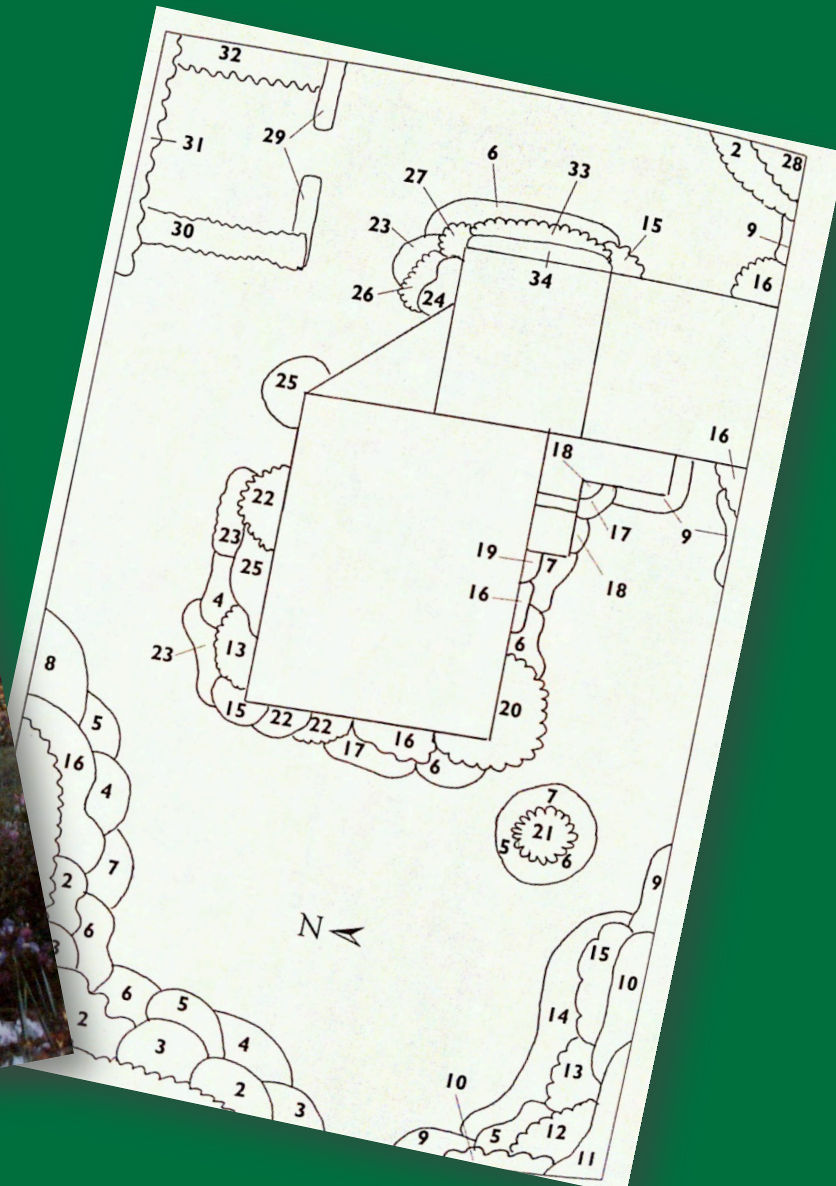
- Repellents may work when deer pressure and damage is light
- Fencing provides reliable control when deer damage is moderate to heavy
- Manage herd density where possible
- Deer feeding is illegal in NYS
- Choose plants that are less attractive to deer

Plant Palatability



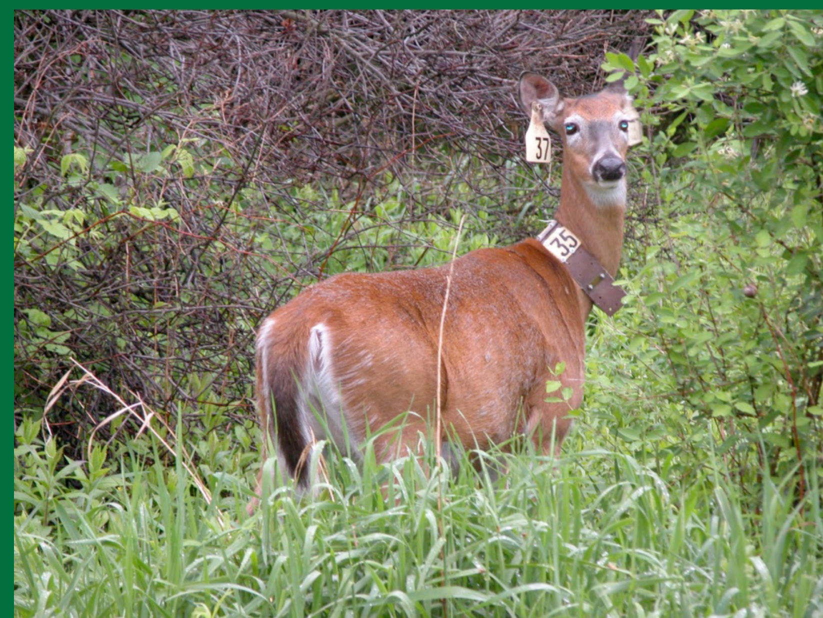
Plan Your Planting!





Factors Influencing Deer Feeding Pressure

- Deer population density
- Food & cover sources
- Travel corridors
- Alternative foods
- Season & weather
- Deer nutrition
- Plant palatability & nutrients
- Previous experience
- Presence of dogs



Repellents

- BGR Deer-Away
- Hinder
- Deer-Off
- Chew-Not (20% thiram)
- Bonide Rabbit/Deer Repellent
- Hot Sauce Repellent
- Tree Guard
- Other

Deer Exclusion Alternatives

- 8-foot woven-wire fences
- Electric fences
- Individual plant protection
- Dogs
- Motion-activated devices

Avoiding Deer-Vehicle Collisions

- Driver education
- Speed limit reductions and enforcement
- Peak months Oct, Nov, and Dec
- Be extra careful at dawn and dusk
- Heed deer crossing signs; they're there for a reason

Avoiding Collisions (continued)

- Scan the roadsides for eye reflections
- Watch where deer came from, not where they're going
- Manage herd density where possible
- Do reflectors and whistles work?
- Don't rely on devices; awareness is your best defense!

Deer Population Reduction

- Fertility control
- General hunting
- Controlled hunting
- Deer Management Assistance Program (DMAP)
- Deer damage permits
- Special urban deer permits (such as bait and shoot)
- Trap and Transfer

Fertility Control

- Still experimental
- Only permitted in communities involved with scientific research
- Costly
- Does not reduce existing population
- Takes years before possible results seen
- A one-dose vaccine is being tested, but awaits FDA approval

DMAP

- Deer Management Assistance Program
- Additional antlerless tags from DEC for use during hunting season
- For specific properties
- Categories:
  - Agricultural
  - Municipality
  - Significant Natural Communities
  - Forest Regeneration
  - Custom Deer Management

Controlled Hunting

- Landowners have full control of what they allow on their property
  - Days hunted
  - Hunt timing
  - Implements used (gun or bow)
  - Location
  - Hunter numbers
  - Hunter characteristics (ethics, proficiency, trustworthiness, etc)
- Can require removal of one or more female deer before buck (“Earn-a-Buck”)
- May be discharge of firearms restrictions in place that would limit this option (variance?)
- There are ways to address safety concerns

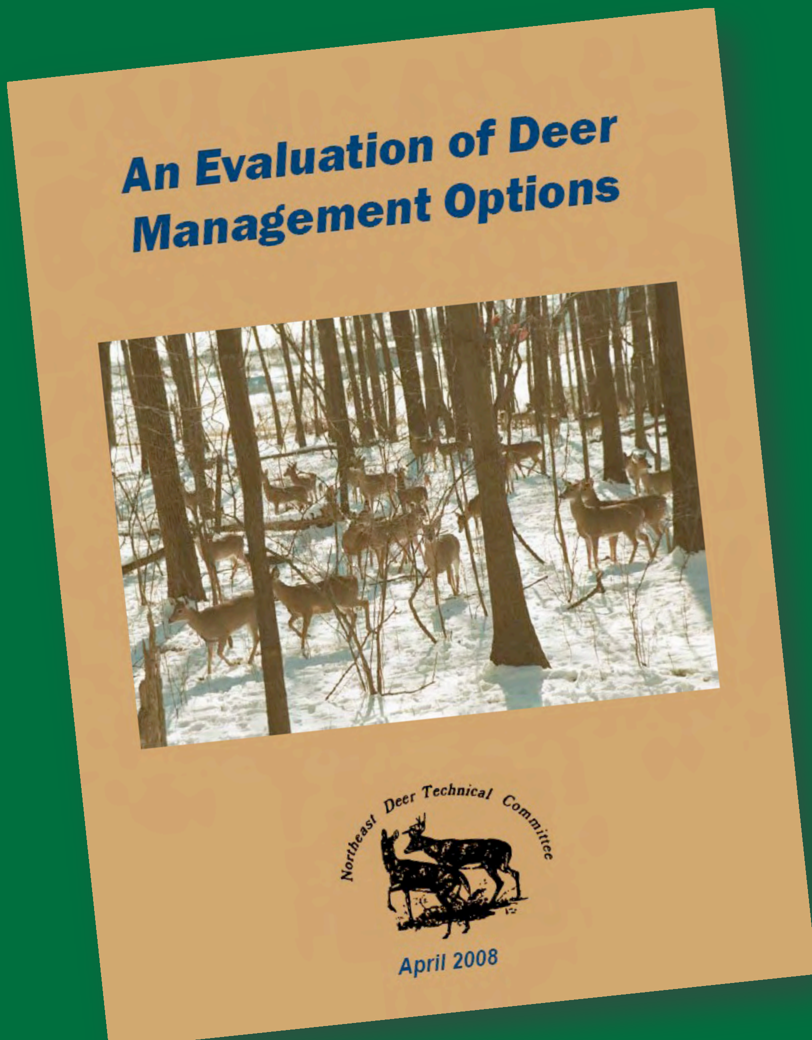
Deer Damage Permits

- Site specific
- Usually agricultural damage only
- To address damage on crops in the ground
- Usually for antlerless deer only
- For use outside of the hunting season

Special Urban Deer Permits

- Issued to a municipality
- Geared toward population reduction
- Covering such activities as “Bait and Shoot”

For more information:

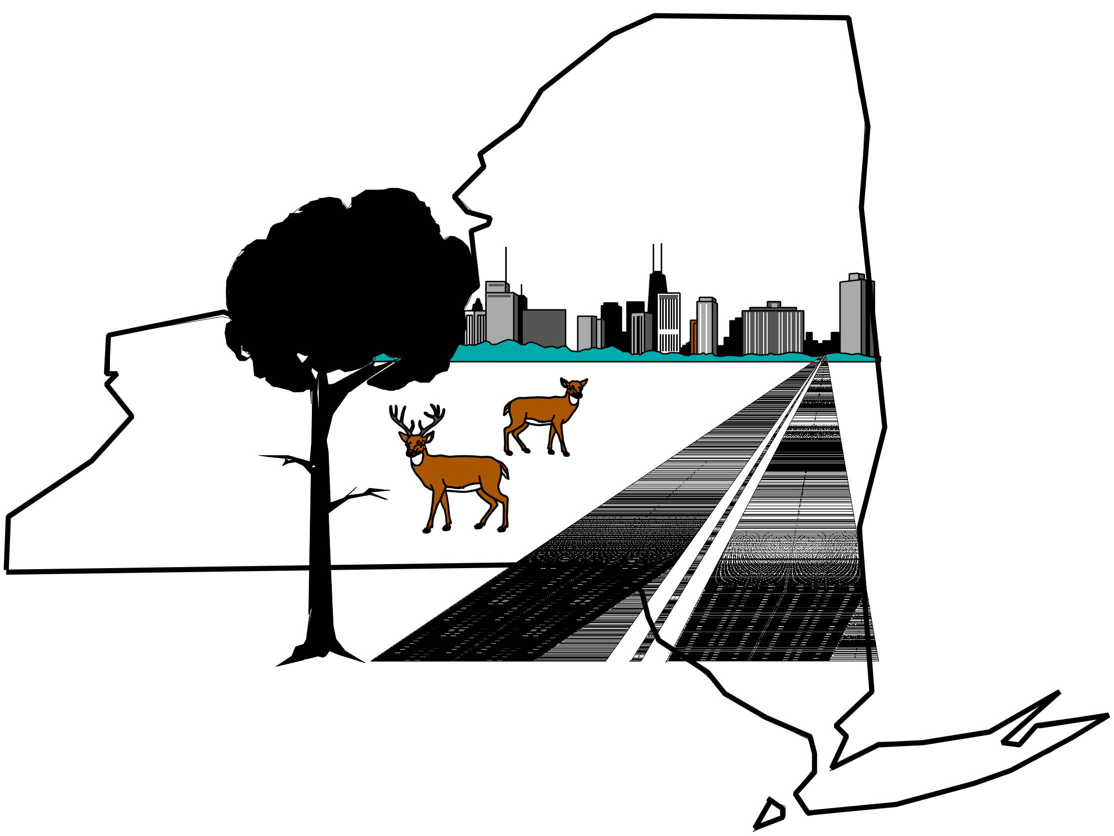


or visit:

www.dec.ny.gov

New York State
Department of Environmental Conservation

A Citizen's Guide to the Management of White-tailed Deer in Urban and Suburban New York



Written by: P. Bishop, J. Glidden, M. Lowery and D. Riehlman
Revised 2007: Bureau of Wildlife - Deer Team

Elliot Spitzer, Governor

Pete Grannis, Commissioner

Table of Contents

Deer management consists of decisions and actions that influence deer numbers. Because so many people are affected by and have an interest in deer, homeowners, motorists, farmers, hunters and others all have a stake in deer management decisions.

To establish deer management programs in urban and suburban areas, the views of local interest groups are important. The New York State Department of Environmental Conservation (DEC) recommends communities involve local residents to find answers to questions such as: Are there deer impacts that need to be controlled? Should deer numbers be controlled? If so, how?

This publication is designed to provide guidance on how communities should approach decision making regarding deer and to help inform the public about deer management options.

Values of Deer

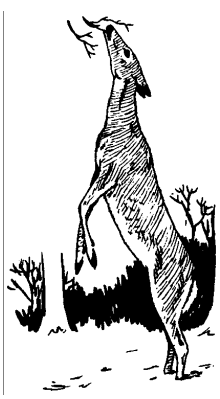
People place many values, both positive and negative, on deer. Whether deer are desirable or not is a matter of personal opinion. The opinions are often influenced by recent experiences.

Benefits

Deer are popular wildlife. Many people appreciate just knowing deer are around. Others enjoy watching, photographing, hunting, learning about and studying deer. People, such as motel, restaurant and sporting goods store owners, derive income from the deer related activities of others.

Problems

Deer often feed on and cause damage to landscape plantings, gardens and agricultural crops. Property damage and personal injuries occur due to deer/car collisions. Personal health concerns also arise due to some diseases.



Deer browsing also influences vegetation in fields and forests.. When deer densities are high, browsing can remove most of the vegetation within reach of deer and completely eliminate some plant species. This affects the quantity and quality of wildlife food and cover present. A study in Pennsylvania found that when deer density exceeded 20 deer per mile^2, the number of plant and animal species present declined. The loss of low growing vegetation also reduces food supplies for deer. In overbrowsed areas, the condition of deer declines, and deer then become more susceptible to diseases, predation and winter losses due to malnutrition.

Why Are There Conflicts?

Both human and deer populations have grown. Expanding deer herds have moved into suburban settings and humans have developed former rural areas. This has increased interactions between humans and deer. Development practices have also increased the likelihood of deer/human interactions. Low density housing, green spaces and parks all provide cover and high quality food like fertilized lawns and shrubs. Deer prosper in these settings.

Developed areas also tend to be relatively secure sites for deer. Typically the last remaining significant predator, human hunters, has been legally or otherwise restricted. Often deer-vehicle collisions become the greatest source of mortality for deer. Low death rates in combination with the deer's reproductive capacity and relatively long life often result in high deer numbers.

Conflicts sometimes arise or are aggravated by people feeding deer intentionally or unintentionally (bird feeders). Fed deer become much more tolerant of humans and are more likely to go where people are, increasing the chances for conflicts. Regulations adopted by DEC in 2002, prohibit the feeding of wild deer.

In summary, ample food and cover, and protection from hunting have increased deer numbers and their boldness in some areas. Not surprisingly, this has increased interactions and conflicts between people and deer.

When is Deer Management Needed?

Despite the high regard most people hold for deer, high deer populations in many urban and suburban areas have caused people to weigh the pros and cons of having deer around. Solutions to deer/human conflicts are often sought.

Opinions and philosophies vary widely about deer management. Some people feel that deer populations should be left to fluctuate "naturally" with no human intervention. They believe people should learn to deal with and tolerate the effects of deer. They also believe the impact of high deer densities on plant and animal diversity should be seen as natural and therefore acceptable.

Other people believe that in today's fragmented and otherwise altered landscapes there is little "natural" in the growth in deer numbers seen in urban and suburban settings. They believe it is appropriate for humans to fill the role of missing natural elements, be it as a predator or protector. They prefer that deer be managed with consideration of human interests and the needs of plants, deer, and other wildlife.

The most basic deer management decision is whether or not to control deer numbers. If deer numbers are not controlled, people must either accept problems or try to reduce them by other means. If a decision is made to control deer numbers, an acceptable method must be chosen.

Neither position, management or no management, is right or wrong. They are based on local interests and personal values, not absolute biological needs. Your choice depends on how you think things "ought to be."

Lacking a clear, nonsubjective means by which to make decisions on deer management, how should decisions regarding deer management be made? DEC believes that decisions should be made through consensus of persons representing larger groups with a local interest or stake in the decision (stakeholders).

Deer Management Options

In this section we describe, and present the costs and benefits of various approaches to deer management and deer damage control. The purpose of this is to provide the basis for informed decision-making by interested parties.

No Population Control

Hands-off

Hands-off means that no effort is made to control deer numbers. By default, this is often the case in many urban, suburban and park areas.

This approach pleases those who feel that wildlife should not be managed or those who do not perceive deer to be a problem. This method is inexpensive to implement in terms of management costs and increases people's chances to see and enjoy deer since the deer are more abundant and often less wary.

In many settings this approach is likely to result in deer numbers remaining high, if not growing. Choosing this option entails accepting the consequences and costs associated with high deer numbers. Considerable costs will result from damage to planted vegetation and car-deer collisions. Deer will also influence natural vegetation and wildlife communities.

Unmanaged deer populations often become susceptible to losses due to disease or malnutrition. Such losses, however, rarely cause deer numbers to decline to the extent that all problems are alleviated.

Damage Control

Damage control techniques can provide relief for site-specific problems and have a place in any deer management program whether or not population control measure are employed. The effectiveness of most techniques generally declines as deer numbers rise, except for complete exclusion by fencing. Use of damage control techniques provides localized protection only and can subject unprotected sites to new or additional pressure. A neighboring property, a different stretch of road, or natural vegetation may suffer greater problems.

Damage control techniques may provide adequate relief at low deer densities, but are unlikely to provide effective long-term solutions when deer numbers are high. Some problems, such as overbrowsing of natural vegetation and deer-car collisions, are impractical for individuals to address through damage control efforts. Any evaluation of the usefulness of damage control techniques should include an analysis of their costs, the value of the property being protected and the consequences on unprotected areas.

OPTIONS AT A GLANCE

No Population Control
- Hands-off
- Damage Control
  - Fencing
  - Repellents and Frightening Devices
- Alternative or Diversion Plantings
- Feeding

Population Control
- Nonlethal Methods
  - Habitat Alteration
  - Capture and Relocation
  - Fertility Control
- Lethal Methods
  - Predator Introduction
  - Parasite or Disease Introduction
  - Poison
  - Capture and Kill
  - Bait and Shoot
  - Traditional Hunting
  - Controlled Hunting

Fencing

Exclusion by fencing offers the only foolproof means to protect a site. Complete exclusion however, requires high (10') fencing which is expensive. Designs involving double rows of fence, outward slanted fences or electrified fences have provided adequate protection in some cases. Less elaborate and less expensive fencing can suffice at low deer densities or to protect individual plants and small areas. Installation costs can range from about $180 to $600 per acre depending on fence type and site conditions. Regular maintenance is essential, adding to costs. Aesthetic considerations, soils, terrain and sometimes local ordinances all influence what is practical or legal at a site.

Repellents and Frightening Devices

Repellents include both chemical repellents and frightening devices. The effectiveness of both types decreases with increasing deer density. Deer often ignore repellents and scare techniques as food becomes scarce and competition for food increases.

A variety of taste and odor repellents is available including chemical mixtures and home remedies, such as human hair and soap bars. Cost estimates for one chemical repellent treatment of orchards and nursery stock range from $10 to $400 per acre, excluding equipment or labor costs. Repellents must be reapplied frequently. Chemical repellents may cause plant damage and leave noxious or offensive residues.

Frightening devices, such as noise makers, lights, scarecrows and balloons, may be effective for short periods. However, deer generally overcome their initial fear of these devices.

Dogs can also provide protection. This can range from the family pet running loose in a fenced yard, to a dog on a lead, to the fairly new use of dogs within "invisible" fenced areas. Recent accounts suggest that in some cases deer can become so bold in some residential areas that even dogs become ineffective.

Alternative or Diversion Plantings

Selecting ornamental plant species less attractive to deer can resolve some problems. Some common ornamental plants, such as yews, are highly preferred by deer and rarely escape being damaged by deer. Other species are considerably less attractive to deer and might only be eaten at high deer densities. (Can we link to a site with this info.)

It is sometimes suggested that food plots could be used to attract deer away from sites where they create a conflict. While this has not been extensively explored, evidence does not suggest this has much merit. Deer by their nature move throughout the course of the day and prospects are that any sites with attractive food sources will be visited. Ultimately, even if effective to some degree initially, diversion plantings may be self-defeating as described in the feeding section below.

Feeding

Supplemental feeding is often proposed as a means to improve the condition of deer or to take pressure off other food resources. Regulations established in 2002 due to concerns about Chronic Wasting Disease completely prohibit the feeding of wild deer in New York. The following information is presented simply to describe the potential effects of feeding.

Feeding programs, if properly conducted, could help some deer. They are, however, usually self-defeating. If feeding programs allow a deer population to remain high or grow, problems likewise are likely to remain high. Further, if feeding improves deer survival, deer numbers and browsing will increase. Deer would need to be fed ever-increasing quantities of food to compensate for the growing shortage of the natural foods.

Some people suggest that feeding deer during critical periods will reduce personal property and habitat damage. Unfortunately, even when provided with unlimited supplies of food, deer continue to feed on natural vegetation. Damage near feeding sites usually increases. Plants preferred by deer may be eliminated, altering habitat for many wildlife species.

Another important consideration is that fed deer become increasingly tame and more likely to tolerate human activity. This increases the likelihood of deer/human interactions and conflicts such as personal injury, damage to personal property and motor vehicle collisions.

Feeding deer can be expensive and does not prevent deer damage problems. Concentrating deer at feeding stations increases the prospects for disease transmission and can make deer more vulnerable to predation by dogs or coyotes. Deer may become increasingly dependent on supplemental food and loose the wild character that is part of their allure to many people. Community satisfaction, though potentially high at the onset of a feeding program, may decline over time.

Population Control

Population control methods seek to maintain deer numbers at a level compatible with local conditions and stakeholders interests. Unless deer are completely eliminated from a site, all deer control methods must be repeated at regular intervals. Most methods involve the removal of deer, others seek to reduce deer numbers over time by decreasing habitat or reproductive capacity. Removal methods are the only effective way to reduce deer numbers and associated problems quickly. Limiting births results in a slow decline in deer numbers.

Regardless of how deer numbers are to be controlled, stakeholders must decide how many deer or, more to the point, what level of conflict is acceptable. Stakeholders should also select a time frame for achieving the desired change.

Nonlethal Methods

Habitat Alteration

Theoretically, deer numbers or the frequency with which they use an area could be reduced by removing the plants which provide deer food and shelter. To be effective over large areas, however, this approach might require the alteration or removal of most of the vegetation. This would be costly and have important environmental impacts that could threaten the local existence of some plants and animals.

Extensive habitat alteration would probably be opposed by many individuals, groups and regulatory agencies. Agreement and coordination of such action would likely be difficult since many landowners could be involved.

Deer movement caused by habitat alterations could simply shift problems elsewhere. Community acceptance of this approach would likely be difficult to obtain.

Capture and Relocation

Deer numbers at a location could be reduced by capturing deer and taking them elsewhere. At the present time, the Environmental Conservation Law §11-0505 (3) prohibits the trapping of deer except under special permit issued by the DEC for scientific purposes. The following discussion of trapping techniques is for informational purposes only.

Methods to capture deer include the use of drive nets, drop nets, rocket nets, corral traps, clover traps, box traps, and remote chemical immobilization using dart syringes. Capturing and relocating deer is difficult and expensive. Costs range from $110 to $800 per deer captured, depending on the method used. Efforts become less efficient as deer numbers decline and deer become more wary.

Capture and relocation is also stressful to the animal. Injury and loss of some deer during capture and relocation efforts are common and can be significant, and the long term survival of relocated deer is often low. Personnel handling deer are exposed to potential physical injury from the deer and to accidental exposure to the immobilization drugs.

Another serious constraint on capture and relocation programs is the availability of release sites to receive the captured deer. Release sites commonly proposed include:

(1) Release to the wild: Few, if any, areas within the range of the white-tailed deer could benefit from deer releases. Many areas are already occupied by deer, and residents of the receiving area may oppose a release. In addition, moving deer can spread disease and parasites to the local wild deer population.

Relocated deer are vulnerable since they are unfamiliar with their new range, and deer coming from

overpopulated areas are often at a disadvantage due to their poor physical condition. Survival of relocated deer has proven to be poor, with up to three-quarters of relocated deer commonly succumbing to malnutrition, vehicle collisions, or predation within one year.

A DEC permit is required to capture and relocate deer. Permits are not issued to relocate deer to the wild because acceptable release sites are not available and because the poor chances for deer survival do not warrant the risks.

(2) Release to captive facilities: There are many facilities licensed to possess deer in New York. Typically these facilities possess deer for display, to raise stock for sale to other deer facilities, for venison production or for game on a shooting preserve. Current laws dictate that all deer on these facilities come from domestic sources. While the legal constraint to move wild deer onto a captive facility might be addressed, other practical constraints would remain.

The largest constraint is the threat of disease introduction from wild deer into domestic stock. The New York State Department of Agriculture and Markets herd certification requirements for Chronic Wasting Disease and Tuberculosis are such that few facilities are likely to welcome deer from wild sources as it would jeopardize their disease certification status. The costs and problems associated with catching and moving deer would be as discussed above, though a facility might be willing to "shoulder" some of the costs. Interest for deer by captive facilities is likely to be very limited. Though many in a community may support this approach, some people may object to the ultimate fate of deer. Concerns over the costs and stress involved in trapping and handling deer may also cause some opposition to this approach.

A DEC permit is required to capture and relocate deer. Current laws and concerns about disease preclude such permits being issued.

Fertility Control

Research continues in search of a practical technique to control reproduction in wild free ranging deer. Though there are effective techniques and chemical agents that inhibit reproduction in deer in controlled environments, finding a practical system to treat wild deer in sufficient numbers to effect population change remains a challenge.

Fertility control methods include the use of synthetic chemical steroids and immunocontraceptives or surgical treatments, such as vasectomy and tubal ligation. Steroid treatments work like human birth control pills, while immunocontraceptives cause a deer's immune system to interfere with some phase of reproduction, such as fertilization.

While these methods have been used successfully in captive deer, none have yet proven effective in controlling populations of wild, free-ranging deer. A major difficulty with any birth control technique lies in treating enough deer. A high percentage of the females in a deer population, generally agreed to be well over 75%, must become unproductive to control population growth. If males were the focus of treatment an even higher percentage would need to be successfully treated. Methods requiring capture and handling of deer (surgery or implants) offer the least hope for practical field applications. Such efforts would be very costly and would be stressful on the animals.

Fertility control techniques that do not require handling deer offer the most hope for practical field application. Remote delivery of chemical agents through treated baits or injection by dart are two possible methods, and the use of plastic bullets impregnated with an immunocontraceptive is being explored. Contraceptive treatment of wild deer is often complicated by the need for multiple applications each year of desired infertility. Ongoing studies are working to develop a single-shot contraceptive agent that is effective for multiple years and is practical for application to free-ranging deer.

No contraceptive agents have been approved by the US Federal Drug Administration for non-research based use on wildlife populations. All chemical techniques, and steroids in particular, raise concerns about potential impacts on non-target species. The similarity of hormones within all mammals, including humans, presents a problem if non-target species consume the chemical directly or consume the flesh of a treated animal. For example, deer treated with contraceptives may not be suitable for consumption by hunters and their families.

Questions remain regarding potential behavioral and genetic impacts from fertility control. Until these questions and others are resolved, fertility control will remain experimental.

An important consideration with any fertility control technique is that it is not a viable approach when a quick reduction in deer numbers is sought. If effective, fertility control will reduce deer numbers slowly. This is because birth control does not remove any existing deer, but rather prevents additions to the population. Deer numbers would remain high for several years after beginning birth control efforts. Meanwhile, whatever conflicts triggered the desire to implement management will continue.

Costs of fertility control programs vary depending on the number of treatments required per year of infertility. Reducing the treatment frequency will reduce costs. Yet fertility programs are the most expensive option for deer population control due to the costs of manpower and materials and the level of effort needed to treat an adequate number of deer. Based on current knowledge, many wildlife professionals believe fertility control will only be practical for small, isolated populations.

Lethal Methods

Predator Introduction

Predators, with few exceptions, rarely control the numbers of the animals on which they prey. In fact, typically the opposite is true with the prey base determining the size and health of the predator population.

Coyotes now occupy suitable habitat in and around many suburban areas. They kill deer, but are obviously not controlling deer populations in these areas. Coyotes also generate considerable concern by some residents. Larger predators would likely cause even greater anxiety.

Large mammalian predators, such as black bears, wolves or cougars, have large home ranges. Most locally overabundant deer herds are located in suburban areas or small parks which would be unsuitable for these large predators due to high human densities, extensive road networks and inadequate habitat.

DEC would not support introducing large predators into areas where they would not be expected to stay or survive.

Parasite or Disease Introduction

The risks and uncertainties associated with parasite or disease introduction make it an impractical option for deer population control. Several parasites and diseases kill deer, but none, capable of significantly reducing the population, is specific to deer. Other wildlife or livestock could be adversely affected if this method were used to reduce deer numbers. That fact alone makes this technique unacceptable.

Confining the pathogen, retrieval and disposal of carcasses, and sanitizing the affected area afterward would also pose significant problems and expense. To purposely expose deer to the effects of a disease or parasite would be inhumane.

Public opposition is likely for a variety of reasons. Regulatory agencies, both federal and state, would not likely permit such activity.

Poison

Currently there are no toxins, poisons or lethal baits registered for deer control. Quick-acting lethal chemicals are available, but there are no safe methods for delivering lethal dosages specifically and solely to free-ranging deer. The use of poisons carries potential risks to other wildlife and humans. This includes potential direct exposure to non-target animals as well as secondary exposure to animals, including humans, who may consume the flesh of poisoned deer. Clean up and disposal of carcasses would add to the expense of this approach.

The public would most likely oppose poisoning as a control method. Regulatory agencies, both federal and state, would not likely permit such activity.

Capture and Kill

Deer could be captured and killed to control local deer populations. Capture methods and legal constraints would be the same as previously described for ***Capture and Relocation***.

Once caught, deer could be killed in a variety of ways including injection of lethal drugs, captive bolt or shooting. The costs would vary with the method used. Use of the meat by charitable organizations or others could enhance the acceptability of a capture and kill program for some people. However, use of drugs to capture or kill the deer would preclude human consumption of the venison. If the meat is not to be consumed, disposal of carcasses may be a problem.

Bait and Shoot

This technique would involve baiting deer to strategic locations where a shooter could then kill the deer. Bait and shoot operations may be useful in suburban and urban areas where there is not enough undeveloped land for traditional hunting. This technique has been used successfully in several small areas of New York.

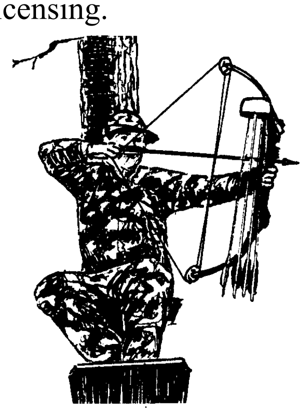
While some people believe that shooters designated for bait and shoot operations would be safer, more accurate and would routinely kill deer more quickly and humanely than hunters, these assumptions have not been tested. There are relatively few people specifically trained or experienced in this practice.

Taking deer in this manner may have the additional benefit, as does hunting, of instilling some heightened wariness in remaining deer. Wary deer are less likely to frequent areas inhabited by humans and are more likely to respond to repellents such as blood meal and human hair. However, wary deer may also be less susceptible to future culling efforts.

Similar to capture and kill programs, bait and shoot operations could provide a source of meat for local charitable organizations yet without concern of drug residue in the meat. Though bait and shoot operations cost more than traditional hunting (about $300 per deer killed), they are likely to be less costly than relocation, or capture and kill efforts. The implementation of a bait and shoot program in an area where traditional hunting could occur would be very controversial as it would deny citizens access to a renewable public resource.

Traditional Hunting

Traditional hunting is defined here as hunting by licensed sportsmen and women using legal firearms or longbows. Hunting seasons are set by NYS Environmental Conservation Law or NYSDEC Regulations. Hunters are entitled to keep and use the deer killed. New York hunters must pass sportsmen education courses before buying licenses. No further qualification is necessary after licensing.



Traditional hunting has been used successfully to control deer populations over much of the species' range. It is more cost-effective than other control methods because hunters provide much of the labor at no cost.

A possible benefit of hunting is that hunted deer are generally more wary of humans. Wary deer are less likely to frequent areas inhabited by humans and are more likely to respond to repellents such as blood meal and human hair. Another benefit of hunting is that many small businesses derive income due to the activities of hunters.

Some people oppose hunting, and local laws sometimes prohibit hunting in urban, suburban or park areas. Some opposition reflects personal values, but much is based on fears for personal safety. The presence and use of firearms evokes concerns in many people, despite the extremely low risks associated with hunting. When warranted, special controlled hunts can allay fears and further ensure public safety.

Controlled Hunting

The effectiveness and public acceptance of hunting as a deer management program can be increased through controlled hunts, particularly in areas where traditional hunting is impractical due to housing density, local laws, or restricted land access. Controlled hunts can be tailored to meet a variety of local conditions. Marksmanship requirements and restrictions on who may hunt, hunting methods, hunting times and locations, and the sex, age and number of deer to be taken are often employed.

DEC may be able to offer assistance to landowners desiring to implement controlled hunts. The DEC Deer Management Assistance Program (DMAP) offers landowners or communities the means to increase harvest of antlerless deer and can be very useful in controlled hunts.

DEC Perspective

As a state agency, the DEC is obligated to consider factors that may be overlooked by an individual or community. Some considerations are required by law and others are generated by broad resource, social or economic concerns. DEC wildlife staff have reviewed the issues and options discussed previously and have made recommendations on preferred options.

Management Criteria

The following factors were considered for each option prior to making recommendations:

Species Perpetuation - ensure that deer and other species' populations are not adversely affected.

Safety - reduce risk to public and participants.

Humane Treatment - reduce stress and trauma to deer.

Cost - consider cost effectiveness of control operations.

Public Use and Access - provide the fullest array of resource benefits now and in the future.

Nuisance Concentration or Relocation - avoid concentrating or relocating problems.

Disease Transmission - reduce potential for disease transmission.

Recommendations

Damage Control Techniques are recommended to address site specific problems, whether or not population controls measure are considered. Fencing and repellents can offer effective site-specific relief, but are limited or impractical for addressing issues such as damage to natural vegetation and deer-vehicle collisions. The fact that problems may shift to unprotected sites must be recognized.

Feeding, large-scale habitat alteration, relocation to the wild or captive facilities, poisoning, and introduction of predators or diseases are not recommended solutions to overabundant deer populations for ecological, social or practical reasons.

If a decision is made to implement a Population Control Technique two basic options exist: fertility control and lethal removal. While fertility control offers the potential to control deer numbers, at present this method is experimental. DEC will permit *bona fide* research testing of this technique. However, it is likely that the applicability of fertility control will be limited to small, isolated deer populations.

The remaining candidate techniques are all forms of lethal removal. In terms of population control, it makes no difference how deer are removed from an area. If enough deer are removed, population control can be achieved. Removal techniques, however, vary widely in their consistency with the above management criteria. **Considering all the above criteria, the DEC's recommendations for dealing with overabundant deer in <u>urban and suburban areas</u> are in preferential order:**

1. **traditional hunting;**
2. **controlled hunting;**
3. **bait and shoot or capture and kill, with use of meat and hides;**
4. **bait and shoot or capture and kill, without use of meat and hides;**

Local interests and concerns will dictate the deer control option of choice in any given setting. When the consensus of local stakeholders is to implement an approach requiring a permit (all management actions, other than hunting during legal seasons, require appropriate permits.), the DEC will work with local entities to see that effective deer management programs can be carried out.

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THE MISSION
OF THE
BUREAU OF WILDLIFE

To Provide
the People of New York
the Opportunity to Enjoy
All the Benefits
of the Wildlife of the State,
Now and in the Future.

This Shall be Accomplished
Through Scientifically
Sound Management of
Wildlife Species in a
Manner that is Efficient,
Clearly Described,
Consistent with Law,
and in Harmony with
Public Need.

HOPEWELL VALLEY
DEER MANAGEMENT PLAN

Submitted to the Hopewell Township Committee

by the

Hopewell Valley Deer Management Task Force

PRIORITY READING

September 2010

Hopewell Valley Deer Management Task Force Members

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Denise Moser, Private Resident, Co-Chair
William Cane, Private Resident, Co-Chair

James Amon, D&R Greenway Land Trust
Francesca Calderone-Steichen, Hopewell Township
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Michael Van Clef, Friends of Hopewell Valley Open Space
David Van Selous, Private Resident
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Executive Summary

In September 2009, the Hopewell Valley Deer Management Task Force ("Task Force") was created by the Hopewell Township Committee to develop a plan to mitigate negative deer impacts on the quality of life of its residents and the ecological integrity of its forests. Specifically, the Task Force was charged with: 1) Initiating a public education program, 2) Creating a comprehensive deer management plan, and 3) Determining requirements for long-term sustainability of a successful deer management plan.

The Task Force conducted eight public meetings since November 2009 and presents this plan containing its recommendations to the Hopewell Township Committee. In addition to the meetings that involved a variety of stakeholders, the Task Force engaged in several vital activities. Public outreach included the creation, distribution and analysis of a public questionnaire; 71% of respondents felt that "deer cause many problems and solutions are needed". It performed a night-time spotlight survey of the deer population and published several informative articles in local newspapers.

White-tailed deer are often considered one of the most beautiful large mammals commonly encountered in the Hopewell Valley. However, the dramatic rise in the deer population during the last century resulted in significant adverse impacts in recent years. Negative impacts include a variety of human health, economic and ecological issues. Lyme disease, deer-vehicle collisions, agricultural losses, and landscape planting damage all adversely affect the quality of life for residents of the Hopewell Valley. Forests are also adversely impacted by overabundant deer that eat native plants. The long-term maintenance of forest cover is in jeopardy because new trees are eaten before they can replace those that fall.

In response to the foregoing, the Task Force recommends a set of five comprehensive goals to remedy the situation. It also offers eleven specific strategies to meet those stated goals (See "Summary of Goals and Strategies" on the following page). The recommendations represent a consensus of Task Force members, but some members did not agree with all of some of the recommendations. All goals are quantifiable and continual reporting should be based upon three-year cycles to evaluate plan success.

For simplicity, goals suggest a simple 25% reduction for each measurable impact over the next three years and 75% reduction within nine years. Reducing deer impacts will depend upon reducing the size of the deer population **-** the 2010 survey indicated an early spring population of 37 deer per square mile. An informal deer herd goal that assumes a one-to one relationship between deer numbers and stated goals would suggest a herd reduction of 25% by 2013 (28 per square mile) and a 75% reduction by 2019 (9 per square mile). However, some strategies could lessen the need to reduce herd size in order to achieve many stated goals. Therefore, success should be measured by stated impact reduction targets and not based upon measured deer population size.

The Task Force requests approval from the Hopewell Township Committee for the following:

1) The assignment of a permanent Deer Management Task Force to implement the plan. This body would meet periodically and have ongoing responsibility to implement strategies that achieve stated goals with assistance from Hopewell Valley municipalities and other stakeholders from public and private sectors.

2) The ongoing commitment of the Township Committee and staff to implement the plan. Examples include initiation of a Township-led deer management program on municipal lands and utilization of the Township website for public outreach/communication. Most recommendations are 'budget neutral', but all require commitment from elected officials and municipal staff.

3) Provide an annual contribution of $5,000 as seed money to establish a venison donation program. This would allow the donation of 50 deer (equivalent to 5,000 pounds of venison or 20,000 meals). The Task Force would seek additional funding from public and private sources to grow the program.

Summary of Goals and Strategies

Goal #1: Reduce Lyme Disease Cases
There has been an annual average of 170 reportable cases of Lyme disease from 2007-2009. The Task Force recommends a 25% reduction goal by 2013 (128 cases) and a 75% reduction goal by 2019 (43 cases).

Goal #2: Reduce Deer Vehicle Collisions
There has been an annual average of 567 deer-vehicle collisions from 2007-2009. The Task Force recommends a 25% reduction goal by 2013 (425 collisions) and a 75% reduction goal by 2019 (142 collisions).

Goal #3: Reduce Agricultural Losses
The public questionnaire results suggested that 27% of respondents had crop losses exceeding $5,000 per year. The Task Force recommends a 25% reduction goal by 2013 (20% of respondents) and a 75% reduction goal by 2019 (7% of respondents).

Goal #4: Reduce Landscape Planting Losses
The public questionnaire results suggested that 55% of respondents had severe or moderate landscape damage. The Task Force recommends a 25% reduction goal by 2013 (41% of respondents) and a 75% reduction goal by 2019 (14% of respondents).

Goal #5: Reduce Ecological Damage
Local forest health has been monitored through two science-based protocols called 'sentinel seedlings' (measuring deer browse on planted tree seedlings) and 'forest secchi' (measuring the density of forest understory vegetation). The average browse on planted tree seedlings has been 59% from 2006 - 2009. The average amount of native understory vegetation has been 21%. The Task Force recommends a 25% improvement by 2013 (44% browse on planted seedlings & 26% native understory cover) and a 75% improvement by 2019 (14% browse on planted seedings & 37% native understory cover).

The Task Force recommends three sets of strategies to obtain these stated goals (See Section V for details):

Strategy Set #1: Improvement of Hunting Access
- 1A) Encourage and facilitate hunting access on public and private lands
- 1B) Develop strategies to access "pocket deer" in residential areas

Strategy Set #2: Improvement of Hunting Efficacy
- 2A) Encourage and facilitate coordinated hunting activities among neighboring landowners
- 2B) Encourage and facilitate use of Agricultural Depredation Permits by farmers
- 2C) Encourage and facilitate Deer Management Programs that focus harvests on female deer
- 2D) Encourage and facilitate program for venison donation to local food banks
- 2E) Consult with the NJ Division of Fish & Wildlife and other wildlife professionals to facilitate strategies 1A through 2D

Strategy Set #3: Avoidance of Deer Impacts
- 3A) Improve awareness of methods that reduce Deer Vehicle Collisions
- 3B) Improve awareness of methods that reduce Lyme disease
- 3C) Improve awareness of methods that reduce landscape damage
- 3D) Discourage the intentional feeding of deer in non-hunting situations

Table of Contents

List of Tables, Figures and Appendices

List of Tables

List of Figures

List of Appendices

I. Introduction

White-tailed deer are often considered one of the most beautiful large mammals commonly encountered in the Hopewell Valley. However, deer population numbers rose dramatically during the last century and impacts of deer have become significant in recent times. Deer impacts range from human health issues and property losses to degradation of forests. Deer-vehicle collisions, Lyme disease, agricultural losses, and landscape planting damage all directly impact the quality of life for residents of the Hopewell Valley. Forests are severely impacted by overabundant deer through the preferential browsing of native plants, which facilitates the spread of invasive weeds that are unpalatable to deer - the long-term maintenance of forest cover is at jeopardy because new trees are eaten before they can replace those that fall.

History and Accomplishments of the Hopewell Valley Deer Management Task Force

The Hopewell Valley Deer Management Task Force ("Task Force") began as an informal conversation among various Township officials and staff, members of the Environmental Commission, Open Space Advisory Committee, Agricultural Advisory Committee, and others during the summer of 2009. Various deer impacts were discussed (e.g., deer-vehicle collisions, agricultural damage, landscaping damage, Lyme disease and forest health) and the need to determine the scope of the problem and potential solutions was deemed an important activity that might bring together a wide range of Hopewell Valley stakeholders into a formal group. At the request of former Mayor Vanessa Sandom, a request to form the Task Force was presented to the Township Committee by Michael Van Clef (Friends of Hopewell Valley Open Space) in September 2009 and their acceptance of the proposal led to the formal creation of the Task Force. Over 20 members representing various stakeholders were recruited, along with James Burd acting as the Township Committee liaison. The Task Force was charged with several key functions including the creation of the Hopewell Valley Deer Management Plan. Task Force activities were to include: 1) Initiate a public education program, 2) Create a comprehensive deer management plan, and 3) Determine requirements for long-term sustainability of a successful deer management plan.

The first Task Force meeting occurred in November 2009 and was initiated with a conversation regarding the existence and severity of deer impacts with the majority of members agreeing that impacts were present and severe on multiple fronts. There were a total of seven additional meetings throughout 2010 that included discussions of multiple topics that are included in this plan. Task Force accomplishments since inception included preparation of four articles published in local newspapers, development, distribution and analysis of a public questionnaire to determine extent of deer impacts on residents of the Hopewell Valley, and a survey of the Hopewell Valley deer population. Much of this information is provided at the Hopewell Township website (http://www.hopewelltwp.org/current-topics.html). Task Force activities culminate in background information and recommendations provided in this plan.

II. Deer Population in the Hopewell Valley

Introduction

This plan section provides background information on the natural history of white-tailed deer, current and historical statewide deer population size, and results of the 2010 Hopewell Valley deer population survey performed by the Task Force.

Natural History of White-tailed Deer

Information in this section was obtained through NatureServe (2001), unless otherwise noted. White-tailed deer (*Odocoileus virginianus*) are found throughout North America, Central America, and northern South America. Currently, the species is expanding its range northward in Canada. Adult males range in size from 50-350 pounds (average is 125 pounds), while females range from 50-250 pounds (Burt 1976, Webster et al. 1985). Habitat varies from forests to fields with adjacent cover, swamps, open brushy areas, and suburban landscapes. Diet varies seasonally and consists of twigs, shrubs, herbs, grass, fruit, and fungi. Grasses dominate the diet in spring, flowering herbs in early summer, leaves of woody plants in late summer, acorns and other fruit in fall, and evergreen woody shrubs and other woody twigs/buds in winter. Agricultural crops are also commonly consumed.

Deer breed from late October to mid-December with a peak in November. Young are born in May and June. Females can begin breeding at 6 to 7 months of age, but usually breed at 18 months. Males become sexually mature at about 18 months. Deer generally have a 10-year life span in the wild. Deer home ranges can be small - capture and marking studies in Hunterdon County, New Jersey (January 1970 to July 1976) indicate that home range size of deer in this area of New Jersey is generally one mile or less. In this study, the largest percentage of deer (68%) were recovered within one mile of their original capture locations; 27% ranged from one to eight miles and 5% ranged from 10 to 19 miles (NJ Division of Fish and Wildlife 2002).

Bucks and does exhibit different territorial behaviors and patterns of movement. Bucks tend to be solitary for most of the year and are more mobile than does. Does form herds consisting of a related family group with a rigid matriarchal hierarchy (Matthews 1989, McNulty et al. 1997). The herd is dominated by a single eight- to ten-year old doe and one or two sub-dominant five- to seven-year old does. Younger does and recent offspring (both male and female) make up the remainder of the herd. The size of the deer population within a given area is primarily a function of the density of individual matriarchal herds occurring within that area and their annual reproductive output (McNulty et al. 1997, Miller and Ozoga 1997, White and Bartmann 1997). These matriarchal deer herds are strongly territorial and display a very strong tendency to remain within their established territories and aggressively defend them from other deer herds (Jones et al. 1997, McNulty et al. 1997).

Historic and Current Statewide Deer Population

The historical analysis of the white-tailed deer population density in North America (pre-European colonization) is 10 per square mile (McCabe and McCabe 1984). Figure 1 shows the estimated statewide population size based upon the historical estimate for North America and deer population estimates reported by the New Jersey Division of Fish & Wildlife (http://www.state.nj.us/dep/fgw/deer.htm). By 1900, deer were nearly extinct in New Jersey because of unregulated market hunting for the sale of venison. The recovery of deer population, through the implementation of various game regulations, is a significant conservation success story. However, the deer population mushroomed during the 1900's and peaked in 1995 with 3X more individuals than pre-European estimates. In 2006, there were 2X more individuals than pre-European estimates. In the late 1990's, the NJ Division of Fish & Wildlife implemented changes to reduce the deer herd (e.g., "Earn-A-Buck" program that encouraged harvest of antlerless deer) (Figure 2). Although there have been other recent and upcoming changes to facilitate hunting success (e.g., Sunday bow hunting, use of crossbows, reduction in the bow hunting safety zone), population levels continue to exceed pre-European densities with noticeable impacts (See Section III).

Figure 1. Historic and Current New Jersey Deer Population Estimates

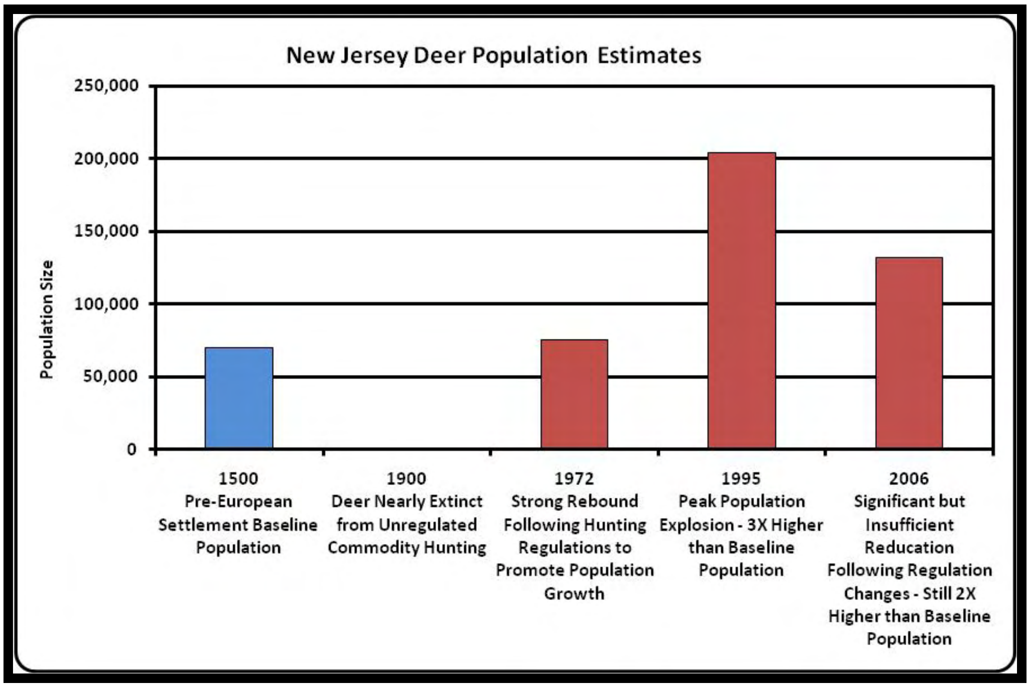
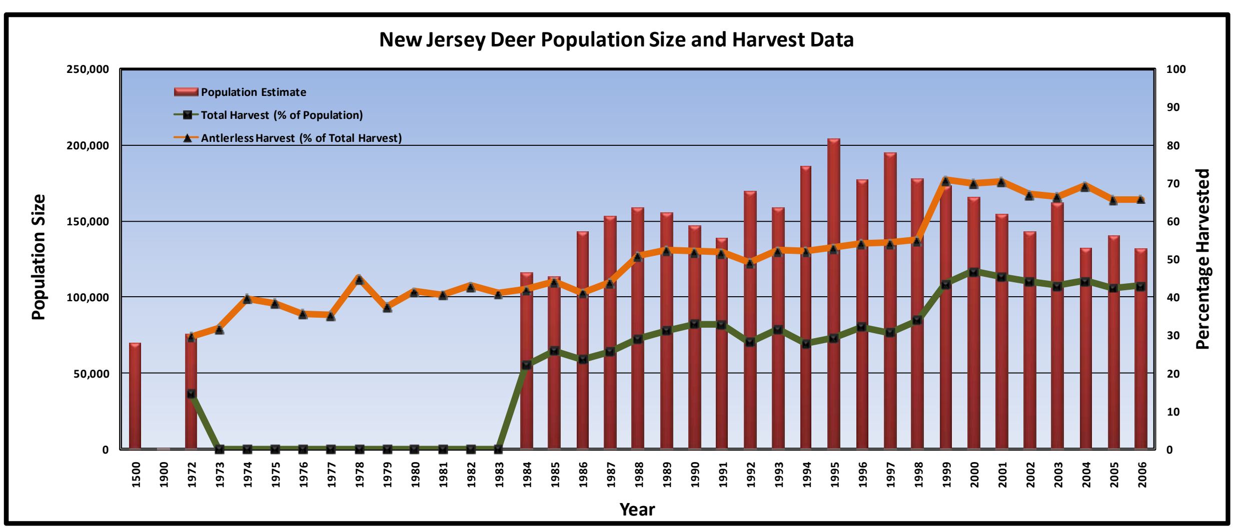


Figure 2. New Jersey Deer Population Size and Harvest Data



A simplified explanation of deer management issues and consequences are depicted in Figure 3. All deer management efforts must consider the current habitat conditions that serve deer population growth. Deer prefer forest edges and fields for feeding and utilize forests for cover and supplemental feeding (See Figure 4 depicting abundance of forest edges in Hopewell Valley - forests shown in green represent 15,000 of the 40,000-acre Hopewell Valley). Deer also utilize agricultural crops as food sources and residential areas for both food and cover from hunters (state regulations prohibit hunting within 450 feet of an occupied or potentially occupied structure). Both restrictions on hunting access and limited hunting efficacy, relative to the ability of the landscape to serve as excellent incubator for deer population growth, have made deer management difficult in recent times.

Figure 3. Deer Population Growth Factors and Impacts

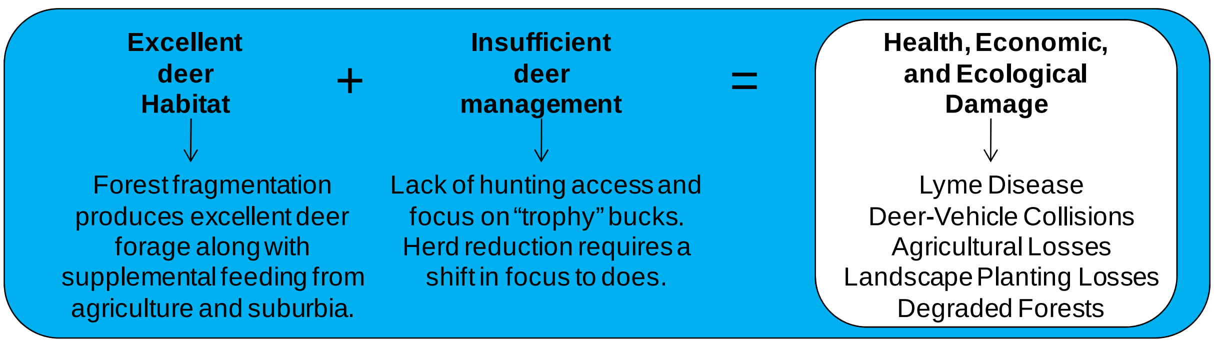
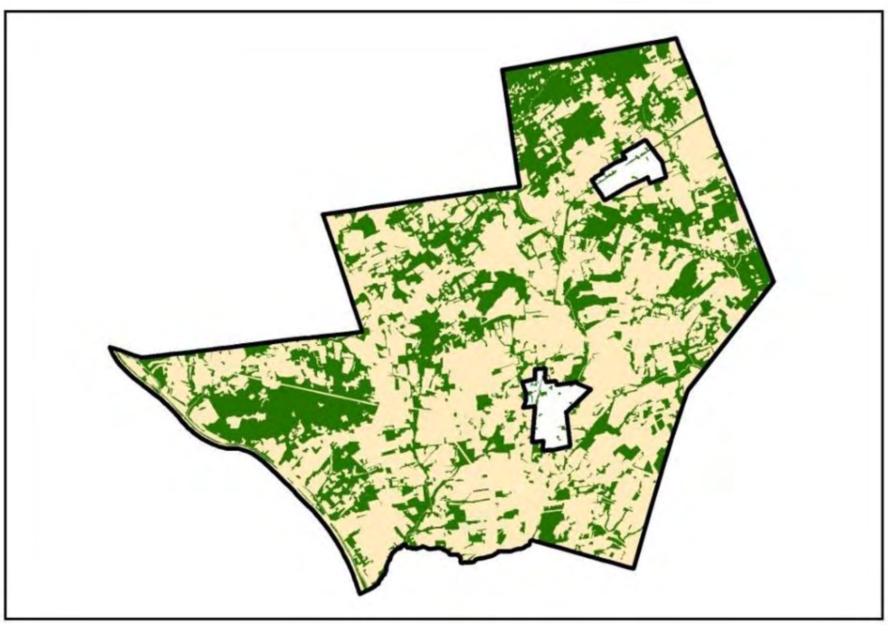


Figure 4. Forest Fragmentation in the Hopewell Valley



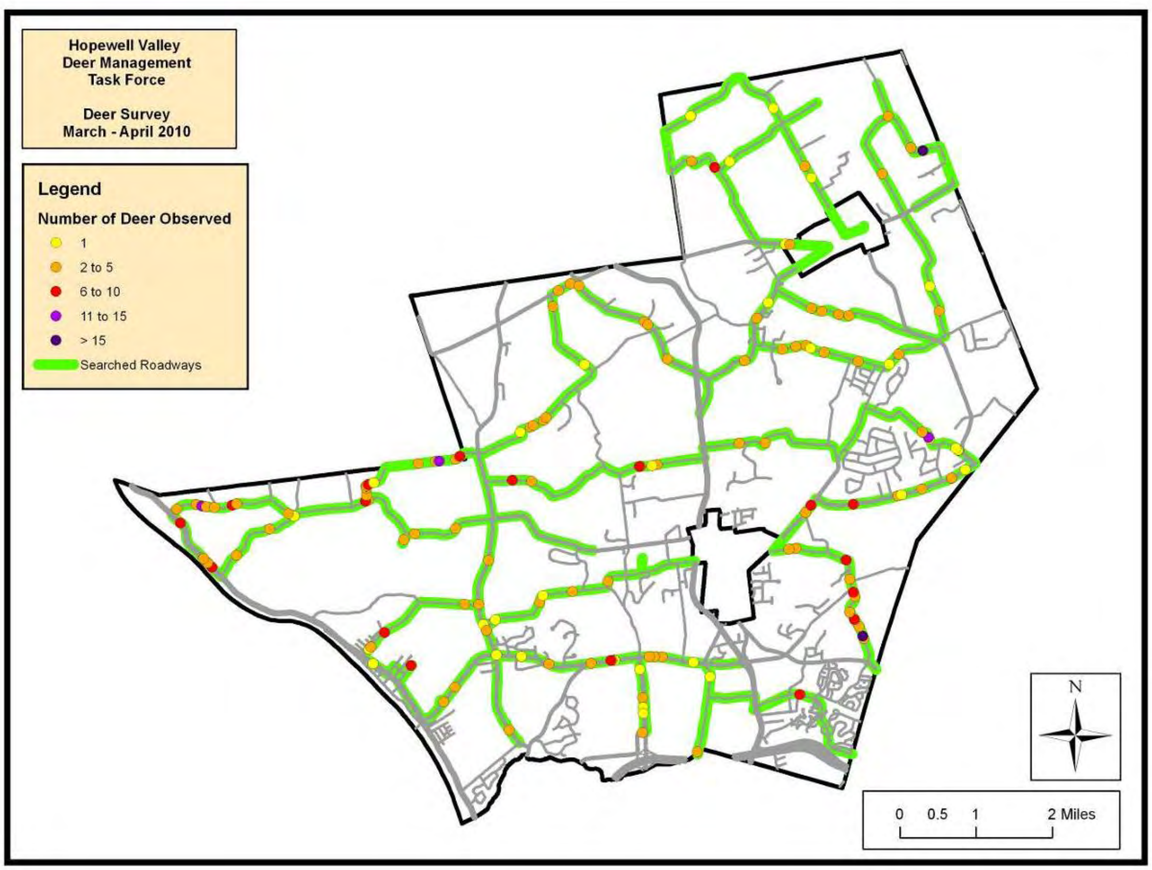
Hopewell Valley Deer Population - 2010 Survey

A determination of the Hopewell Valley deer population was performed by the Task Force to understand the scope of the problem relative to known deer impacts. While the use of deer population size alone is not adequate to measure reductions in deer impacts, population estimates are useful in setting goals for deer herd reduction (See Section V).

There are two major counting methods that are accepted by wildlife biologists. The first is "Forward-Looking Infrared Radar" that uses an infrared camera mounted on an aircraft to count deer on winter nights. This method is costly (estimated at over $100,000 for the entire Valley). There is a less expensive method called "Distance Sampling" that is considered just as reliable by wildlife professionals (S. Predl, NJ Division of Fish & Wildlife, personal communication). Members of the Task Force and other interested private citizens drove over 70 miles along Valley roadways over four nights in late March/early April using spotlights and an electronic rangefinder. They collected information on the number of deer observed and their distance from the roadway. This data was input into a computer program, which provided a statistically reliable population estimate. Figure 5 depicts deer observations (by group size) and travelled roadways during the 2010 Hopewell Valley deer population survey.

The population estimate was 37 deer per square mile (or nearly 2,300 total deer). This number represents the lowest point of the year for the deer population because it followed hunting season and a very snowy winter. Because deer are very prolific, the summer density was expected to grow to over 3,400 deer after spring birthing (equivalent to 54 deer per square mile). For reference, wildlife researchers have estimated that deer densities of 10 per square mile were typical prior to colonization of the United States (McCabe and McCabe 1984) and impacts to forest health become noticeable above this level (deCalesta 1994, deCalesta 1997). See Section IV for additional discussion on ecological impacts of overabundant deer.

Figure 5. Hopewell Valley Deer Population Survey (2010)



III. Deer Impacts in the Hopewell Valley

Introduction

The impacts of deer in the Hopewell Valley were determined through a public survey, interviews with local farmers and review of existing data on Lyme disease, deer-vehicle collisions and ecological monitoring of forest health. Public survey methods are described below. A brief literature review of impacts, along with Hopewell Valley data, is provided in three categories: Human Health Impacts, Economic Impacts and Ecological Impacts.

A recently completed, comprehensive study of the costs of deer impacts in Fairfield County can be found at http://www.deeralliance.com/index.php?pageID=3&articleID=154. Although this level of analysis has not been performed in Hopewell Valley, estimates for individual municipalities within Fairfield County ranged from $1.9 to $17 million per year (included Lyme disease, tick control efforts, deer vehicle collisions and vegetation damage).

Public Questionnaire Methods and Results Summary

The Task Force prepared a questionnaire to determine the impacts of deer to the general public (See Appendix A for a complete list of questions and responses and Appendix B for results presented as charts). An open-ended comment section was also provided with the questionnaire (See Appendix C for a complete set of comments). Particular sets of questions were specifically designed for farmers (impacts and issues related to agriculture) and hunters (hunting activity and constraints). A total of 5,000 questionnaires were printed by Hopewell Township and Task Force members made them available through several venues including Pennington Quality Market, Mercer County Library - Hopewell Branch, Rosedale Mills, and Pennington Farmer's Market. The questionnaire was also made available on-line through the Hopewell Township website (http://www.hopewelltwp.org/current-topics.html).

The questionnaire results cannot be considered a statistically valid representation of the entire Hopewell Valley because the questionnaires were not randomly assigned to recipients. In all cases, interpretation of the results is confined to respondents (e.g., 'a certain percentage of *respondents* have reported Lyme disease' as opposed to extrapolating the results by saying 'a certain percentage of *Hopewell Valley residents* have reported Lyme disease'). A total of 575 questionnaires were submitted to the Task Force between June 1 and July 10, 2010. Complete questionnaire responses are detailed in Appendices A and B and key results are categorized within this and subsequent plan sections. The majority of responses were received from Hopewell Township (74%), followed by Pennington Borough (19%) and Hopewell Borough (7%).

Overall, deer impacts were considered significant – 71% of respondents felt that "deer cause many problems and solutions are needed." It is important to note that while the overwhelming majority of respondents are looking for action to reduce deer impacts, a minority of respondents were strongly opposed to hunting (See discussion of population control methods under Section IV).

Responding households reported deer impacts including Lyme disease (26%), deer-vehicle collisions (28%), landscape damage (24% reported severe damage and 31% reported moderate damage), and bird feeder damage (17%).

Households with hunters constituted 11% of the respondents. The majority of hunting households (80%) harvest less than four deer per year. The single largest factor restricting an increased harvest was "more places to hunt in Hopewell Valley, including public lands" (22%). An increased availability for venison donation was also significantly limiting (18%), while increased time to hunt was least important (10% of responding hunting households).

Households with farmers constituted 12% of the respondents (60 responses), but only 8% of all questionnaire respondents were currently farming - 39 farming households). Ten percent of responding farmers stopped because of deer predation, while 25% stopped farming for other reasons. Crop losses from deer were common (52%). The majority of damage was less than $5,000 per year (73%). Nineteen percent of damage cost between $5,000 and $25,000 per year. Approximately 8% of damage was greater than $25,000 per year. Other impacts included stopping the production of particular crops due to deer damage (37%), planting of sacrificial crops that are used to deter deer from feeding on higher value crops (8%), and utilization of fencing (51% of responding farmers). The use of hunting on farmland may be impacted by land ownership / lease arrangements (11% of responding farmers do not own any land). Fifty eight percent of farmers that own their own land allow hunting. Sixty four percent of respondents that lease land have landowners that do not allow hunting on any of their leases – an additional 16% lease some lands where hunting is not allowed. Agricultural depredation permits are utilized by 17% of responding farmers (88% of these permits are utilized on lands owned by farmers).

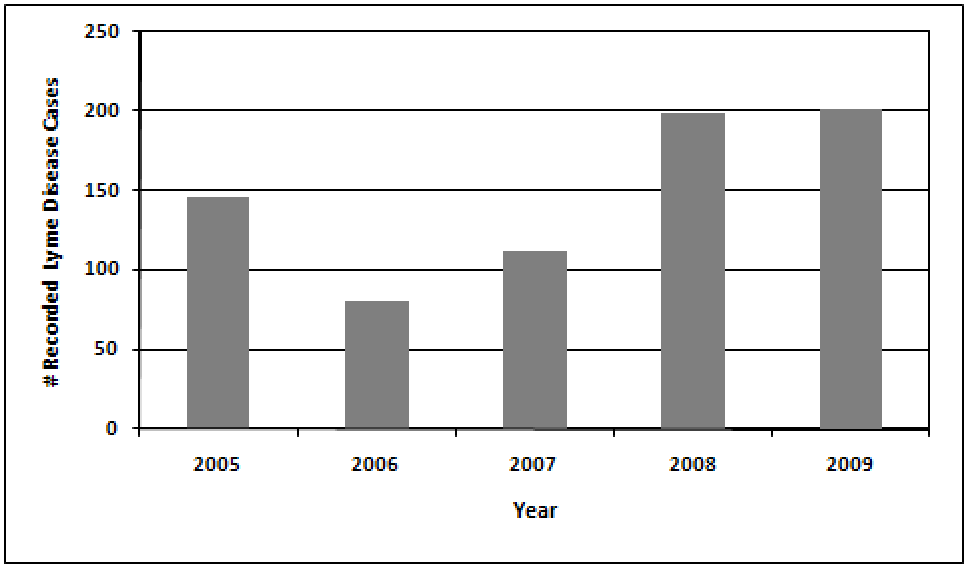
Human Health Impacts

Lyme Disease

Lyme disease has become a significant problem across the United States and is particularly prevalent in the Northeast (Centers for Disease Control 2010). New Jersey ranks fourth in the nation with over 35,000 reported cases between 1990 and 2007 (NY, PA, and CT reported the three highest number of cases). According to a study reported from Connecticut (Stafford 2007), deer population size is linked to incidences of Lyme disease. This relationship is dependent upon a threshold deer population size, requiring a population size of 10-12 deer per square mile to show substantial reduction in human cases of Lyme disease. Although deer do not directly transmit the disease bacteria (*Borellia burgdorferi*), they support large populations of the deer tick (*Ixodes scapularis*) that perpetuates the disease primarily through their other important host, white-footed mice (*Peromyscus leucopus*). In essence, deer act as an incubator to support tick population growth, which then become infected through contact with mice and subsequently transmit the disease to humans. Readers may refer to various sources for additional information on Lyme disease – See Fairfield County Deer Alliance, www.deeralliance.org or the Centers for Disease Control and Prevention, www.cdc.gov.

Hopewell Valley Lyme Disease data is reported in Figure 6. These cases include all residents from Hopewell Township, Hopewell Borough and Pennington Borough that were diagnosed with Lyme disease by their physician (and confirmed through blood testing). The average number of annual cases since 2005 was 147. It is important to note that many cases are unreported because physicians often diagnose and treat the disease without the blood testing required for formal tracking purposes. The public questionnaire results indicated that 26% of responding households had at least one case of Lyme disease over the last three years.

Figure 6. Reported Lyme Disease Cases in the Hopewell Valley
Source: Hopewell Township Health Department



Economic Impacts

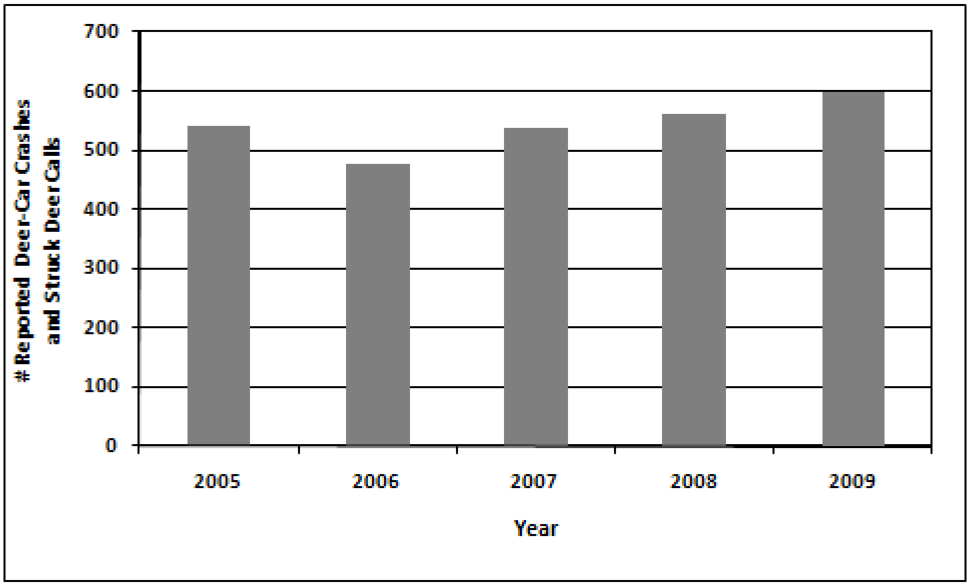
Deer Vehicle Collisions

Deer Vehicle Collisions (DVC) occurred at the rate of 100,000 per month nationwide (State Farm Life Insurance Company 2009). Although New Jersey does not rank in the top ten for total DVC's, the state had a 54% increase in collisions over the last five years (highest in the nation). New Jersey has approximately 15,000 collisions per year at an approximate cost of $3,050 per collision – total annual statewide cost is $45,750,000 (J. Baldino, State Farm Life Insurance Company, personal communication).

DeNicola and Williams (2008) report a one-to-one reduction in DVC's with reductions in deer density. Through the use of sharpshooting, deer herd size reductions led to DVC reductions in Iowa City, IA (76% population reduction, 78% DVC reduction), Princeton, NJ (72% and 75%, respectively), and Solon, OH (54% and 49%, respectively). In Princeton Township, the pre- and post-culling deer density was 114 and 32 per square mile, respectively (Culling activities were conducted from 2000 - 2006). Additional information on DVC's can be found at Deer Crash (http://www.deercrash.com/index.htm).

Hopewell Township tracks DVC's through two methods – reported deer-car crashes and struck deer calls. The average number of reported deer-car crashes over the last five years is 159 crashes per year. It is important to note that all deer-car crashes do not result in a formal police report (see discussion on 'Struck Deer Calls' below). In all years, reported deer-car crashes represent approximately 20% of the total number of reported car crashes (G. Meyer, Hopewell Township Police Chief, personal communication). The number of struck deer calls is drawn from dispatch records. A struck deer entry is made whenever a dispatcher receives a call for a struck deer on or near the roadway and there is no striking vehicle present. A struck deer entry is also made when a motorist comes to police headquarters and reports that they struck a deer (in such cases a police crash report is NOT filed, so they are not double counted). These people are provided with a State of New Jersey form so they can file their own report. This is done because there was no police response to the accident scene. The average number of struck deer calls is 375 over the last five years. It is reasonable to assume that the reported deer-car crashes and struck deer calls can be added to better estimate the total number of deer car collisions in the Hopewell Valley. The combined average is 531 deer-car collisions per year since 2005 (Figure 7).

Figure 7. Sum of Reported Deer-Car Crashes and Struck Deer Calls for Hopewell Township
Source: Hopewell Township Police Department



Agricultural Losses
Deer overabundance impacts include direct annual crop losses, land abandonment (permanent loss of productivity), crop switching (reduction in profit by planting less palatable crops that are not as profitable as more palatable crops), sacrificial crops (loss of productivity by planting crops to attract deer without the intention of harvesting to avoid damage on more valuable nearby crops), and fencing costs. The Rutgers University Cooperative Extension conducted a statewide survey in 1998 (http://njaes.rutgers.edu/pubs/deerdamage/), which reported information on the impacts noted above.

Information on impacts collected from Hopewell Valley farmers through the public questionnaire are summarized in Section II.

Landscape Planting Losses
Residential landscapes are also subject to significant damage. Lists of deer resistant plants, deer repellants and fencing requirements are common topics among gardeners. Although deer impacts can be characterized as a quality of life issue, cost estimates for residential landscape damage are not available.

Persistent deer damage has led many gardeners to utilize unpalatable invasive species such as Callery Pear, Japanese Barberry and Chinese Silvergrass. These species, and many others, cause significant damage to natural areas in the Hopewell Valley.

Information on impacts collected from Hopewell Valley residents through the public questionnaire are summarized in Section II.

Ecological Impacts

Stewardship of Natural Lands

The broader view of ecological impacts must consider that direct human uses (e.g., homes, farms) have consumed about 50% of New Jersey's land area. Obviously, these human uses directly destroy natural systems and continued development remains the greatest statewide threat. The other 50% of New Jersey's land exists in a natural state. However, severe impacts on our remaining natural areas are indirect - i.e., they do not involve outright destruction, but are consequences of human activities. Examples include overabundant deer and invasive species. The goal of land stewardship is to restore ecological health by reducing human impacts. The ultimate desired outcome for our remaining natural areas is to maximize ecological health and natural functions to resist continuing human impacts.

Effective stewardship strategies are guided by science and are carefully formulated to maximize ecological health of plant communities that serve both rare and common species. Broad stewardship strategies involve the following prioritized list: 1) Deer herd reduction to facilitate robust native plant communities that exert ecological control over less palatable invasive species, 2) Early Detection & Rapid Response (ED/RR) to prevent establishment of newly emerging invasive species, and 3) Protection of sites with high conservation values by a) eradicating small, outlier populations of all invasive species, and b) intense, long-term control programs to reverse larger infestations. For some rare species, it may be necessary to formulate strategies on a species- and site-specific basis with the goal of promoting long-term, self-perpetuating survival of populations. Direct restoration of degraded lands is an important strategy that is employed on a case-by-case basis and can be considered after (or during) commitment to the stewardship activities outlined above.

Figure 8. Stewardship Philosophy

'Nature manages itself' is commonly heard from those that feel stewardship of natural resources is inappropriate. In some cases, this is based upon a simplistic understanding of natural systems and the forces that create or maintain them. Some proponents of this view fail to acknowledge that there are many indirect impacts of human activities on natural systems (e.g., introductions of non-native species, irreversible fragmentation of natural areas that support deer population growth, profound alteration of soils from past agricultural use, etc.). Other proponents of this view suggest that nature will have to balance itself within the framework established by human activities and that we should not intervene further. Finally, there are well-qualified experts including some experienced natural historians and research professors that understand that our knowledge of natural systems is incomplete and suggest that stewardship should not be practiced until we learn more about natural systems and how they will react to particular management regimes.

In contrast, proponents of stewardship proceed from the viewpoint that human activities directly and indirectly shape the remainder of our natural world and that there is an obligation to intervene to promote ecological health and avoid further losses to biodiversity. In short, stewardship may be defined as 'the mitigation of human impacts on natural systems'. Stewards feel that action is required when human impacts severely threaten ecological health, thereby consciously reducing human impacts through management strategies and actions.

In most cases, stewards strive for short-term interventions that correct natural systems with declining trajectories. Examples of short-term interventions include significant reductions of the white-tailed deer population (i.e., culling) and control of nascent populations of invasive species. In other cases, the continuing needs of the human population require that active management be perpetual (e.g., creation and maintenance of early successional habitats because catastrophic wildfires must be suppressed or a continuing Deer Management Programs to maintain a smaller deer herd).

In general, there are relatively few compromises available to proponents of the extremes of these two opposing viewpoints. However, most individuals realize that a balance is possible, especially when stewardship is coupled with careful monitoring or designed research experiments that provide greater insights to practice adaptive management. Overall, stewardship strategies should seek to utilize minimal human intervention to foster ecological health and stimulate research to provide a better understanding of the natural world.

Forest Health Degradation

Numerous studies and reviews have been conducted on the impacts of white-tailed deer on forest ecosystems. A comprehensive review was conducted in Pennsylvania (Latham et al. 2005, http://pa.audubon.org/deer_report.html); an overview of impacts throughout the Northeast is provided by Rawinski (2008), http://na.fs.fed.us/fhp/special_interests/white_tailed_deer.pdf. Other comprehensive sources include Warren 1997 and McShea et al. 1997.

In general, native species diversity / abundance and overall forest health drop significantly with increasing deer herd size. An often cited research project that provides quantitative guidance on deer population levels associated with ecological damage was performed by David deCalesta, based at the US Forest Service in Pennsylvania (deCalesta 1994, deCalesta 1997). Over the course of a 10-year study using forest enclosures with known densities of deer, deCalesta determined that native forest herbs and tree seedlings became less abundant with deer densities between 10 and 20 per square mile. At densities exceeding 20 per square mile, palatable native plant species disappear and forest shrub-nesting song birds drop in abundance with the loss of the shrub layer. Starvation of deer occurred when densities exceeded 65 per square mile. This study suggests that deer densities exceeding 10 per square mile have negative ecological impacts (Note: Independent historical studies determined that pre-European colonization deer densities were approximately 10 per square mile and breakage – McCabe and McCabe 1984 and breakage of the Lyme disease transmission cycle may occur at 8 deer per square mile – Stafford 2007).

Hopewell Valley forest health data has been collected by the Friends of Hopewell Valley Open Space utilizing the methodology established as part of a statewide 'New Jersey Forest Health Monitoring System' designed by Michael Van Clef (See Figure 11). This system for measuring deer browse on experimentally planted tree seedlings ("Sentinel Seedlings") and current density of woody understory plants ("Forest Secchi") has been utilized by 15 organizations at 38 sites since 2006.

A total of 16 sites in the Hopewell Valley were tested from 2006 - 2009 (data from an additional 13 sites in Northern New Jersey tested within the same time period are provided for comparison) (See Figure 9 and Table 1). The desired threshold value of 10% seedling browse over a 6-month period (December to June) has not been recorded at any site. The average deer browse measurement is 59% over a six month period. Because tree seedlings require at least several years to grow above the typical maximum deer browse height (ca. 4.5 feet), forests at all tested sites are not expected to be able to regenerate following the death of existing canopy trees.

The understory of most mature forests should be filled with tree saplings and shrubs that provide habitat for wildlife (Note: A forest begins to mature at 50-75 years old) (See Figures 12 & 13). This concept is expressed as the desired threshold of 70% native plant cover utilizing the "Forest Secchi" methodology. The average site measured in the Hopewell Valley has 21% native cover, which mimics the statewide average (See Figure 10 and Table 2). The cover of non-native invasive plants is 31% in Hopewell Valley (15% higher than the statewide average). The reason for the low levels of native understory plants (and relatively high levels of invasive plants) may be attributed to deer overabundance over a prolonged period of time.

Figure 9. New Jersey Forest Health Monitoring System - "Sentinel Seedlings"
Source: Michael Van Clef, Ph.D., Friends of Hopewell Valley Open Space

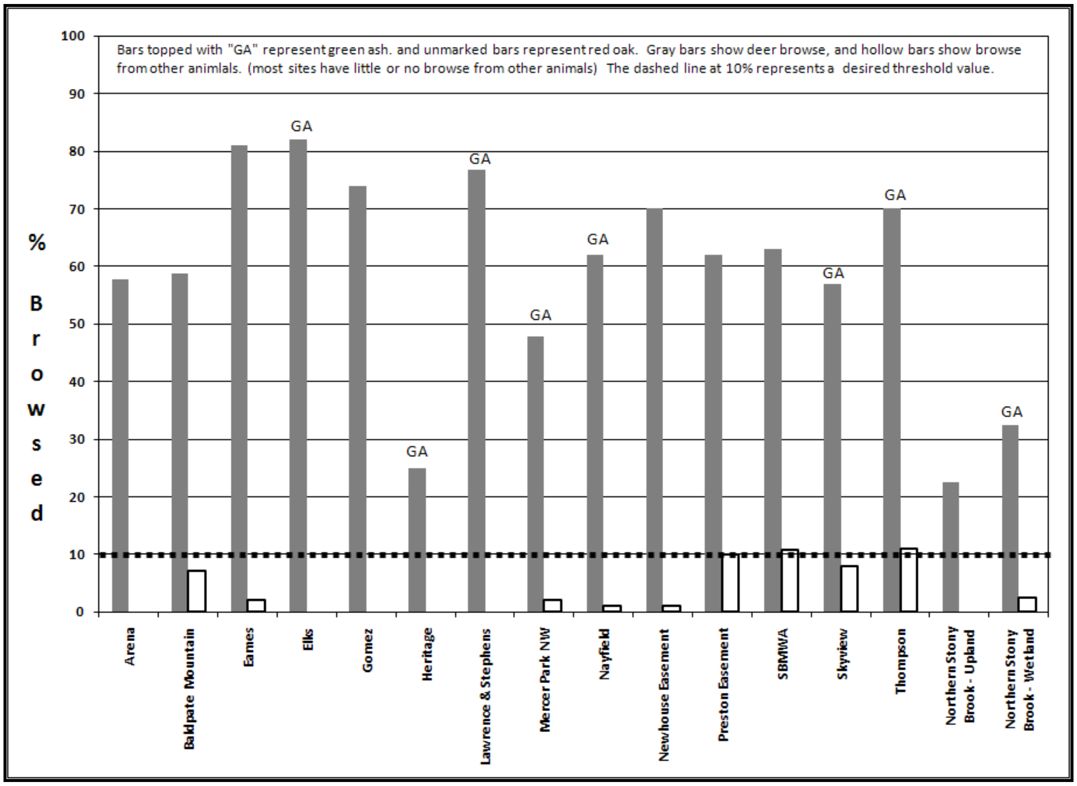


Table 1. Summary of Experimental Seedling Browse Measurements ("Sentinel Seedlings")

Area	Average Deer Seedling Browse (%)	Range of Deer Seedling Browse (%)	Average Other Animal Seedling Browse (%)	Average Other Animal Seedling Browse (%)
Hopewell Valley Sites (16 sites)	59	23-82	3	0-11
Other New Jersey Sites (13 sites)	59	33-82	1	0-6
Combined Statewide Sites (29 sites)	59	23-82	3	0-11

Figure 10. New Jersey Forest Health Monitoring System - "Forest Secchi"
Source: Michael Van Clef, Ph.D., Friends of Hopewell Valley Open Space

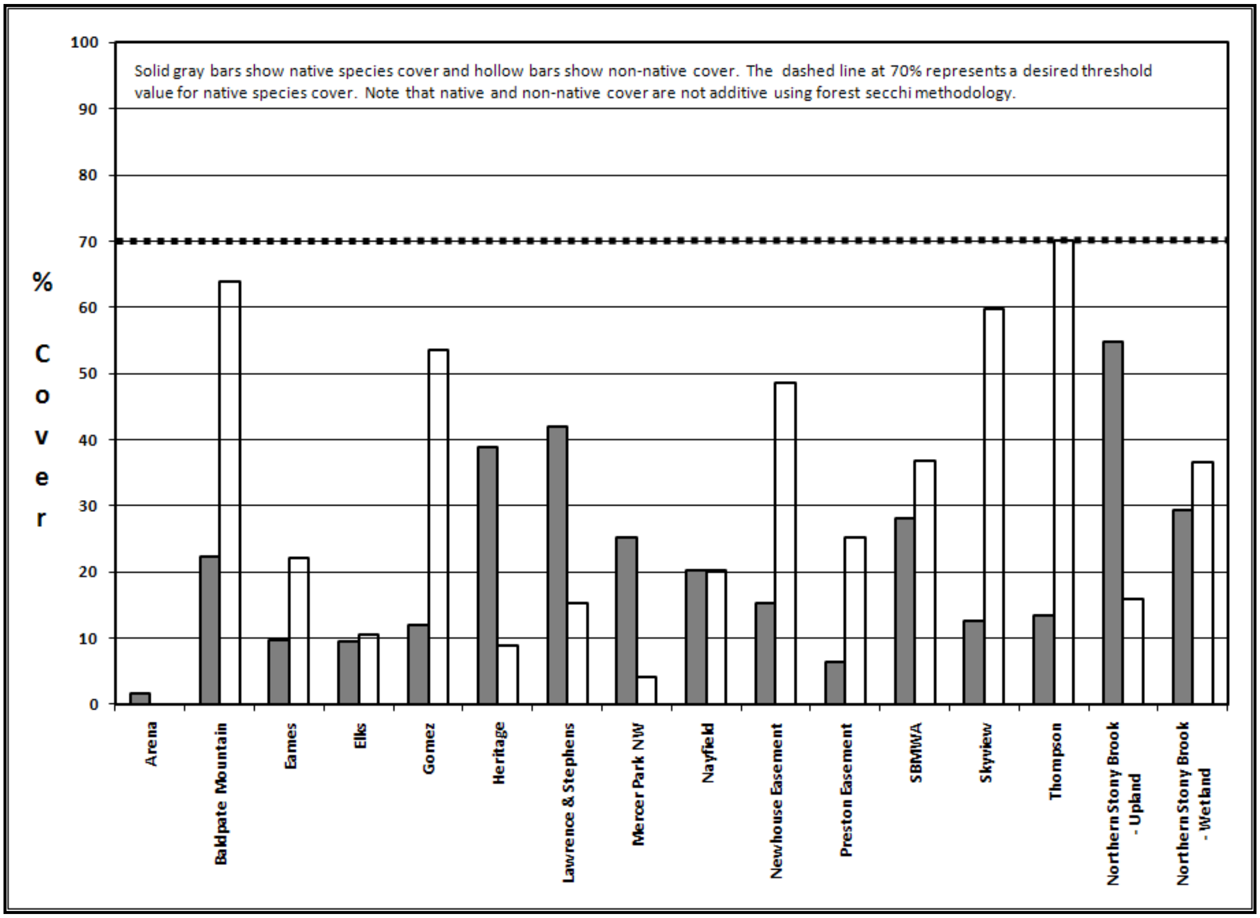


Table 2. Summary of Forest Understory & Canopy Measurements ("Forest Secchi")

Area	Average Native Cover	Range of Native Cover	Average Non-Native Cover	Range of Non-Native Cover	Average Total Cover	Range of Total Cover	Average Canopy Cover	Range of Canopy Cover
Hopewell Valley Sites (16 sites)	21	2-55	31	0-70	47	2-80	93	82-98
Other New Jersey Sites (15 sites)	21	6-52	16	0-46	33	12-61	89	69-98
Combined Statewide Sites (31 sites)	21	2-55	24	0-70	40	2-80	92	69-98

Figure 11. New Jersey Forest Monitoring System Protocol Design

Left: Browse on planted oak seedling, note unbrowsed Japanese Stiltgrass (an invasive species) in background, Center: Sentinel Seedling Plot Design, Top Right: Forest secchi board – the number of grid cells with vegetation are counted to estimate understory cover, Bottom Right: Unbrowsed invasive Japanese Barberry at a site with very high deer density (photo taken adjacent to the browsed oak seedling at left).

Figure 12. Forest Degradation Series Photographs

Top: Healthy forest containing dense understory growth, Middle: Understory browsed away by deer, Bottom: Canopy gaps fill with unpalatable invasive species and native trees cannot grow because of excessive deer browse

Figure 13. Forest Recovery at Ted Stiles Preserve at Baldpate Mountain

Left: Photo of native spicebush thicket within the core of the Preserve – this area harbors forest birds such as Kentucky and Hooded Warblers not found in most places in the Hopewell Valley, Right: Close-up photo of thicket showing spicebush (larger leaves) overtopping the invasive Japanese barberry. This is an example of "ecological control" of invasive species by native species. Although the Deer Management Program at Baldpate has produced significant improvements within the core of the Preserve, additional deer herd reduction is required to restore large portions of the site.

IV. Deer Management Options

Introduction

The decision to reduce impacts of white-tailed deer must be accompanied by review of all available options. The selection of particular methodologies must consider efficacy and cost. The Task Force has reviewed and discussed the management options below. Through consensus, it was determined that an active and coordinated hunting program must be the key management option to meet deer impact reduction goals (See Strategy Sets #1 and #2 in Section V). Non-lethal options are also incorporated into the recommended strategies (See Strategy Set #3 in Section V). It is important to note that a minority of Task Force members and public questionnaire respondents were strongly opposed to lethal control options. Although these opposing viewpoints cannot be reconciled, the Task Force decided that lethal options are required and the explicit incorporation of particular non-lethal options, as appropriate, is also important to meeting stated deer impact reduction goals.

Those interested in comprehensive reviews of deer management options should see DeNicola et al. 2000 (http://ecommons.cornell.edu/handle/1813/65), Drake et al. 2002, and Northeast Deer Technical Committee 2009 (http://www.state.nj.us/dep/fgw/pdf/deer_mgt_options.pdf).

Non-Lethal Options

Birth Control
The use of birth control to limit deer population growth is currently experimental. The NJ Division of Fish & Wildlife provides permits for studies using GonaCon (recently approved for use by U.S. Department of Agriculture and U.S. Environmental Protection Agency). Although efficacy may be possible for captive deer populations, there are currently no commercially available systems to provide population control over wild deer. Costs to administer drugs to wild deer are extremely high (approximately $1,000 per treated deer). A recent summary of the current status of birth control can be found at http://deeralliance.com/index.php?pageID=24&articleID=78.

Deer Exclusion Fencing
Deer exclusion fencing is a relatively expensive technique to protect small areas of high value lands. This can include whole farm fields with high value crops (e.g., sweet corn, vegetables), portions of forests to allow tree regeneration and development of understory vegetation, whole residential properties, or residential gardens. Deer fencing is minimally seven feet tall and may be constructed of various materials including plastic or metal mesh affixed to wood or metal posts (or sometimes existing trees). A review of fencing types can be found at the Internet Center for Wildlife Damage Management (http://icwdm.org/handbook/mammals/Deer.asp).

Repellants
Repellants may be suitable for the protection of residential garden plantings. Efficacy may vary with product utilized and generally needs to be re-applied continuously throughout the year to provide protection. The use of repellants for agricultural crops, forests or large landscapes is cost prohibitive. Information on the efficacy of deer repellants can be found at http://www.walnutcouncil.org/deer_repellent_study.htm and http://yardener.com/YardenersToolshedofProducts/PestAnimalControlProducts/DeerControlProducts/RepellentsForDeer.

Road-related Deer Countermeasures
The Deer Vehicle Crash Information Clearinghouse (www.deercrash.com) published a report that reviewed numerous countermeasures to minimize deer vehicle collisions (Knapp et al. 2004 - http://www.deercrash.com/Toolbox/finalreport.pdf). Evaluated methods included in-vehicle technologies, deer whistles, roadway lighting, speed limit reduction, deicing salt alternatives, deer flagging models, intercept feeding, roadside reflectors and mirrors, repellents, hunting for herd reduction, public information and education, roadside vegetation management, exclusionary fencing, roadside maintenance, design and planning policies, and wildlife crossings. The report suggests that exclusionary fencing and wildlife crossings were the only two sufficiently studied methods that generally produce reductions in deer vehicle collisions – exclusionary fencing and wildlife crossings.

Landscape Use of Unpalatable Plants
Homeowners and grounds managers can consider the use of unpalatable plants to minimize deer damage. Lists of such species often reference the fact that no plant is "deer proof", but many species appear to receive less damage than other favored deer browse. It is important to consider whether unpalatable species are considered "invasive" to natural areas before purchasing. Invasive species are those non-native species that have the ability to dominate natural areas and push out the native flora. Over time, many of the valued landscape plantings have become those that are unpalatable to deer (e.g., Callery Pear, Japanese Barberry, Chinese Silvergrass, etc.), but there are select native species that are not severely browsed (e.g., Indian Grass, Sweet Fern, White Snakeroot). In all cases, purchasers should consider the use of unpalatable native species or non-native species that are not considered invasive.

Lethal Options

Recreational Hunting
Recreational hunting has been a long-standing tradition in the Hopewell Valley and represents the primary source of deer herd management. Hunting regulations are set annually by the Fish & Game Council. These regulations are informed and implemented by the New Jersey Department of Environmental Protection - Division of Fish & Wildlife. The annual Hunting Issue of the Fish and Wildlife Digest is published in August. The Digest defines Regulation Sets that correspond to Deer Management Zones throughout the State. Currently, there are three zones in Hopewell Valley (Zones 12, 14 and 41) that have a single Regulation Set (Set #8). The regulations define harvest limits based upon the particular bow or firearm seasons throughout the overall hunting season (See Table 3 for additional details). Regulations in the Hopewell Valley are considered 'liberal' in that the harvesting of antlerless deer is unlimited in most or all defined hunting seasons.

Figure 14 summarizes the recreational deer harvest across Hopewell Valley (includes Hopewell Township, Pennington Borough and Hopewell Borough). The average total deer harvest over the last eight years was 1,158. Harvest numbers were slightly higher from 2002 - 2004 than in more recent years. The average harvest over the last three seasons was 1,037, with a slight trend to increasing harvest numbers since 2007.

Table 3 summarizes the deer harvest since 2002 based upon hunting season. Overall, bow hunting accounts for approximately 35% of the total harvest, while firearms account for 65% of the harvest. All bow seasons combined account for approximately 5.5 months of the year (ca. early September to mid February). Firearm seasons are conducted over a 2.5 month period (ca. late November to mid February). Overall, firearms produce higher harvest numbers in a shorter period of time, but bow hunting constitutes a significant proportion of the total harvest.

Impacts on the efficacy of recreational hunting toward reducing the deer population include restriction of access (either complete exclusion of hunting or significant time restraints) and lack of coordination between hunters on neighboring parcels leading to 'pushing' deer from areas of higher to lower hunting activity. In addition, a significant number of hunters prefer to harvest antlered deer relative to antlerless deer, which leads to unbalanced sex ratios in the population (many more females than males). The imbalance of females allows rapid annual population growth as relatively few males impregnate all mature females. An additional limitation on harvesting deer is a lack of options for venison consumption (See Public Questionnaire Results in Section III).

Figure 14. Hopewell Valley Deer Harvest Totals (2002 – 2010)
Source: New Jersey Division of Fish & Wildlife (S. Predl, personal communication)

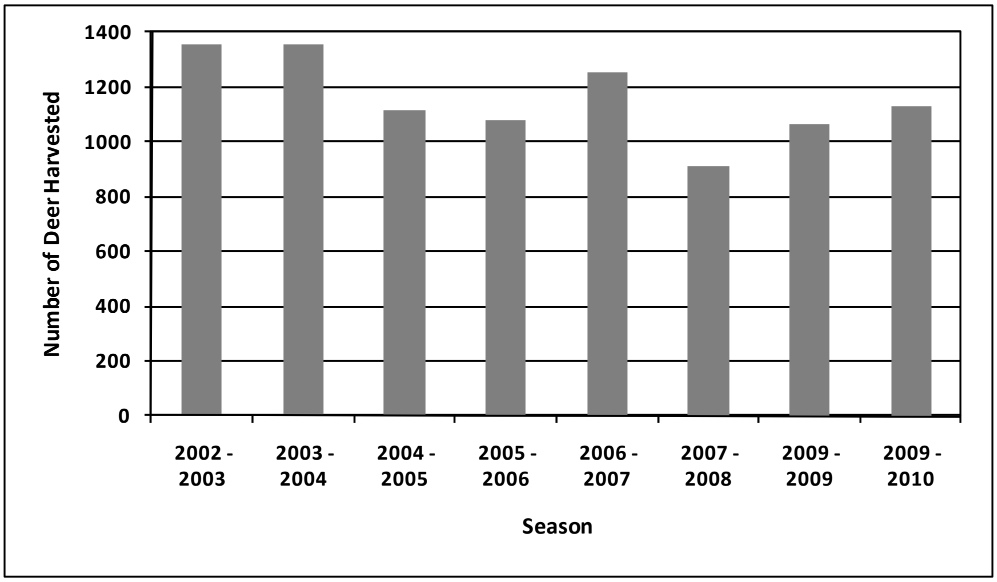


Table 3. Hopewell Valley Deer Harvest by Hunting Seasons (2002 - 2010)
Source: New Jersey Division of Fish & Wildlife (S. Predl, personal communication) and 2009 Hunting Issue of the Fish & Wildlife Digest

Season Name	% of Total Harvest	Approximate Timing	Harvest Notes
Fall Bow	22.8	Duration: 2 months, Early September – Late October	Unlimited antlerless, limit of one antlered. "Earn-a-Buck" required during September only.
Permit Bow	10.9	Duration: 2 months, Late October – Late December	Unlimited antlerless, limit of one antlered with purchase of additional permit
Six Day Firearm	15.2	Duration: 1 week, First full week in December	Two antlered deer limit (antlerless harvest not allowed, but may be harvested under permits within concurrent seasons)
Permit Muzzleloader	10.3	Duration: 2 months, Late November – Mid February (with gaps, various restrictions on timing of antlered deer harvest)	Unlimited antlerless, limit of one antlered with purchase of additional permit.
Permit Shotgun	39.1	Duration: 2 months, Early December – Mid February (with gaps, various restrictions on timing of antlered deer harvest)	Unlimited antlerless, limit of one antlered with purchase of additional permit (no antlered deer may be harvested if two were already taken during Six Day Firearm).
Winter Bow	1.0	Duration: 1.5 months, Early January – Mid February	Unlimited antlerless, limit of one antlered
Youth Day	0.7	Duration: 2 days, End September (bow) & End November (firearm)	One deer of either sex

Agricultural Depredation Permit
Farmers may apply for an agricultural depredation permit through the Division of Fish & Wildlife. The procedure includes a survey of crop damage by a Conservation Officer and the completion of a one-page form. Depredation permits allow the harvesting of deer at any time of day and there are no limits on harvesting deer of either sex. Harvesting may only be conducted by use of a shotgun.

Community Based Deer Management Program (CBDMP)
The NJ Division of Fish & Wildlife offers the CBDMP to municipalities and county government under particular circumstances. The program allows site-specific strategies such as season extensions and use of professional sharpshooters. The program is generally applied to areas where recreational hunting is restricted by dense residential areas and permits have been provided to many government entities. Princeton Township was the first municipality to participate in this program - relatively recent programs have been conducted at Bernards Township, South Mountain Reservation (Essex County) and Millburn Township. Additional information on the CBDMP can be found at http://www.state.nj.us/dep/fgw/cbdmp.htm.

Deer Management Assistance Program (DMAP)
The DMAP allows for improved localized (property specific) deer management in Deer Management Zones that have limits on antlerless deer harvest (Regulation Sets 0 – 3, which includes 17 Zones). This program does not currently apply to the Hopewell Valley because all Zones allow unlimited antlerless harvesting. Additional information on DMAP can be found at http://www.state.nj.us/dep/fgw/pdf/dmap_regs.pdf and http://www.state.nj.us/dep/fgw/dmap.htm.

Deer Management Program (DMP)
Deer Management Programs have been established by multiple non-profit and government entities on their fee-owned properties. The goal of a DMP is to decrease herd size through the selective harvesting of female deer. DMP participants are recreational hunters that are provided access in return for following site-specific rules (e.g., harvesting of one or more antlerless deer before harvesting an antlered deer, harvesting a pre-determined number of antlerless deer). Examples of DMP programs from the Hopewell Valley and nearby areas can be found at http://deerinbalance.org/deer-management-program-resources/.

Quality Deer Management Cooperatives
Quality Deer Management (QDM) is a holistic approach to deer management. The goal of QDM is to manage the deer herd within their habitat constraints and generally leads to smaller, healthier herds. The traditional element of DMP's (i.e., focus on antlerless deer harvest) is coupled with restrictions on harvesting young bucks to allow the growth of larger bucks. The restoration of balance between males to females in the population, along with healthy habitats filled with high-value forage (a.k.a. ecologically healthy forests and fields) is required for successful QDM.

In some areas, QDM cooperatives are formed by neighboring property owners that jointly abide by QDM principles. Generally, a minimum of 1,000 acres is required to create a successful cooperative. Due to the relatively small size of typical parcels in the Hopewell Valley, many hunters interested in QDM fear that hunters on neighboring parcels will not participate and successful QDM is not possible without support from Division of Fish & Wildlife deer regulations. The Fish & Game Council and NJ Division of Fish & Wildlife have the ability to change regulation sets toward favoring QDM. Currently, some Zones in New Jersey (outside of the Hopewell Valley) have restrictions on the harvest of young bucks, but there are no zones with the full complement of regulations and other incentives required for effective QDM.

Professional Services
There are a several local/regional professional service contractors that have the ability to carry out a variety of deer management techniques in places where recreational hunters may not be effective. Professional services may be utilized to control "pocket" or "yard" deer that that cannot be controlled through traditional methods (i.e., deer that occur within 450-foot safety zones of human-occupied structures). Methods utilized by particular municipalities in New Jersey include trap and euthanasia and sharpshooters. Trap and euthanasia involves netting deer and using a specialized tool to deliver a slug that kills the deer. Specially trained sharpshooters can also be utilized with permission of affected landowners. Some contractors utilize typical hunting firearms, but are specifically paid to reduce the deer population. Professional contractors that can conduct these methodologies include White Buffalo, Inc. and Deer Management Systems, Inc. Costs vary based upon methods utilized, but can range from $100 to $1,000 per deer (which usually includes butchering costs to allow donation of venison to local food banks). In most cases, utilization of professional services must be conducted under a Community Based Deer Management Program (CBDMP) permit issued by the Fish and Game Council and administered by the Division of Fish & Wildlife.

The widespread use of professional services throughout the Hopewell Valley (ca. 40,000 acres) would be cost prohibitive. However, localized use of these services may be considered in the future if traditional methods prove to be ineffective for alleviation of deer impacts.

Consideration of Multiple Land Uses
Most publically-owned open space in the Hopewell Valley has multiple land uses that must be considered while conducting deer management. The balance of deer management with passive recreational pursuits such as hiking may be conducted in a variety of ways depending on ownership and the layout of particular properties. For example, some sites allow deer management to occur concurrently with passive recreation, especially when hunting occurs away from well-travelled trails. In some cases, only bow hunting is allowed to occur concurrently with recreational uses. Some land managers decide to close preserves to passive recreation on pre-determined dates to allow deer management. Some lands prohibit hunting because of perceived conflicts with neighbors or passive recreationists. Ideally, a balance should be sought on publically owned lands to allow effective deer management.

Review of Existing Deer Management Programs

Programs Outside of the Hopewell Valley

Statewide deer management is the responsibility of the New Jersey Fish and Game Council and administered by wildlife professionals of the NJDEP - Division of Fish & Wildlife. They break the state up into 49 Deer Management Zones. Each zone is provided 1 of 4 Regulation Sets that dictate harvest bag limits and timing of individual seasons within the overall hunting season. Regulation Sets are related to one of three broad deer population management goals (increase, stabilize or decrease). All zones within the Hopewell Valley have a goal of decreasing the deer population by allowing the unlimited harvesting of antlerless deer (The amount of desired decrease is not quantified by the Division).

In the last several years, the Pennsylvania Game Commission has instituted new regulations that incorporate Quality Deer Management principles. The goal of these changes is to decrease the deer population and improve overall herd and ecological health. Changes include restrictions on harvesting young bucks (less than 6 antler points) and prohibition on harvesting more than one buck throughout the entire hunting season (both of these changes are expected to indirectly increase the doe harvest to bring about population reduction). Application of these changes in the Hopewell Valley could significantly improve the chances of meeting stated goals and should be considered an important strategy for the Task Force.

The majority of counties and municipalities of New Jersey allow access for hunting. Neighboring towns with successful programs that should be explored by the Task Force include Montgomery Township (http://www.montgomery.nj.us/twpcommittee/deerhunting.asp) and Princeton Township. Some other potential models include Union County, Essex County, Hunterdon County (http://www.co.hunterdon.nj.us/hunting/instruct.htm) and Bernards Township (http://www.bernards.org/boards_commissions/deer_management/default.aspx), but many other municipal and county programs could also serve as models. The most comprehensive example of effective deer management within the region is conducted by the Fairfield County Municipal Deer Alliance (www.deeralliance.org), which should be considered a model for the Hopewell Valley. This model could be adopted in the future as a way for the Hopewell Valley to directly link with efforts in neighboring municipalities.

The majority of private land trusts in New Jersey also conduct deer management on their owned properties. Programs run by the Schiff Natural Lands Trust (See http://schiffdeermanagement.org/ for details on an exemplary program), New Jersey Audubon Society, New Jersey Conservation Society could serve as additional models to similar groups within the Hopewell Valley.

Hopewell Valley Programs

Members of the Task Force collected information via interviews with hunters and other local residents regarding the hunting status of parcels throughout the Hopewell Valley. Results of this effort are depicted in Figure 15 and summarized in Table 4. Forty-seven percent of the land area is hunted through agricultural depredation permits, deer management programs or recreational hunting. Hunting access is prohibited on 43% of the land area and unknown hunting status accounts for 10% of the area. The large amount of area without hunting access (including numerous, small residential plots and some large, public and privately owned lands) will challenge efforts to control the deer population and should inform strategies that must be employed to meet stated goals.

There are several active land managers attempting to reduce the deer population. These include Mercer County Parks, Friends of Hopewell Valley Open Space and D&R Greenway Land Trust (See www.deerinbalance.org for program details). There are also several private land programs that are utilizing Quality Deer Management principles. The use of depredation permits is minimal except for a concentration of activity in the north-central portion of the Valley. While most privately owned larger parcels are hunted recreationally, there are several key public- and corporate-owned parcels that are not hunted.

Safety Zones are also a significant issue in the Hopewell Valley (Figure 16). The cumulative area within safety zones accounts for approximately 50% of the Valley. Although some areas within safety zones are hunted with permission of land owners, many hunted parcels are effectively much less hunted because of safety zones that extend from neighboring parcels with land owners do not provide permission to hunt.

Figure 15. Hopewell Valley Parcel-level Deer Management Status

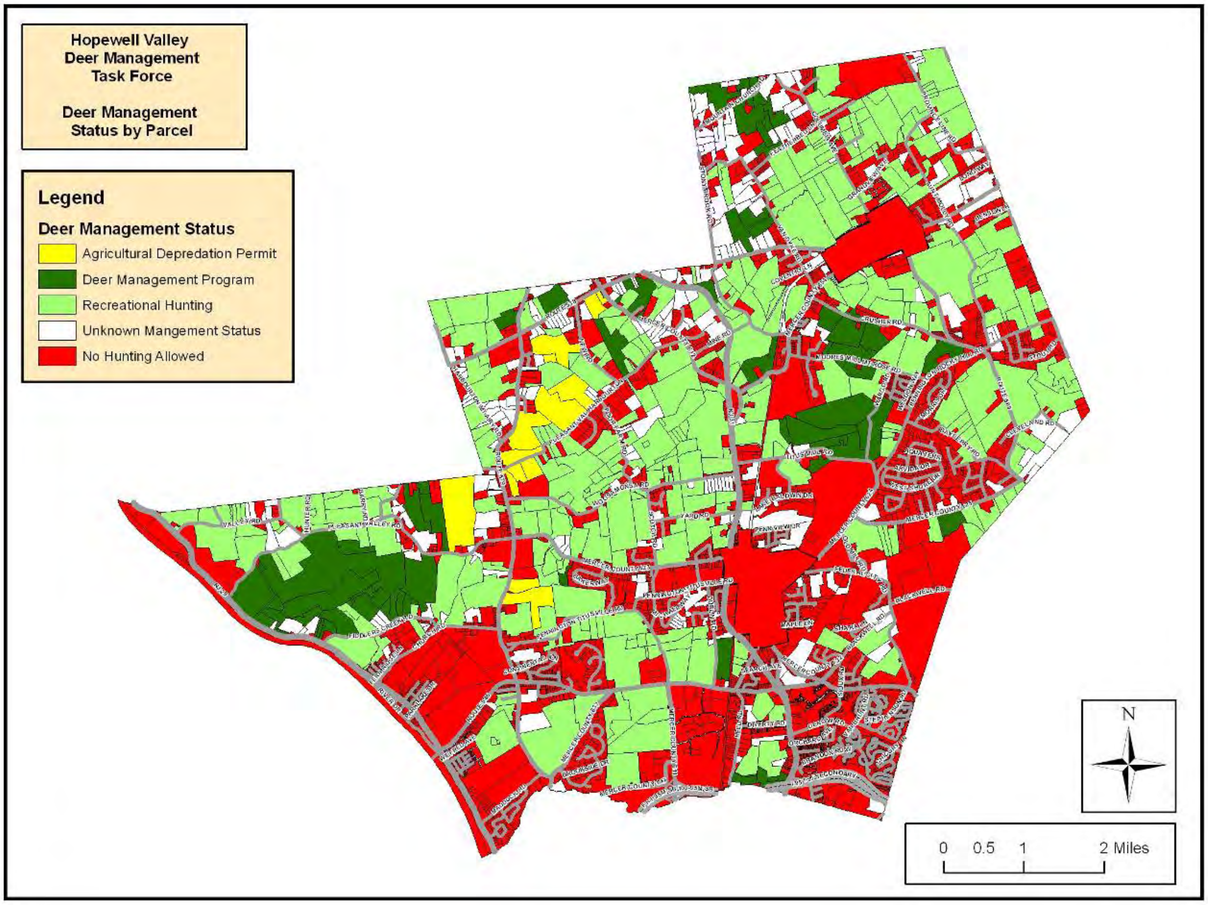
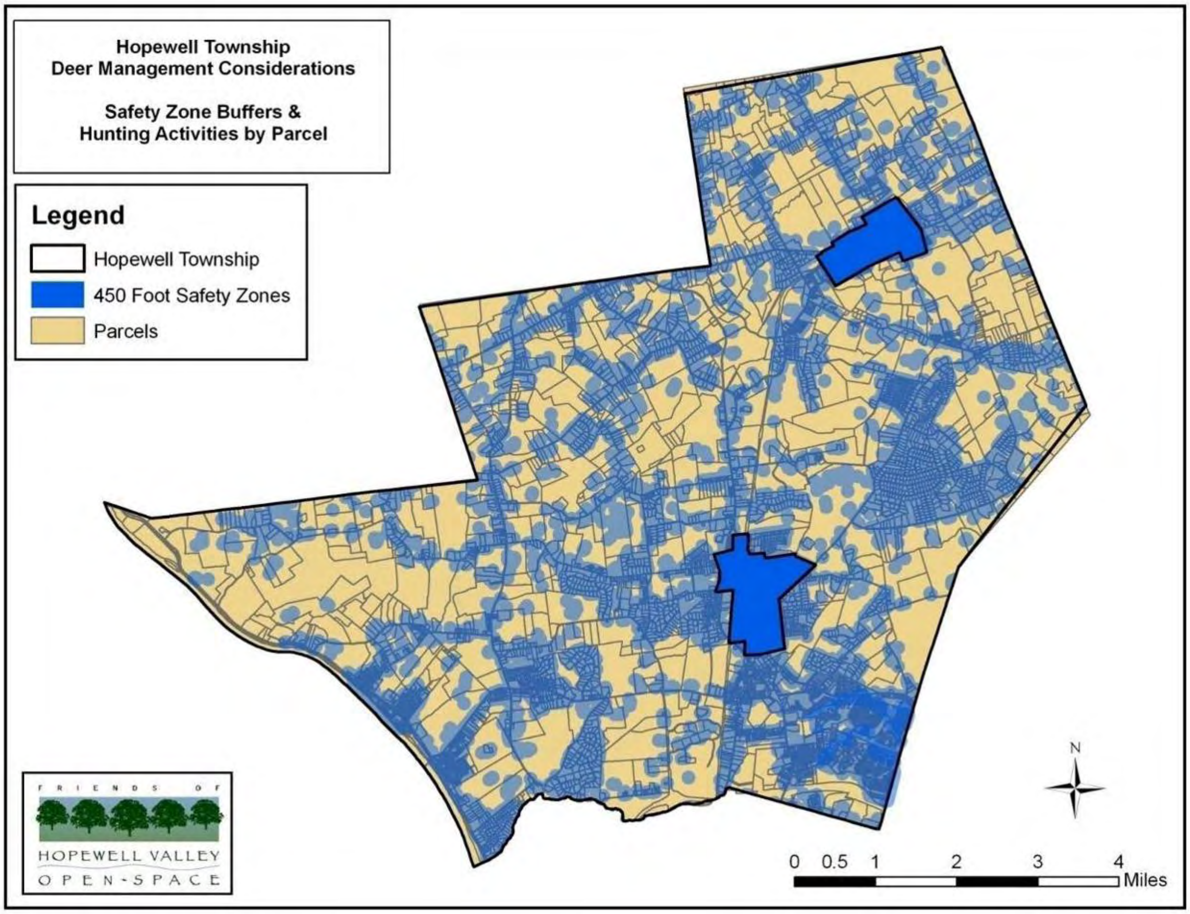


Table 4. Summary of Parcel-level Deer Management Status in the Hopewell Valley

Hunting Status	Number of Parcels	Acres	% of Hopewell Valley*
Agricultural Depredation Permit	14	929	2
Deer Management Program	76	3346	9
Recreational Hunting	335	13578	36
No Hunting Access	6968	14944	43
Unknown Hunting Access	304	3729	10
Totals	**7697**	**37601**	**100**

* Hopewell and Pennington Boroughs were assumed to have no hunting activity, but their acreage totals were considered for calculations.

Figure 16. Hopewell Valley Safety Zone Map



V. Hopewell Valley Deer Management Goals and Strategies

Introduction

The Task Force recommends a set of comprehensive goals along with specific strategies to meet stated goals (recommendations represent a consensus of Task Force members, but opinions of particular members may not be represented). All goals are quantifiable and continual reporting should be based upon three-year cycles to evaluate success. For simplicity, goals suggest a simple 25% reduction for each measurable impact over the next three years and 75% reduction within nine years. Reducing deer impacts will depend upon reducing the size of the deer population - the 2010 survey indicated an early spring population of 37 deer per square mile. An informal deer herd goal that assumes a one-to one relationship between deer numbers and stated goals would suggest a herd reduction of 25% by 2013 (28 per square mile) and a 75% reduction by 2019 (9 per square mile). However, deer impacts may not relate to impacts on a one-to-one basis (e.g., 25% reduction in deer might result in a 10% reduction in Lyme Disease, but a 75% reduction in deer could result in a 90% reduction – in either scenario a very active public education campaign might amplify the success of meeting Lyme Disease reduction goals). Therefore, success should be measured by stated impact reduction goals and not based upon measured deer population size.

The Task Force understands that financial support for this effort is difficult under existing economic conditions. Nearly all recommendations are ‘budget neutral’, but will require commitment from elected officials and municipal staff toward attainment (e.g., initiating a hunting program on Hopewell Township lands, encouraging hunting access on other public and private lands). The only recommended budget request is for $5,000 from Hopewell Valley municipalities to initiate a venison donation program.

The Task Force strongly recommends that the Township Committee assign a permanent body to facilitate goals and strategies summarized below and detailed within this plan. It is recommended that a permanent Task Force consist of no more than seven members representing various stakeholders (e.g., Township Committee liaison, Chief of Police, agricultural community, conservation community, hunting community, corporate community, and private residents of the Hopewell Valley that have related professional experience). The number of members should be an odd number for voting purposes / decision resolution and should include one non-voting member to act as secretary. The Task Force would meet periodically and have ongoing responsibility to implement strategies that achieve stated goals with assistance from Hopewell Valley municipalities and other stakeholders from public and private sectors.

For all goals and strategies, the Task Force strongly recommends a tracking system that sets an agenda with timelines for completion, quantifies progress and allows effective communication with all stakeholders. Lyme disease and deer vehicle collisions are tracked continuously through existing mechanisms by the Hopewell Township Health and Police Departments, respectively. It is recommended that public questionnaires, as performed in 2010, be repeated every three years to track landscape and agricultural impact reduction goals and overall public opinion. Ecological health is tracked annually on various private and public parcels by the Friends of Hopewell Valley Open Space – summaries of these activities should be provided to the Task Force annually and a report should be provided every three years. The tracking of the deer population should also be repeated every three years using the same seasonal timing and methodology utilized in 2010. Brief but effective tracking / reporting should also be included within each listed strategy to assure effective communication and evaluation of their effectiveness toward meeting stated goals. Specific strategy measures should be developed by Task Force members that are assigned to implementing them.

Recommended Goals

Goal #1: Reduce Lyme Disease Cases
There has been had an average of 170 reportable cases of Lyme disease from 2007-2009. The Task Force recommends a 25% reduction goal by 2013 (128 cases) and a 75% reduction goal by 2019 (43 cases).

Stafford (2007) reviewed studies exploring the link between deer / tick abundance and human cases of Lyme disease. It is suggested that deer densities lower than 8 per square mile could interrupt the life cycle of the Lyme disease organism and nearly eliminate transmission to humans. However, reductions in Lyme disease could be expected at higher deer densities – for example, there was a 90% reduction in Lyme disease at Bluff Point Coastal Preserve in Connecticut when deer densities were reduced from 200 to 30 per square mile (85% reduction).

Goal #2: Reduce Deer Vehicle Collisions
There has been an average of 567 deer-vehicle collisions from 2007-2009. The Task Force recommends a 25% reduction goal by 2013 (425 collisions) and a 75% reduction goal by 2019 (142 collisions).

Data linking deer herd reduction with reduced deer vehicle collisions is sparse. However, Princeton Township experienced a 75% reduction in deer vehicle collisions (from 342 to 85 per year) following a six-year deer management program that resulted in a 72% reduction of the deer population (from 114 to 32 deer per square mile) (DeNicola and Williams 2008).

Goal #3: Reduce Agricultural Losses
The public questionnaire results suggested that 27% of respondents had crop losses exceeding $5,000 per year. The Task Force recommends a 25% reduction goal by 2013 (20% of respondents) and a 75% reduction goal by 2019 (7% of respondents).

Agricultural losses are a significant concern in the Hopewell Valley and complete results of the public questionnaire are provided in Section III and Appendix A. There are no published guidelines linking particular deer densities with agricultural losses, but continual tracking of the above stated goal is expected to act as a proxy for the variety of deer impacts to agricultural viability in the Hopewell Valley.

Goal #4: Reduce Landscape Planting Losses
The public questionnaire results suggested that 55% of respondents had severe or moderate landscape damage. The Task Force recommends a 25% reduction goal by 2013 (41% of respondents) and a 75% reduction goal by 2019 (14% of respondents).

Landscape planting losses are a quality of life issue in the Hopewell Valley. There are no published guidelines linking particular deer densities with landscape planting losses, but continual tracking of the above stated goal is expected to act as a proxy for a range of deer-related impacts within planted landscapes.

Goal #5: Reduce Ecological Damage
Forest health has been monitored through two science-based protocols called the ‘sentinel seedlings’ (measuring deer browse on planted tree seedlings) and ‘forest secchi’ (measuring the density of forest understory vegetation). The average browse on planted tree seedlings has been 59%. The average amount of native understory vegetation was 21%. The Task Force recommends a 25% improvement by 2013 (44% browse on planted seedlings & 26% native understory cover) and a 75% improvement by 2019 (14% browse on planted seedings & 37% native understory cover).

The ultimate forest health goals using the above protocols are subjectively set at 10% seedling browse and 70% native understory cover. Additional work is planned to set forest health goals that are tied to habitat use by sensitive forest birds (i.e., Kentucky Warbler, Hooded Warbler). Reference sites for this work will be located within the Hopewell Valley and measurements will include understory cover and abundance of native herbs. This information can be used to refine forest health guidelines in the future. Literature suggests that pre-European deer densities were approximately 10 per square mile (McCabe and McCabe 1984) and modern studies suggest that densities above 10 deer per square mile are associated with degradation of forest health (deCalesta 1994).

Recommended Strategies for Goal Implementation

The Task Force recommends three sets of proposed strategies to reach stated goals: 1) Improvement of Hunting Access, 2) Improvement of Hunting Efficacy, and 3) Avoidance of Deer Impacts. Brief explanations of control options and avoidance methods are provided in Section IV.

A comprehensive review of many ecological and social issues regarding hunting is provided by McShea et al. 1997, Warren 1997, Drake 2000, and Latham et al. 2005. These documents are especially relevant to meeting ecological goals, which are the most sensitive to deer overabundance (i.e., human health and economic impact reduction goals are likely to be met prior to reaching ecological goals). Quality Deer Management (QDM) is a critical, overarching concept with associated strategies that are necessary to meet all stated goals within the context of recreational hunter satisfaction, which will be required to avoid the need to hire costly professional deer managers. Adherence to QDM principles by Hopewell Valley hunters would result in a smaller, healthier herd featuring large bucks. Multiple documents published by the Quality Deer Management Association (www.qdma.com) explore QDM and should be reviewed by those implementing this plan.

Based upon the 2010 Hopewell Valley deer survey, population growth scenarios were estimated by using a methodology established by Duke Farms in Hillsborough Township (T. Almendinger, personal communication). This method is periodically vetted by wildlife biologists including A. DeNicola of White Buffalo, Inc. and L. Wolgast of the NJ Fish & Game Council. The measured deer density in Hopewell Valley was 37 deer per square mile (total population size approximately 2,300 deer). Based upon population growth calculations, the post-birthing deer density is 54 per square mile (approximately 3,400 deer). A 25% and 75% population reduction goal would result in post-winter deer densities of 28 and 9 deer per square mile, respectively. This is equivalent to deer populations of 1,750 and 560 deer throughout the Hopewell Valley (post-birthing / pre-hunting season deer populations would be approximately 2,600 and 830, respectively). Recent statewide deer population reduction was associated with harvesting greater than 40% of the deer population with greater than 60% of the harvest being antlerless deer (See Figure 2). In order to achieve stated goals within the defined timeframes, Hopewell Valley harvests must exceed these figures. The Task Force should devise annual harvest goals necessary to meet stated goals in consultation with wildlife biologists (e.g., NJ Division of Fish & Wildlife or other wildlife professionals).

Strategy Set #1: Improvement of Hunting Access

1A) Encourage and facilitate hunting access on public and private lands

There are several large public and corporate properties that do not allow hunting access or have limited hunting access. The Task Force, supported by municipal officials and staff, should conduct outreach to support deer management programs on these parcels and any parcels (including private lands) that do not allow hunting access (See Figure 15).

Hopewell Township owns approximately 200 acres of open space that require hunting access to help meet stated goals. Deer Management Programs utilized by other Hopewell Valley land managers, including Mercer County, Friends of Hopewell Valley Open Space, and D&R Greenway Land Trust should be considered models for a program implemented by Hopewell Township (See Section IV). Ideally, Hopewell Township should develop and implement deer management programs on their owned lands as soon as possible to serve as an example for other land owners that do not currently have hunting access.

A possible strategy to pursue is participation from the Hopewell Township Police Department, which could conduct training (e.g., review firearm regulations, test shooting accuracy for bow and firearms) and provide background checks (e.g., verify license, safety record) for interested hunters that could participate in deer management programs on both public and private lands. This effort could ease concerns of neighbors / residents that are hesitant about hunting near or on their properties and provide structure to the program. The cost of such a program would be approximately $500 per training event to pay for police officer overtime (G. Meyer, personal communication) and costs would be assumed by hunters participating in the program (e.g., 25 hunters pay $20 each). A similar program has been utilized in Fairfield County, Connecticut (www.deeralliance.org) to match hunters with prospective property owners and Mendham Township, New Jersey. At a minimum, hunters that may manage deer on Hopewell Township properties could be required to participate in the program.

1B) <u>Develop strategies to access "pocket deer" in residential areas</u>

One of the more challenging aspects of deer management in the Hopewell Valley will be obtaining access to "pocket" or "yard" deer. Some municipalities have utilized contracted professionals under special state permits to reduce deer populations where typical recreational hunting is not feasible (e.g., Princeton Township, Millburn Township). These methods can be expensive and should not be considered the first option in Hopewell Valley. The expected passage of legislation that will increase hunting land near structures may ease this problem (bow hunting will be allowed within 150 feet as opposed to the previous 450 feet safety zone that will continue to apply to firearm hunting). Additionally, lands accessible to hunters that are adjacent to residential developments may consider cooperative efforts to either 'push' (i.e., coordinated deer drives) or 'pull' (i.e., baiting strategies) deer from areas inaccessible to hunting (Strategy Set #2). If these efforts appear inadequate, then municipalities of the Hopewell Valley should consider hiring professional contractors to reduce the deer herd in order to meet stated goals.

Strategy Set #2: Improvement of Hunting Efficacy

2A) <u>Encourage and facilitate coordinated hunting activities among neighboring landowners</u>

The 'pushing' of deer from one parcel to another is a perennial problem in Hopewell Valley. This occurs when one parcel is hunted, but a neighboring parcel does not allow hunting access. It also occurs when hunting occurs at different times on two adjacent parcels that are both hunted. Coordination is critical to meeting stated goals. Land owners that do not allow hunting should be approached by the Task Force and asked to consider hunting access that is coordinated with neighboring parcels. If hunting access is still not acceptable, then the land owners could be asked whether they would allow hunters without weapons to drive deer onto neighboring parcels that allow hunting access. When adjacent parcels both have hunting access, the respective hunters could consider hunting simultaneously – this would increase deer movements and potentially increase harvest numbers for all hunters.

The use of coordinated drives toward strategic culling locations should be developed at multiple locations throughout the Hopewell Valley. Drives could be conducted by individuals passing Hopewell Township Police Department safety training (see above) and be registered for each particular drive before it is initiated. Drive 'teams' should provide a written plan including a map and date/time that drives will occur. The map should include an indication of safety zones (or have written permission from appropriate landowners if conducted within safety zones).

The strategic use of baiting and deer food plots could also be considered as a means of pulling deer off of lands that are not hunted and/or concentrating deer in areas where they can be hunted. As with coordinated deer drives, spatially explicit planning among local hunters will be critical to success of this effort. The Task Force should facilitate both coordination and baiting/food plot among local hunters. As necessary, consultations with wildlife biologists should also be considered.

2B) Encourage and facilitate use of Agricultural Depredation Permits by farmers

The use of agricultural depredation permits should be increased in Hopewell Valley (See Appendix A – Public Questionnaire questions 10F, 10G & 10H). Although it is unclear why use of depredation permits is not more extensive, reasons may include lack of permission on leased farmlands and issues with nuisance complaints from neighbors because of off-season gunfire. Other factors such as use of deer exclosure fencing or crop type (e.g., hay isn't generally over browsed by deer) may also have a bearing the use of depredation permits. A more extensive utilization of this permit can be beneficial toward reducing the deer population in the Hopewell Valley. The Task Force, supported by municipal officials and staff, should work with the agricultural community to increase the use of Agricultural Depredation Permits.

2C) Encourage and facilitate Deer Management Programs that focus harvests on female deer

Deer Management Programs (DMP) are utilized locally by Mercer County Parks, D&R Greenway Land Trust and Friends of Hopewell Valley Open Space (See http://deerinbalance.org/deer-management-program-resources/). The implementation of DMP's by all land managers / property owners that provide access to hunters would significantly reduce the Hopewell Valley deer population. The incorporation of Quality Deer Management (QDM) principles into DMP's should be encouraged to produce a healthier herd structure in addition to reducing the overall herd size. The Task Force should provide outreach to public and private land owners that allow hunting access to increase the use of DMP's containing QDM principles.

2D) Encourage and facilitate program for venison donation to local food banks

The Task Force should assist with a creation of a Hopewell Valley venison donation program. This would include transportation, processing and distribution with a network of hunters, butchers, and food banks. Hopewell Valley hunters that responded to the public questionnaire cited a lack of outlets for venison restricted their harvesting of deer (See Appendix A – Question 9b). The Task Force recommends that Hopewell Valley municipalities contribute $5,000 annually to the program. This amount would accommodate the donation of approximately 50 deer, which translates to 5,000 pounds of venison or 20,000 meals. The Task Force should seek additional contributions from the public and private sector to enhance the program once the program is established with a recurring annual contribution from the municipalities.

A partnership could be formed with Hunters Helping the Hungry (HHH) - www.huntershelpingthehungry.org. HHH is a non-profit organization that facilitates venison donations. In 2009, HHH was able to process 15,000 pounds of venison (ca. 60,000 meals) utilizing $15,000 of funding (ca. $1 per pound of venison). Jack Chellew and John Person are HHH contacts.

The Task Force (via Morton Rosenthal) has conducted research toward establishing a relationship with local food banks, butchers and HHH. The closest food bank to the Hopewell Valley is the Trenton Soup

Kitchen (Denis Micai, CEO). The butcher that that provides meat to the Trenton Soup Kitchen is City Beef. Unfortunately, USDA regulations do not allow City Beef to process game in the same building as agriculturally-produced meats and they would be unable to participate in any future program. [Note: Butchers of venison must meet the following standards: 1) Walk-in cooler with temperatures of 38 degrees or lower, 2) Two tracks or other ways to segregate venison from other meats, 3) Freezer that is at zero degrees, and 4) Pass sanitary inspections by State Board of Health.] HHH lists eight participating butchers in New Jersey. The closest participating butcher is John Person, located on State Highway 31 South in Lebanon, NJ (ca. 30 minutes north of Hopewell Valley). Mr. Person is capable of processing venison that could be supplied to the Trenton Soup Kitchen.

An additional avenue to explore might involve coordination of private landowners and hunters. Research should be conducted to determine the feasibility of allowing private residents that would like to consume venison and hunters that might otherwise limit their hunting activity because they do not have an outlet for harvested deer. As an example, private residents might pay for butchering costs and keep processed venison that a hunter drops off with a participating butcher. The Task Force should work with the Fish & Game Council and Division of Fish & Wildlife to determine whether this strategy is acceptable under current game code and explore options toward modifying the code to allow this strategy in the future.

2E) <u>Consult with the NJ Division of Fish & Wildlife to conduct strategies listed above</u>

The Fish and Game Council and NJ Division of Fish & Wildlife are critical partners in all efforts regarding deer management. Their Community Based Deer Management Program (CBDMP) can allow strategies such as season extensions in particular high deer density areas to increase harvests and special rules to access pocket deer.

A request for changes to the game code for Deer Management Zones in the Hopewell Valley that facilitate Quality Deer Management is seen as critical toward attainment of all stated goals. The Task Force, along with interested Hopewell Valley hunters, has begun to discuss QDM concepts and plan to approach the Division of Fish & Wildlife in fall 2010. Potential changes could include requirements for antlerless deer harvest through licensing incentives and restrictions on buck harvests (e.g., allowance of only one buck per hunter per year, prohibiting the harvest of bucks with less than 6 antler points).

Strategy Set #3: Avoidance of Deer Impacts

3A) <u>Improve awareness of methods that reduce Deer Vehicle Collisions</u>

Research on road-related countermeasures does not suggest any effective methods that could be utilized in the Hopewell Valley. However, increased outreach via public service announcements or other methods should be conducted during the fall to coincide with the deer breeding season when animal movement is generally at its peak and deer vehicle collisions are most likely to occur. For example, electronic traffic message boards can be placed along roadways with the highest risk for collisions during the fall deer mating season. The Task Force should work with Hopewell Valley municipalities to increase outreach and education about deer vehicle collisions.

3B) <u>Improve awareness of methods that reduce Lyme disease</u>

There are multiple strategies that can be carried out by individuals to reduce their risk of contracting the disease. Awareness of ticks and the need to search for ticks following likely exposure activities is critical. The use of repellents, wearing socks over the bottom of pants, wearing of light clothing to detect ticks, etc. are all useful prevention strategies. The Task Force should work with Hopewell Valley municipalities to increase outreach and education about Lyme disease prevention.

3C) Improve awareness of methods that reduce landscape damage

There are a variety of techniques that can be attempted to reduce landscape damage. Options include the use of fencing, repellents and deer resistant plants. In general, fencing can be expensive for significant areas, but low-cost options could be utilized by most residents in defined areas such as vegetable gardens (residents of the Hopewell Valley should consult with their local zoning officer regarding restrictions on fencing height and placement). Repellents were utilized by 60% of public questionnaire respondents, but evaluation of their effectiveness was not explored. There are a wide variety of repellants and cost and effectiveness can vary widely. Deer resistant plants can significantly reduce browse damage, but deer often browse reportedly resistant plants. Lists of deer resistant plants can be found in various websites; however, the use of invasive species that damage natural areas should not be considered viable alternatives to more palatable species. The Task Force should work with the Mercer County Master Gardeners and local garden clubs to provide outreach and education to reduce landscape damage.

3D) Discourage the intentional feeding of deer in non-hunting situations

In addition to the unintentional feeding of deer through landscape plantings and agricultural crops, approximately 4% of questionnaire respondents actively feed deer at their homes. The public questionnaire reported that 65% of respondents would favor a law banning the intentional feeding of deer. However, the Task Force considers enforcement of such a ban to be impractical and instead favors outreach to discourage the intentional feeding of deer in non-hunting situations.

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Appendix A. Public Questionnaire Results – Tabular

Total Number of Respondents: 575

Tracking Number	Main Question and Follow-Up Questions	Response Percentage	Response Number
1	**1. Where do you live?**	**99.0**	**569**
1a	Hopewell Township	74.3	423
1b	Hopewell Borough	6.7	38
1c	Pennington Borough	19.0	108
1-open	Name the closest road intersection	N/A	N/A
2	**2. Has a physician diagnosed you or anyone in your household with Lyme Disease within past three years?**	**100.0**	**575**
2a	No	73.6	423
2b	Yes	26.4	152
3	**3. Have you or someone in household been involved in deer/car collision within past 3 yrs in Hopewell Valley?**	**94.3**	**542**
3a	No	72.0	390
3b	Yes	28.0	152
4	**3. Follow-Up A: Was the collision serious enough that it was reported to the police?**	**30.4**	**175**
4a	No	57.7	101
4b	Yes	42.3	74
5	**3. Follow-Up B: Was any collision serious enought to require hospitalization or visit to a doctor's office?**	**29.7**	**171**
5a	No	94.2	161
5b	Yes	5.8	10
6	**4. Do you experience damage to your landscaping?**	**99.3**	**571**
6a	No Damage	15.4	88
6b	Minor Damage	29.4	168
6c	Moderate Damage	30.8	176
6d	Severe Damage	24.3	139
7	**4. Follow-Up A: Do you use fencing or other repellents to protect your landscaping?**	**99.3**	**571**
7a	No	40.1	229
7b	Yes	59.9	342
8	**5. Have deer created a problem with your bird feeder?**	**99.0**	**569**
8a	No	53.4	304
8b	Yes	16.7	95
8c	Don't have feeders	29.9	170
9	**6. Do you feed the deer with corn or any other supplements?**	**99.5**	**572**
9a	No	95.8	548
9b	Yes	4.2	24

Appendix A. Public Questionnaire Results – Tabular

Total Number of Respondents: 575

Tracking Number	Main Question and Follow-Up Questions	Response Percentage	Response Number
10	**7. Would you support a new law banning residents from feeding deer in Hopewell Valley?**	**99.3**	**571**
10a	No	14.7	84
10b	Yes	64.8	370
10c	Not Sure	20.5	117
11	**8. Which statement best fits your attitude towards our local white-tailed deer population?**	**98.3**	**565**
11a	Deer do not cause any problems in Hopewell Valley	4.8	27
11b	Deer cause some problems, but not enough to worry about	24.6	139
11c	Deer cause many problems and solutions are needed	70.6	399
	HUNTER-RELATED QUESTIONS		
12	**9. Does anyone in your household hunt deer?**	**94.8**	**545**
12a	No --> SKIP TO Q. 10	89.5	488
12b	Yes	10.5	57
13	**9. Follow-Up A: How many *Hopewell Valley* deer are usually taken by hunters in your household each year? (Open Question)**	**9.7**	**56**
13a	0	26.8	15
13b	1	16.1	9
13c	2	16.1	9
13d	3	16.1	9
13e	4	5.4	3
13d	>4	19.6	11
14	**9. Follow-Up B: What factors might lead hunters in your household to take more deer in HV (Check all that apply)? (Three response choices in bold were provided, but results of all combinations are reported below.)**	**12.5**	**72**
14a	**Butcher available who would donate the venison to local food banks**	18.1	13
14b	**More time available for hunting in Hopewell Valley**	9.7	7
14c	**More places to hunt in Hopewell Valley, including public land**	22.2	16
14d	Two choices selected - more places and more time to hunt	5.6	4
14e	Two choices selected - donation availability and more places to hunt	12.5	9
14f	Two choices selected - donation availability and more time to hunt	1.4	1
14g	Three choices selected - donation availability and more time to hunt and more places to hunt	30.6	22

Appendix A. Public Questionnaire Results – Tabular

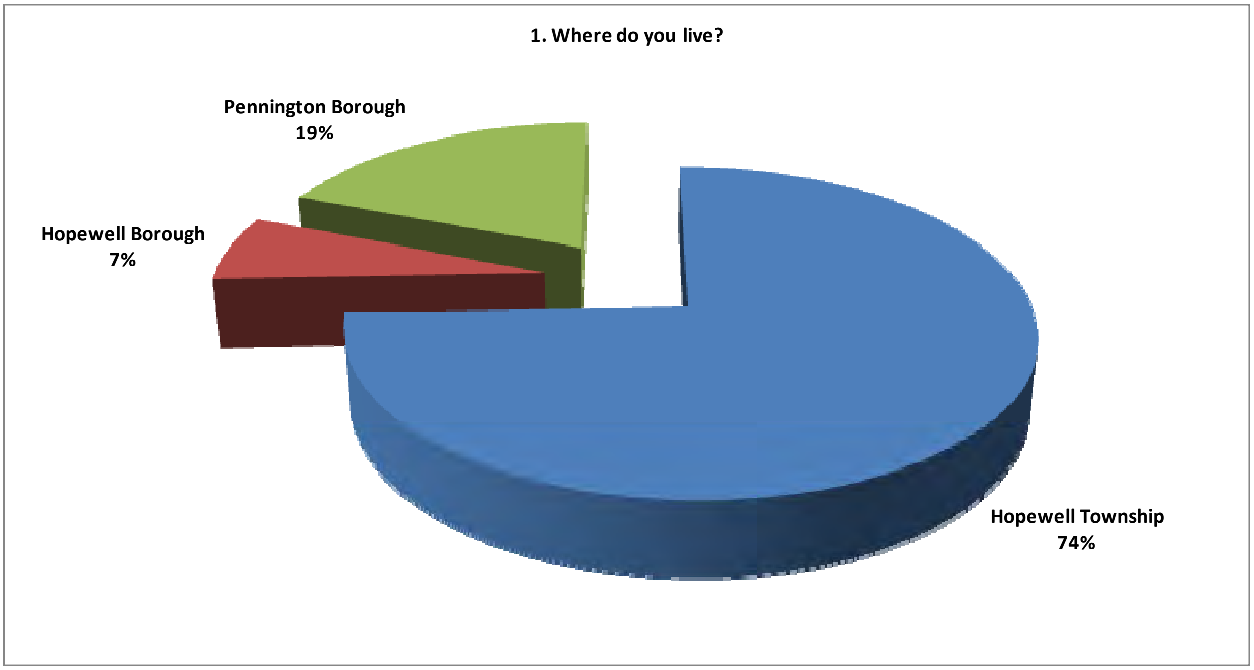
Total Number of Respondents: 575

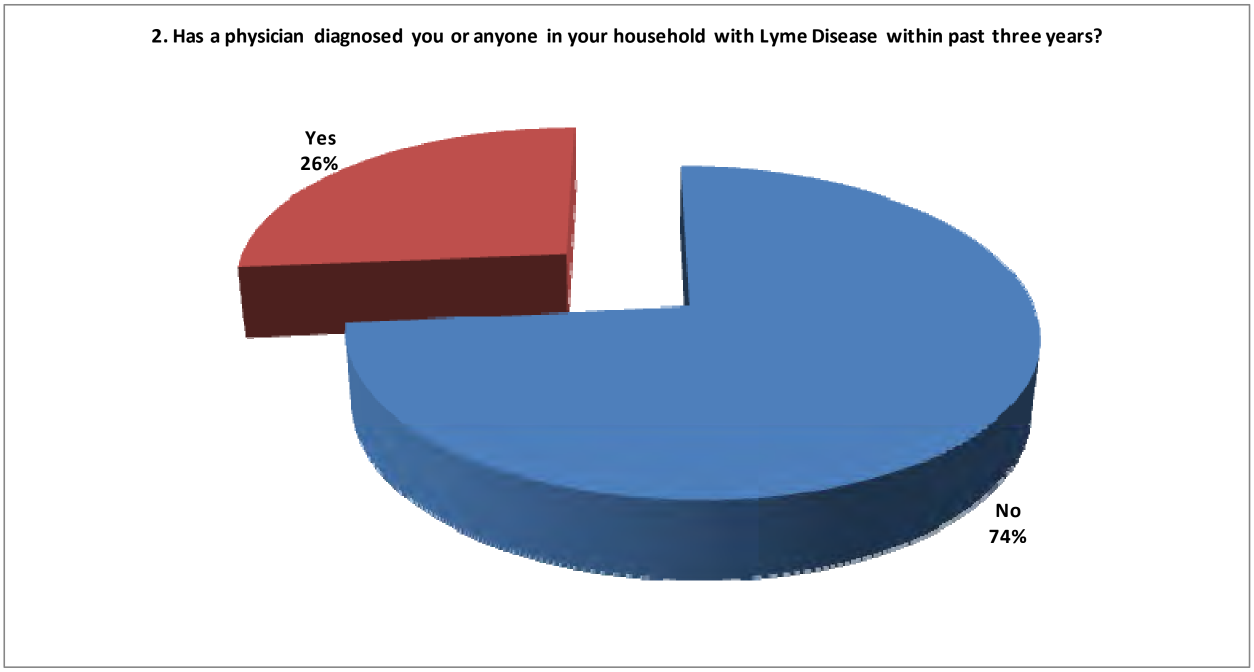
Tracking Number	Main Question and Follow-Up Questions	Response Percentage	Response Number
	FARMER-RELATED QUESTIONS		
15	**10. Has anyone in your household ever been a full or part-time farmer in Hopewell Valley?**	**89.9**	**517**
15a	No, STOP HERE	88.4	457
15b	Yes, still farming	7.5	39
15c	Yes, but stopped because of deer predation	1.2	6
15d	Yes, but stopped for other reasons	2.9	15
16	**10. Follow-Up A: Has anyone in your household experienced crop losses due to deer predation in last the last three years?**	**9.7**	**56**
16a	No	48.2	27
16b	Yes	51.8	29
17	**10. Follow-Up B: Please estimate your average yearly crop losses over the past three years due to deer damage:**	**4.5**	**26**
17a	Less than $5,000	73.1	19
17b	$5,000 - $25,000	19.2	5
17c	$25,000 - $50,000	3.8	1
17d	Over $50,000	3.8	1
18	**10. Follow-Up C: Are there any crops that you stopped planting due to actual or feared deer damage?**	**4.7**	**27**
18a	No	63.0	17
18b	Yes --> Please specify (See below)	25.9	7
18c	Yes, Corn	3.7	1
18d	Yes, Perenials and annuals	3.7	1
18e	Yes, Oak trees	3.7	1
19	**10. Follow-Up D: Have you planted sacrifical crops for deer to protect your cash crops?**	**7.0**	**40**
19a	No	92.5	37
19b	Yes	7.5	3
20	**10. Follow-Up to 10D: How many acres?**	**0.3**	**2**
20-open-a	Three	50.0	1
20-open-b	Eight	50.0	1
21	**10. Follow-Up E: Have you incurred other deer-related expenses, such as increased fencing costs?**	**7.1**	**41**
21a	No	48.8	20
21b	Yes --> Approximate cost over 3 years (See below)	51.2	21

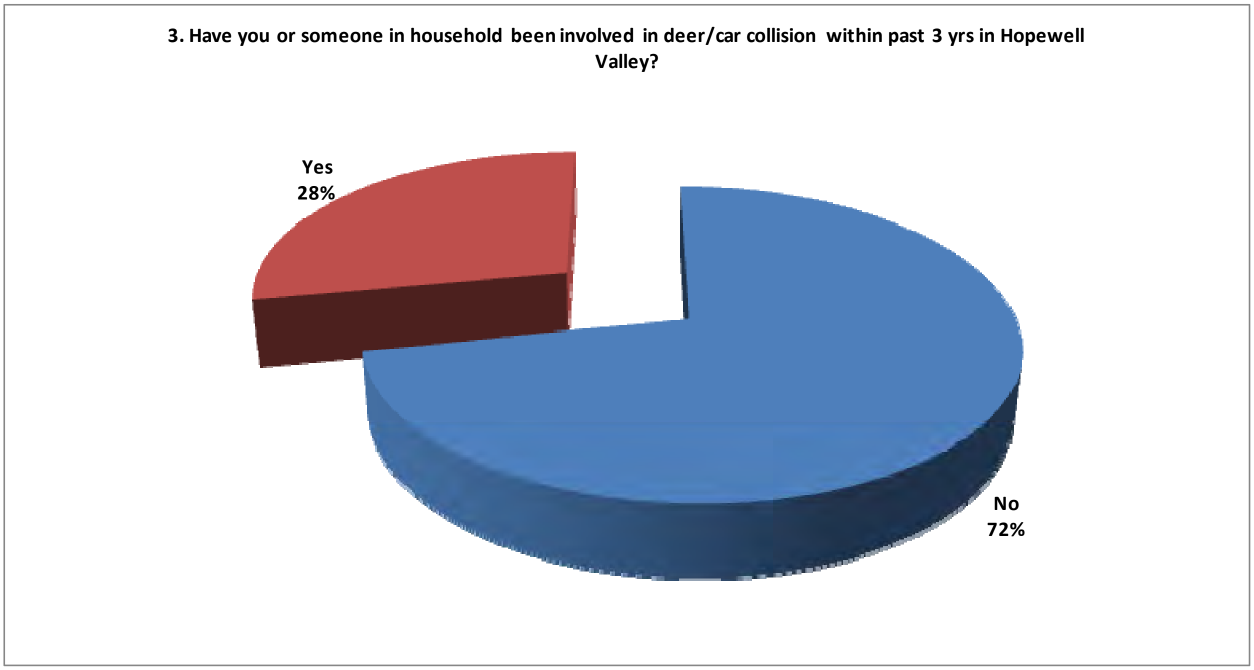
Appendix A. Public Questionnaire Results – Tabular

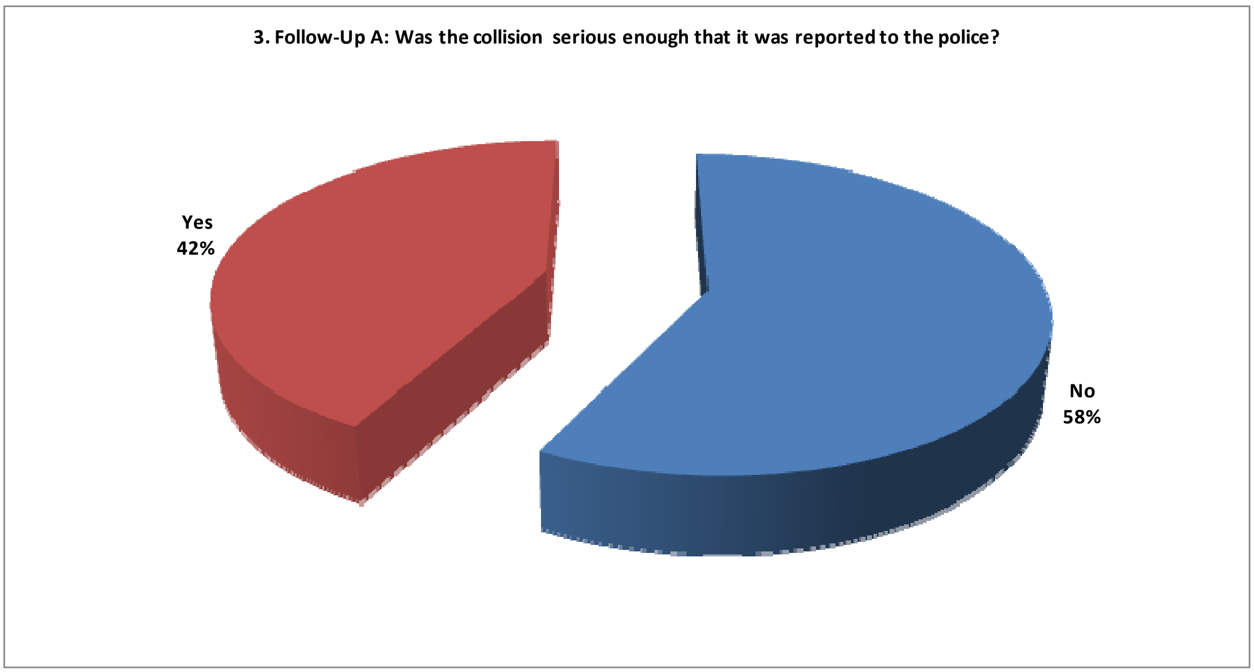
Total Number of Respondents: 575

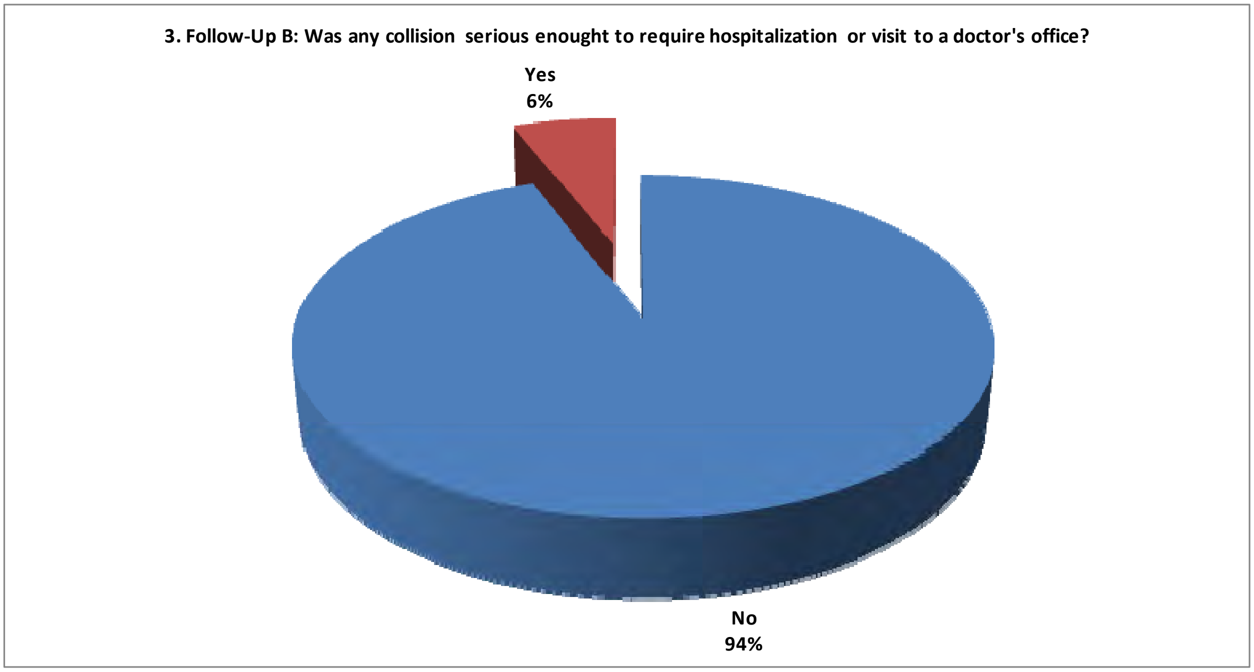
Tracking Number	Main Question and Follow-Up Questions	Response Percentage	Response Number
22	**10. Follow-Up to 10E: Approximate costs over 3 years**	**1.0**	**6**
22a	Less than $1000	100.0	6
22b	Between $1000 and $5000	0.0	0
23	**10. Follow-Up F: Do you allow hunting on your owned farmland?**	**9.4**	**54**
23a	No	37.0	20
23b	Yes	51.9	28
23c	Do not own any land	11.1	6
24	**10. Follow-Up G: Is hunting allowed by the owners of any land you lease for farming?**	**8.3**	**48**
24a	I don't lease any land	70.8	34
24b	No, hunting is not allowed on any of the land I lease	18.8	9
24c	Yes, hunting is allowed on some of the land I lease	4.2	2
24d	Yes, hunting is allowed on all of the land I lease	6.3	3
25	**10. Follow-Up H: Do you use an agricultural depredation permit?**	**8.2**	**47**
25a	No	83.0	39
25b	Yes (owned farmland)	14.9	7
25c	Yes (all leased farmland)	0.0	0
25d	Yes (some leased farmland)	2.1	1

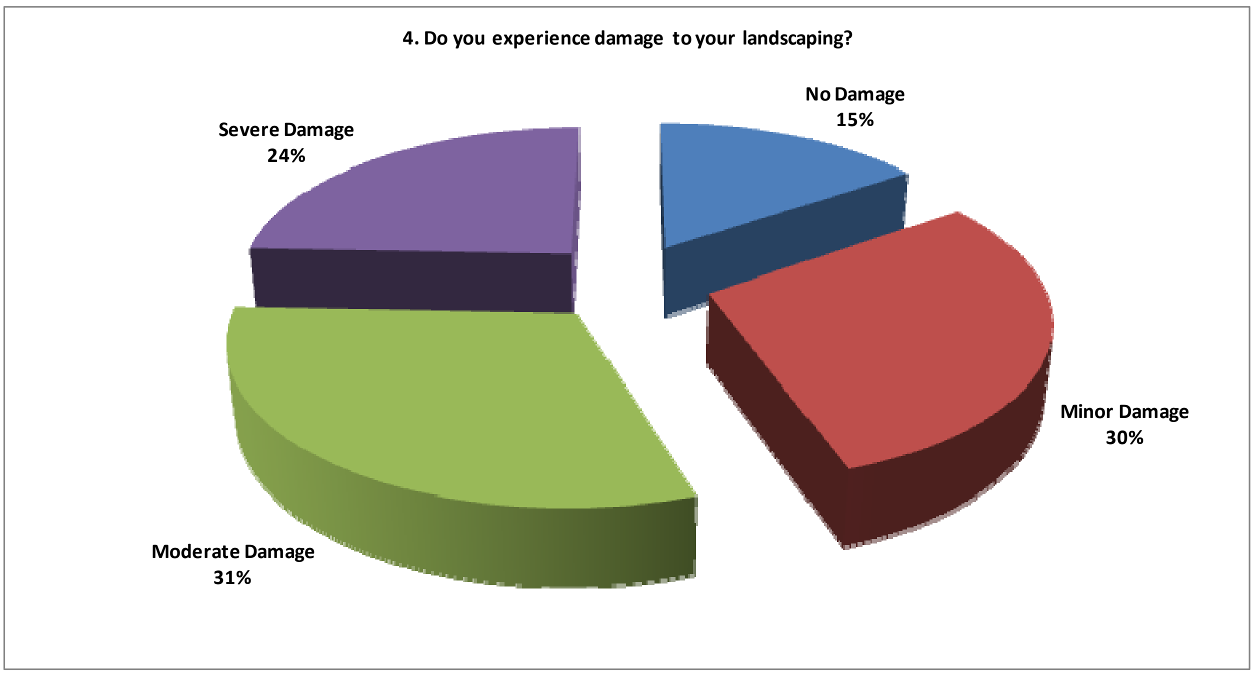

1. Where do you live?
Pennington Borough
19%
Hopewell Borough
7%
Hopewell Township
74%

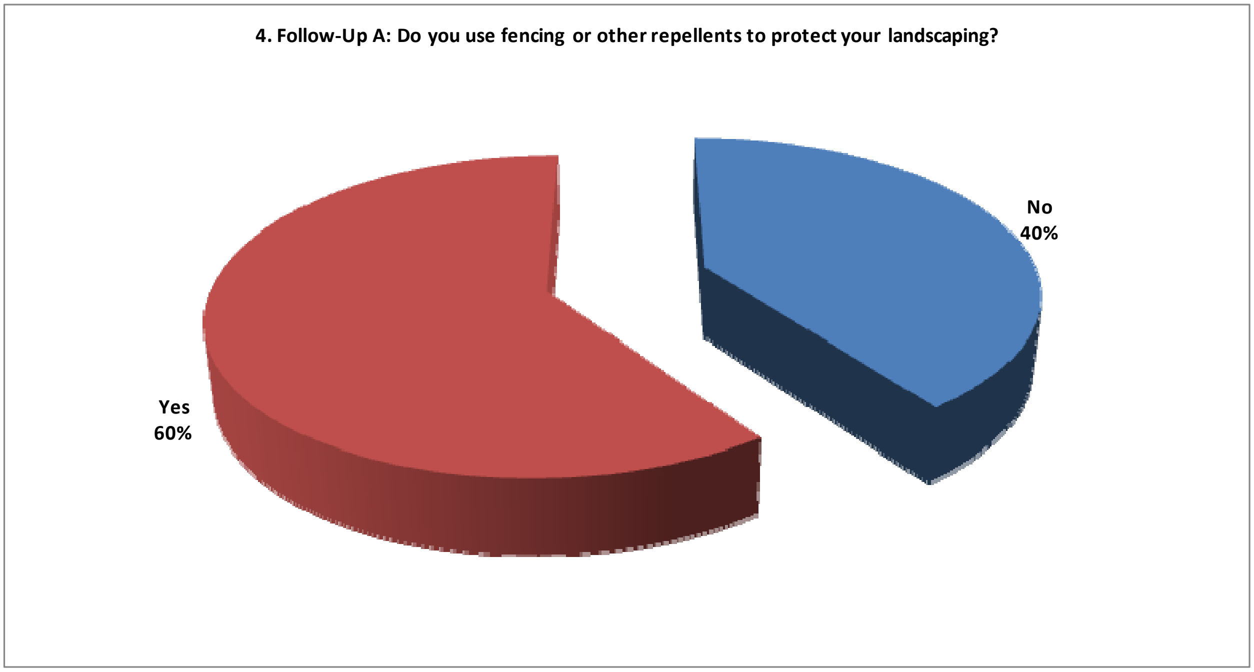

2. Has a physician diagnosed you or anyone in your household with Lyme Disease within past three years?
Yes
26%
No
74%

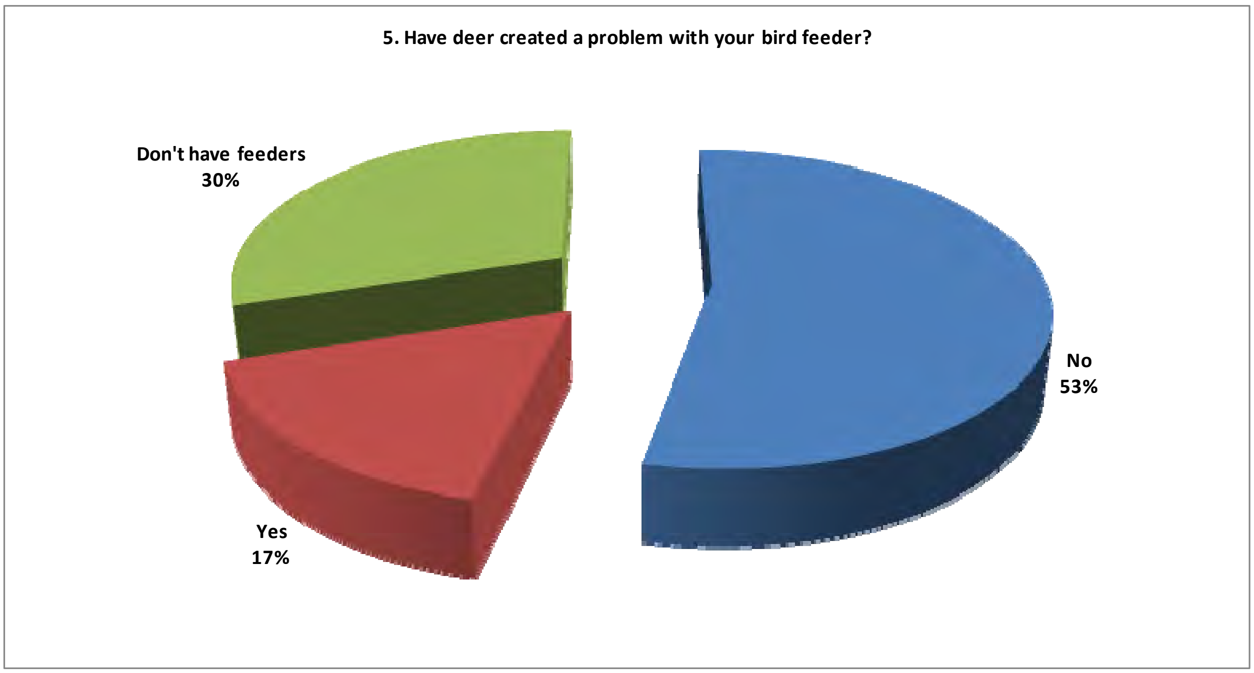

3. Have you or someone in household been involved in deer/car collision within past 3 yrs in Hopewell Valley?
Yes
28%
No
72%

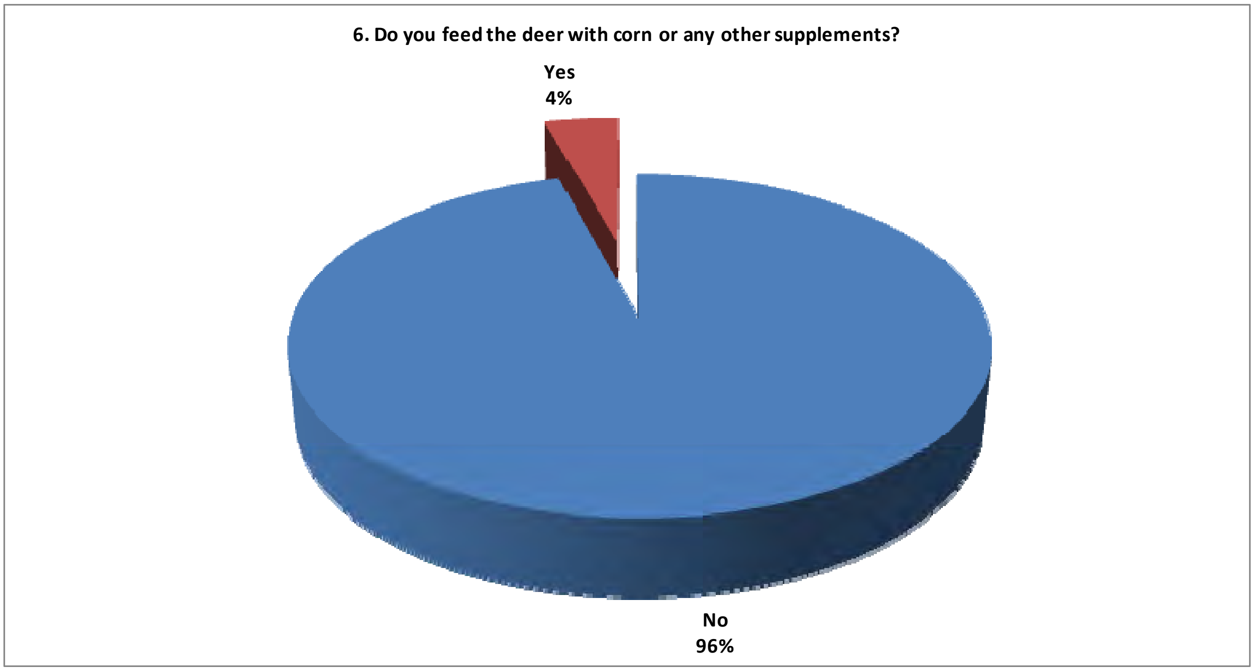

3. Follow-Up A: Was the collision serious enough that it was reported to the police?
Yes
42%
No
58%

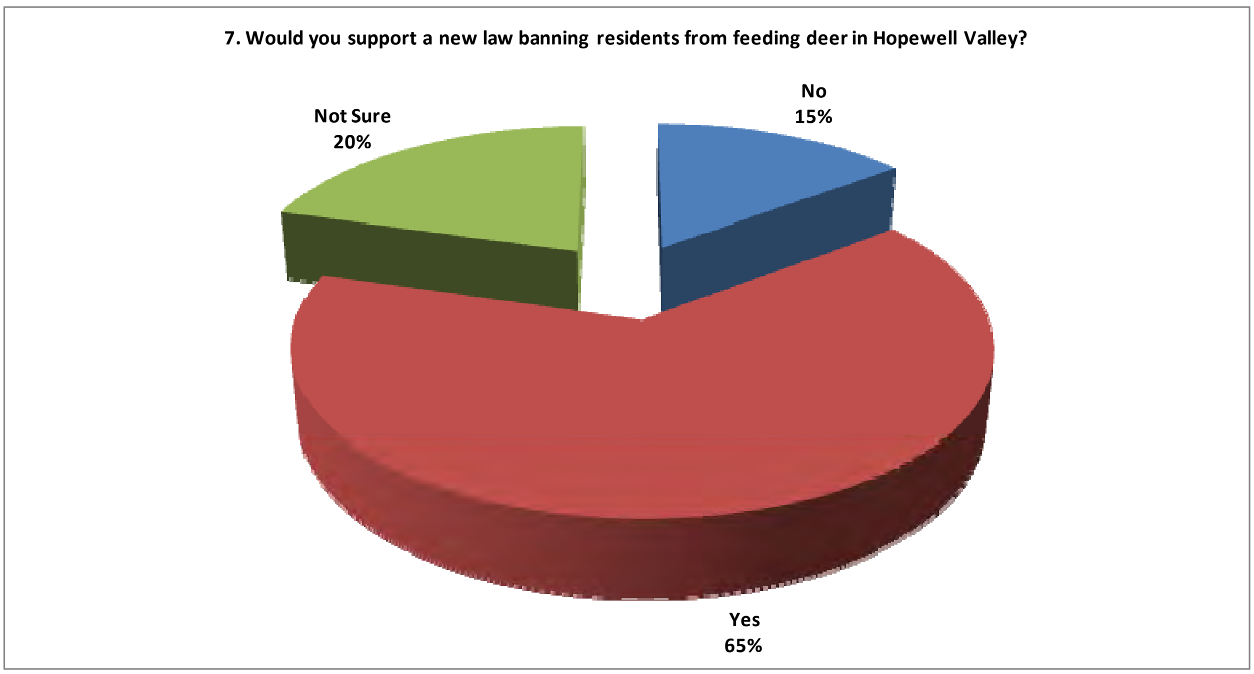

3. Follow-Up B: Was any collision serious enought to require hospitalization or visit to a doctor's office?
Yes
6%
No
94%

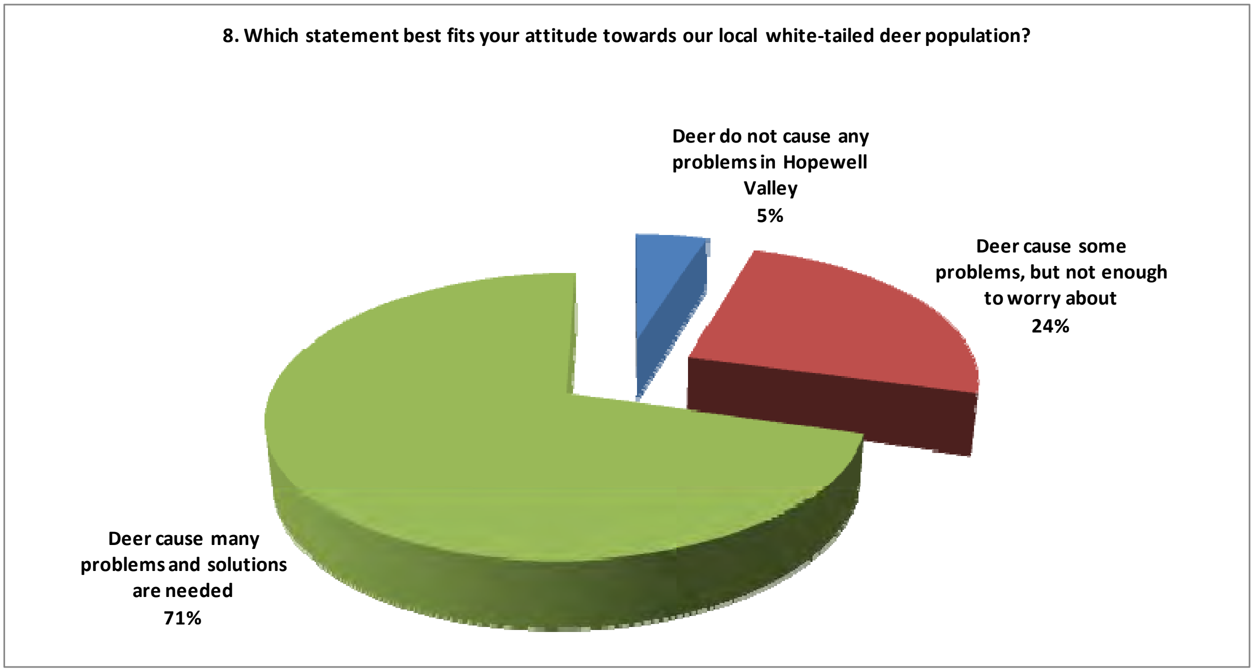

4. Do you experience damage to your landscaping?
Severe Damage
24%
No Damage
15%
Minor Damage
30%
Moderate Damage
31%

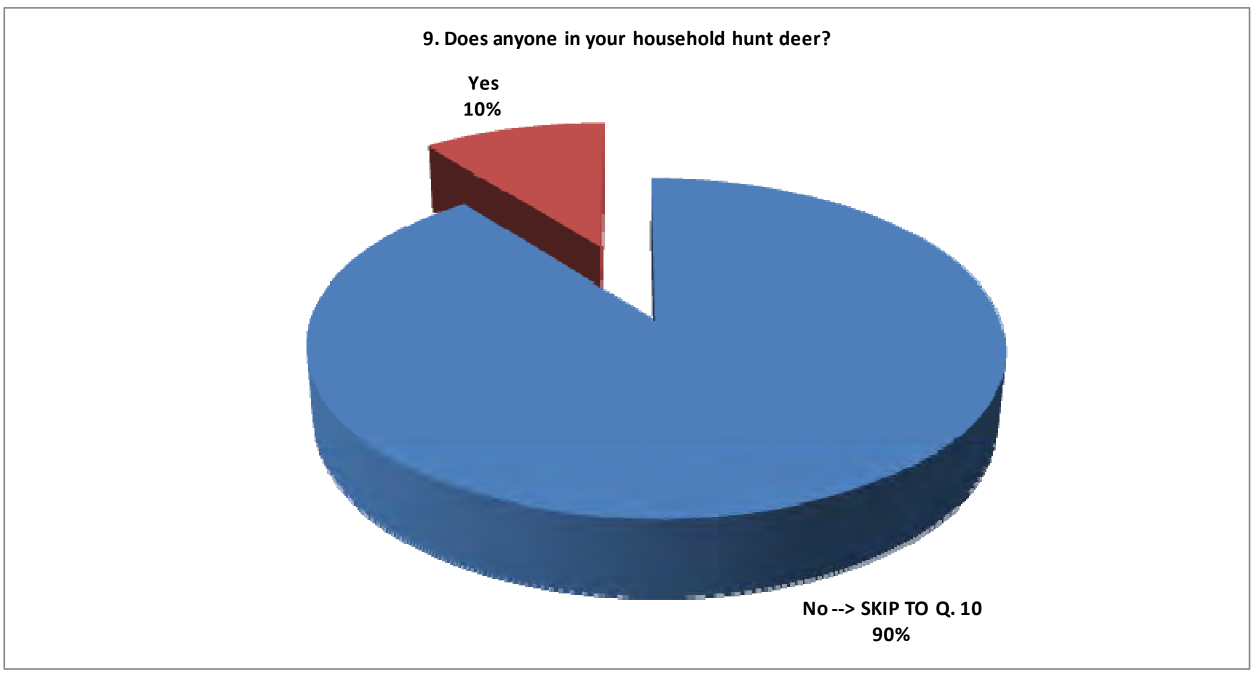

4. Follow-Up A: Do you use fencing or other repellents to protect your landscaping?
No
40%
Yes
60%


5. Have deer created a problem with your bird feeder?
Don't have feeders
30%
No
53%
Yes
17%

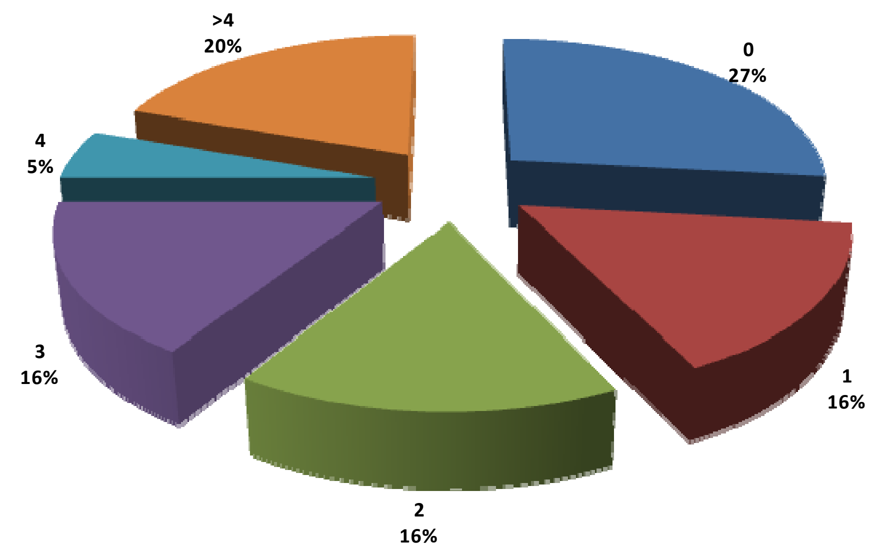

6. Do you feed the deer with corn or any other supplements?
Yes
4%
No
96%


7. Would you support a new law banning residents from feeding deer in Hopewell Valley?
No
15%
Not Sure
20%
Yes
65%

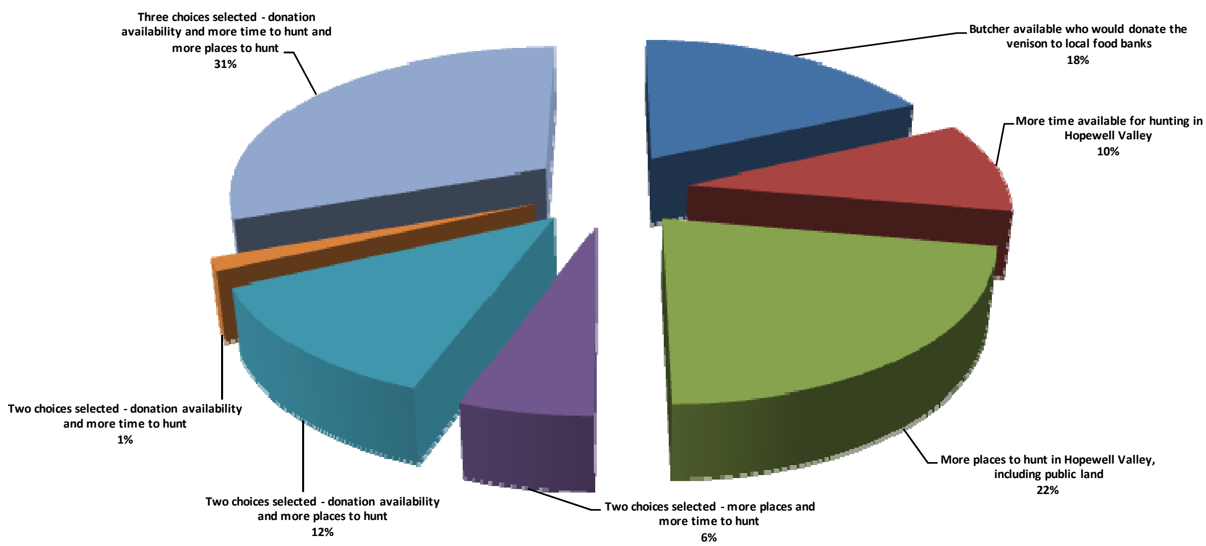

8. Which statement best fits your attitude towards our local white-tailed deer population?
Deer do not cause any problems in Hopewell Valley
5%
Deer cause some problems, but not enough to worry about
24%
Deer cause many problems and solutions are needed
71%

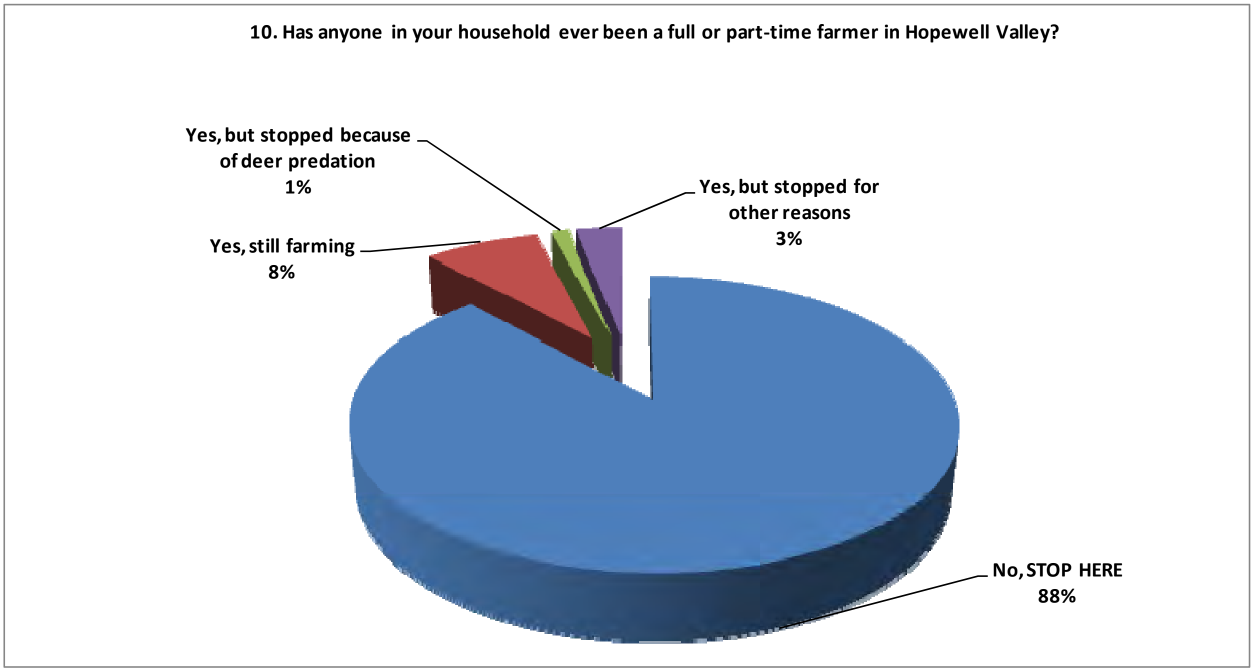

9. Does anyone in your household hunt deer?
Yes
10%
No --> SKIP TO Q. 10
90%

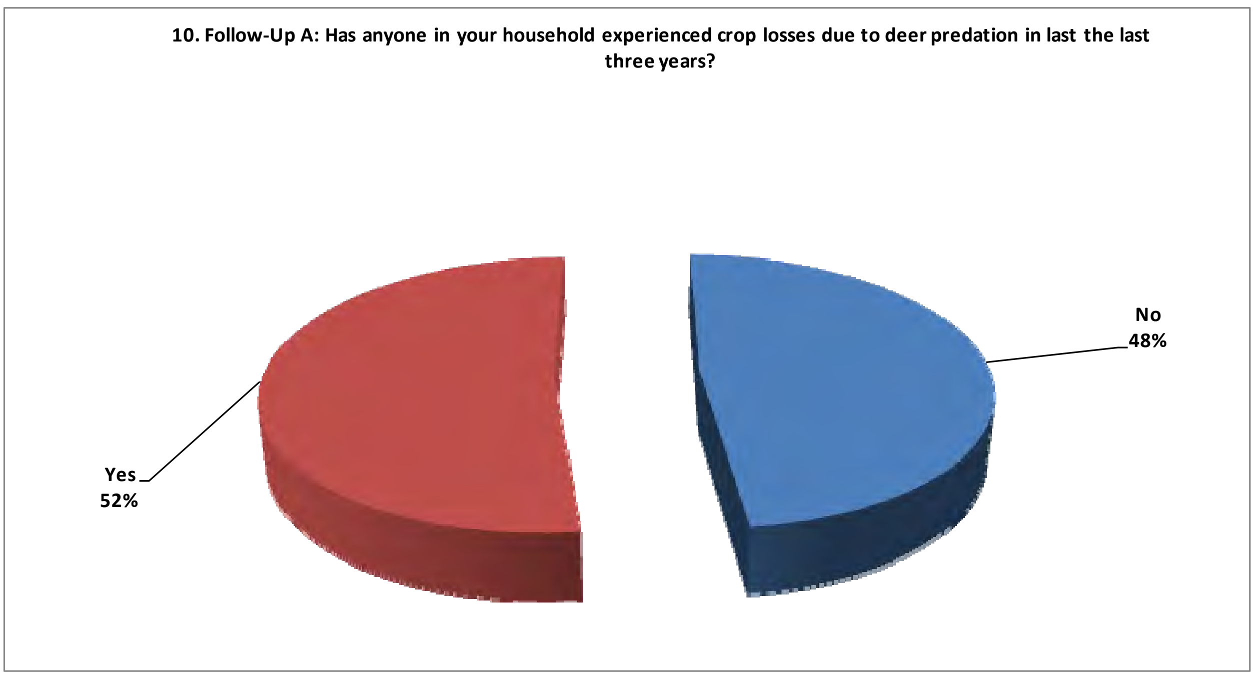
9. Follow-Up A: How many Hopewell Valley deer are usually taken by hunters in your household each year? (Open Question)

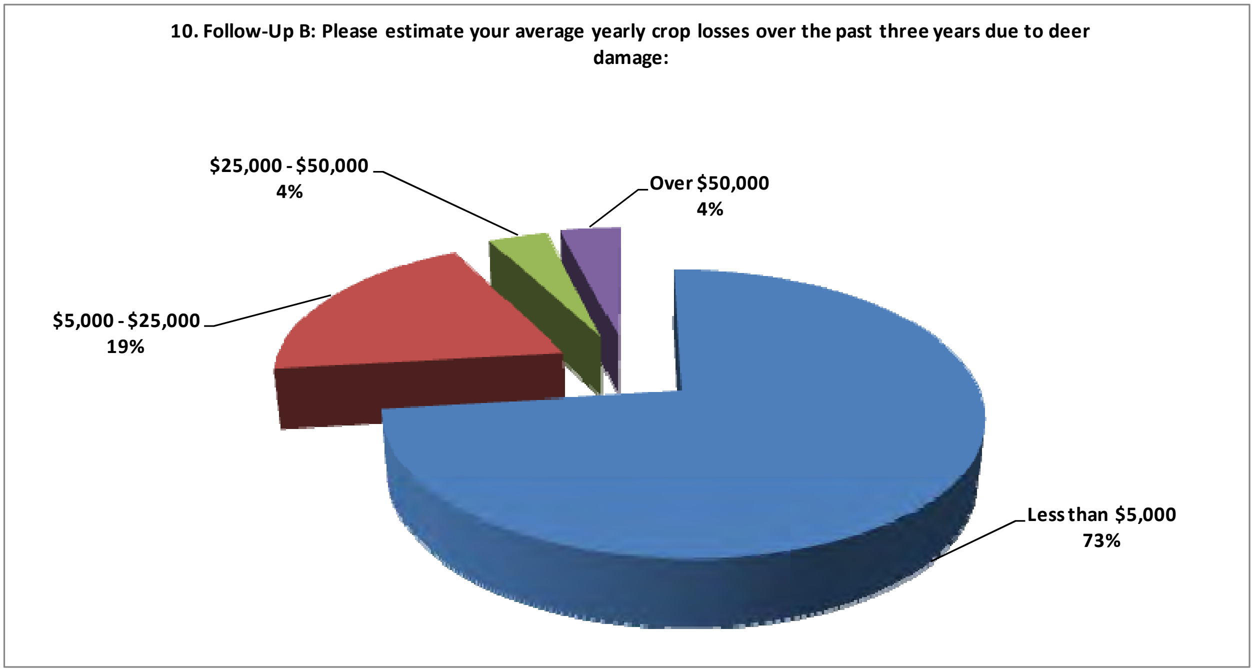


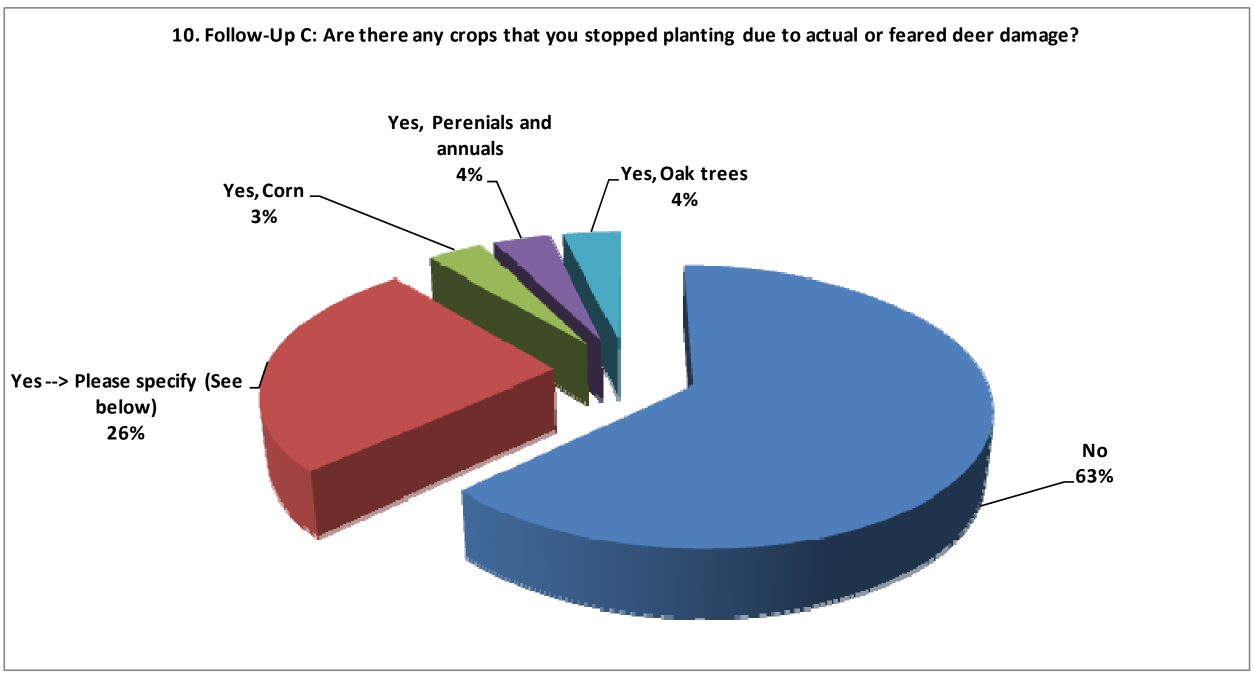
9. Follow-Up B: What factors might lead hunters in your household to take more deer in HV (Check all that apply)? (Three response choices in bold were provided, but results of all combinations are reported below.)

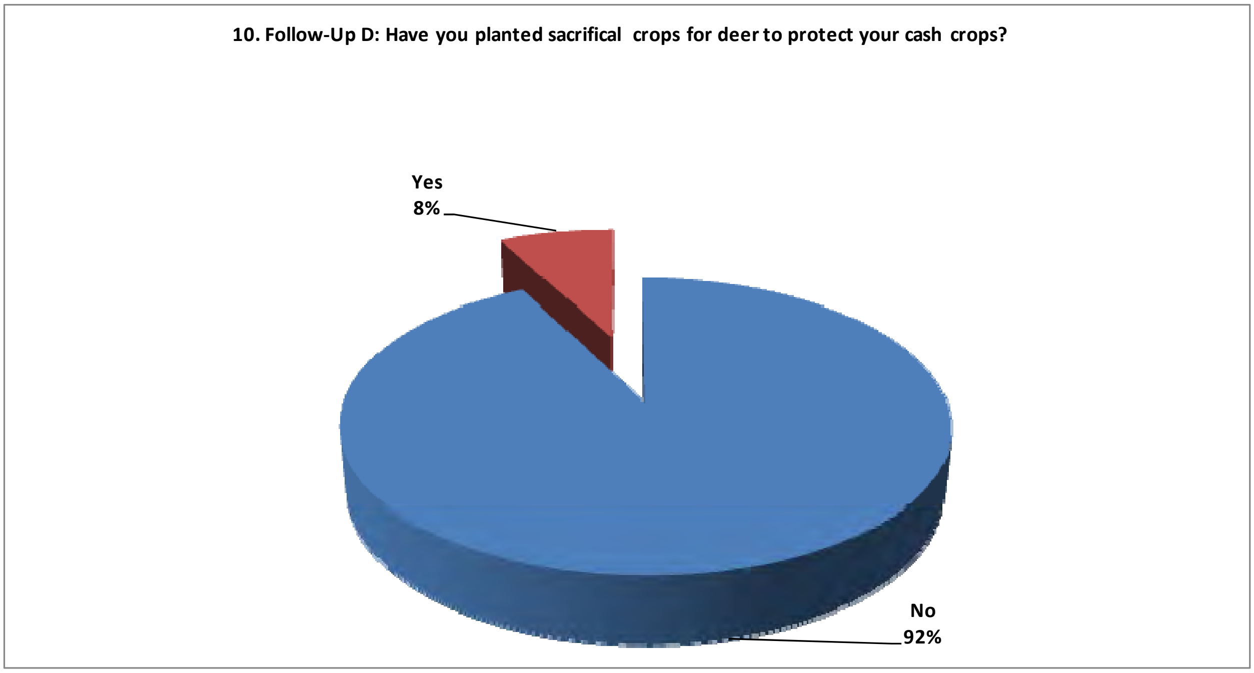


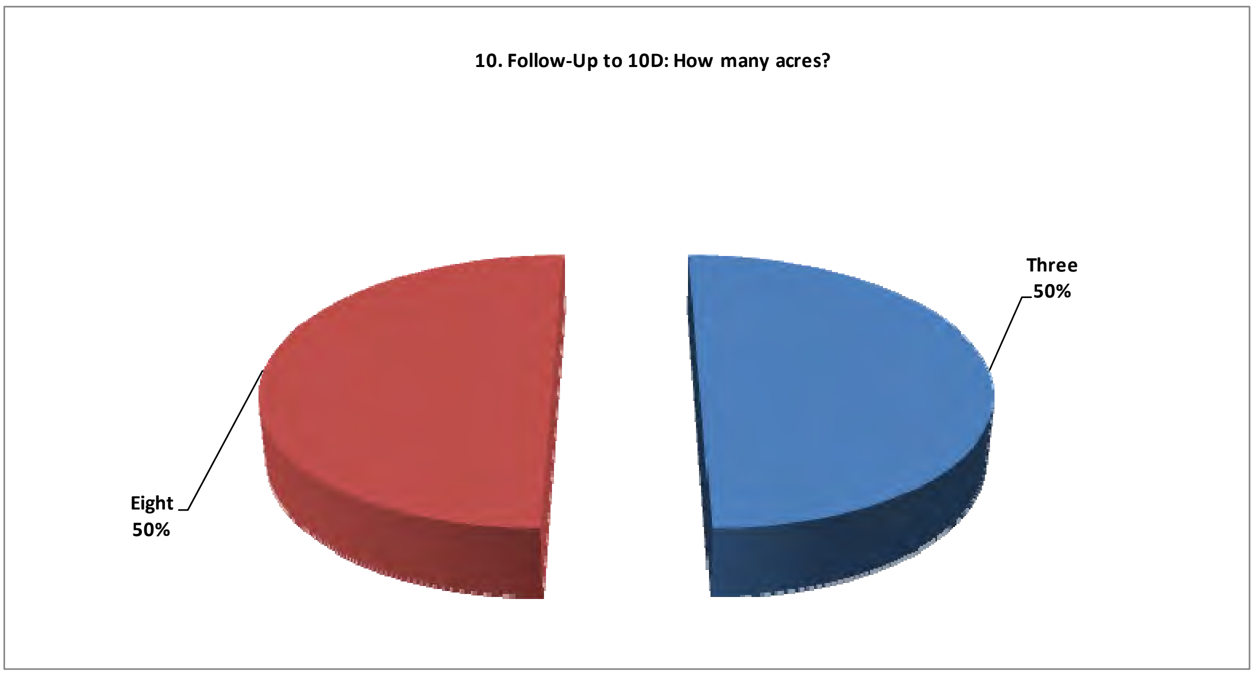

10. Has anyone in your household ever been a full or part-time farmer in Hopewell Valley?
Yes, but stopped because of deer predation 1%
Yes, but stopped for other reasons 3%
Yes, still farming 8%
No, STOP HERE 88%

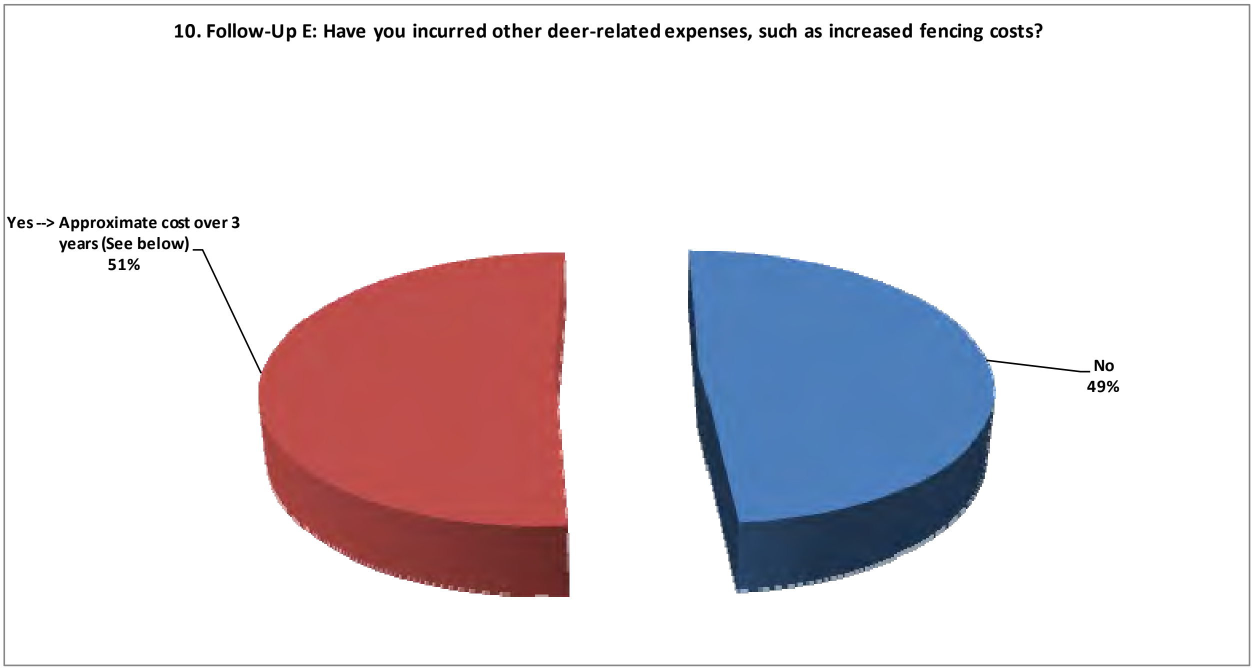

10. Follow-Up A: Has anyone in your household experienced crop losses due to deer predation in last the last three years?
No 48%
Yes 52%

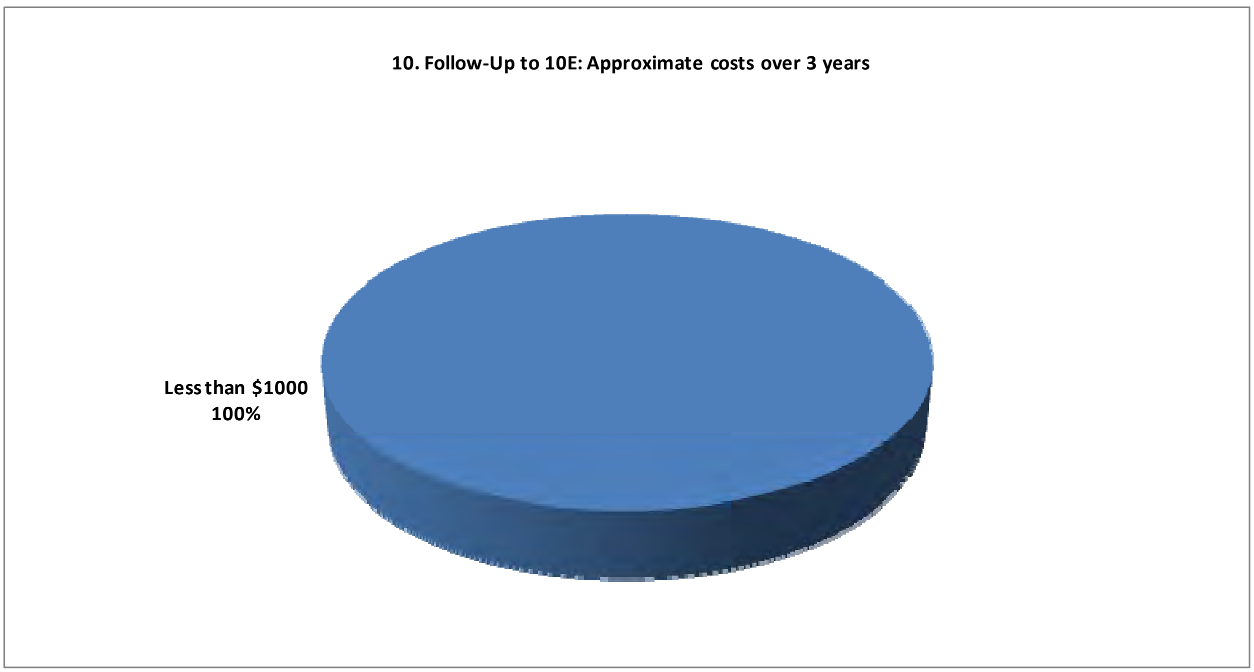

10. Follow-Up B: Please estimate your average yearly crop losses over the past three years due to deer damage:
$25,000 - $50,000 4%
Over $50,000 4%
$5,000 - $25,000 19%
Less than $5,000 73%

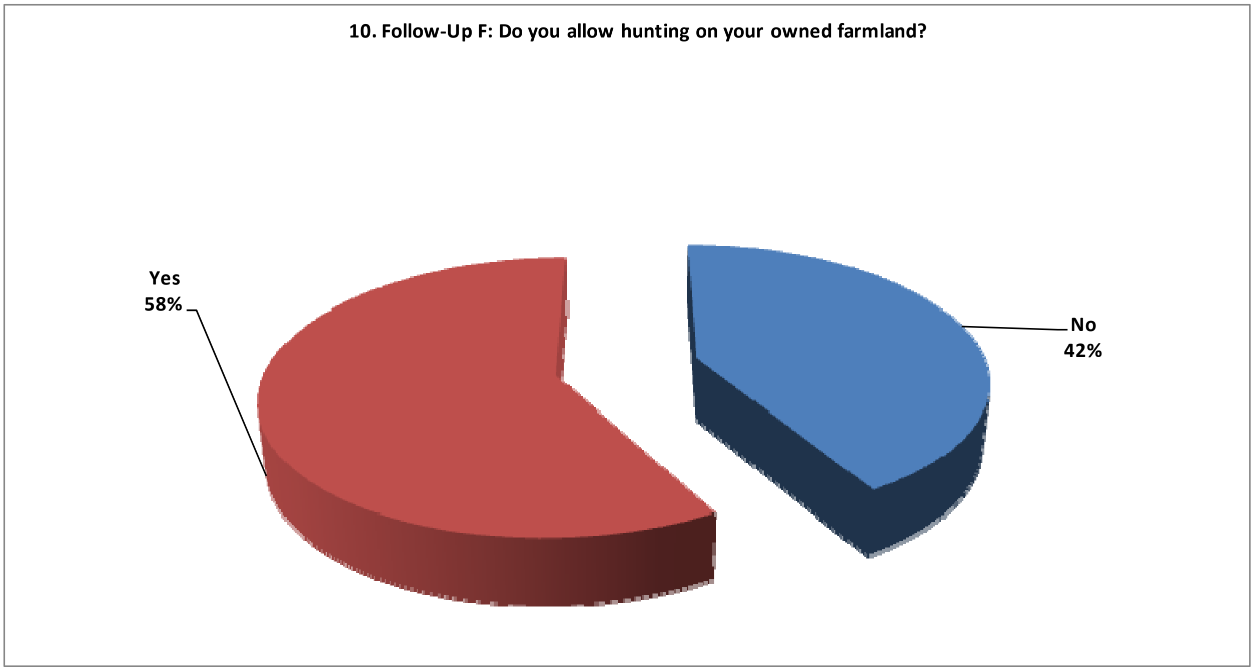

10. Follow-Up C: Are there any crops that you stopped planting due to actual or feared deer damage?
Yes, Perenials and annuals 4%
Yes, Corn 3%
Yes, Oak trees 4%
Yes --> Please specify (See below) 26%
No 63%

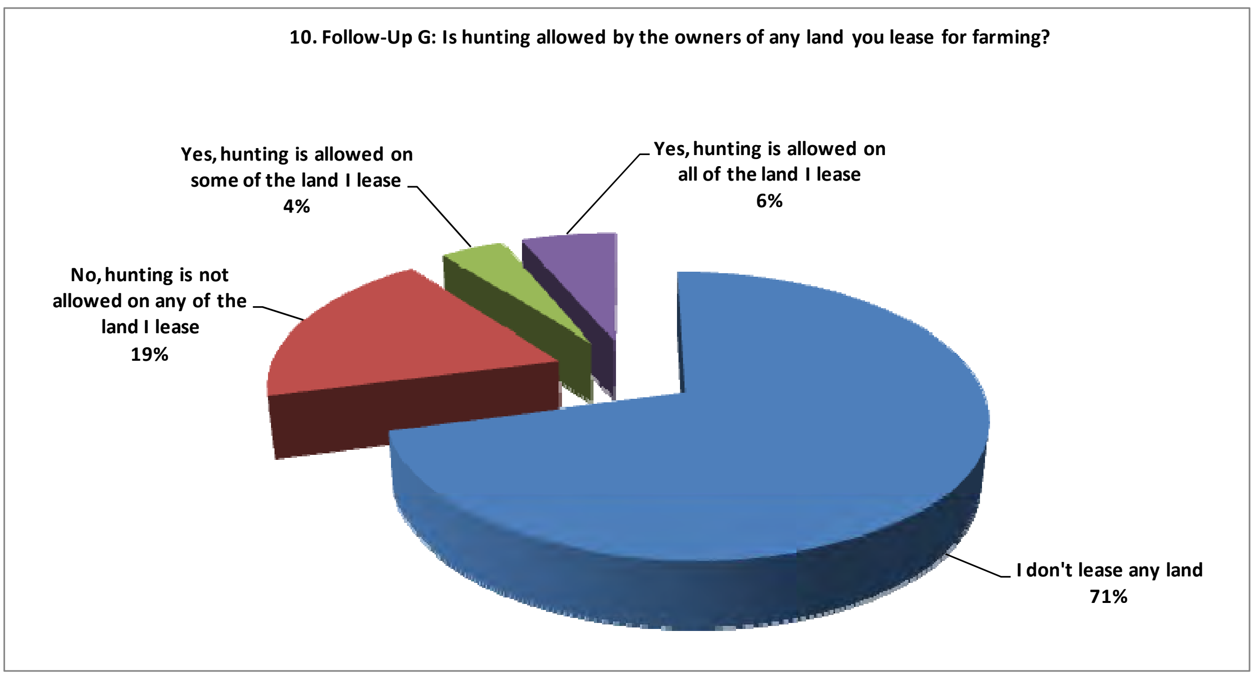

10. Follow-Up D: Have you planted sacrifical crops for deer to protect your cash crops?
Yes
8%
No
92%

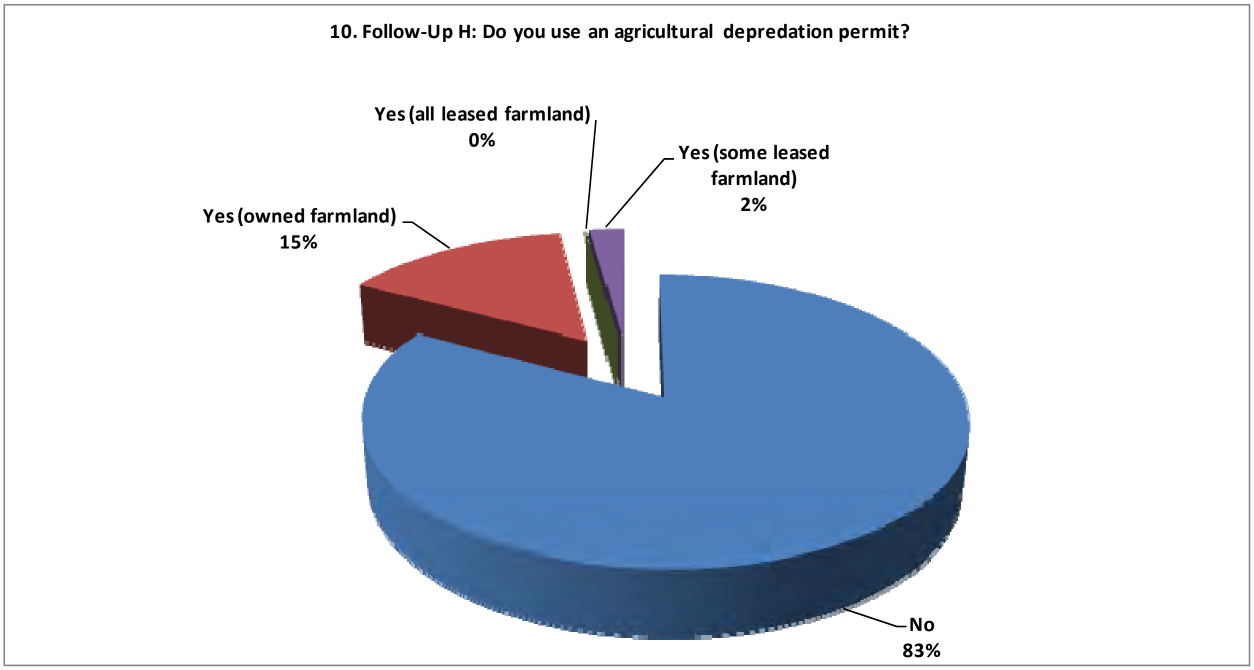

10. Follow-Up to 10D: How many acres?
Three
50%
Eight
50%


10. Follow-Up E: Have you incurred other deer-related expenses, such as increased fencing costs?
Yes --> Approximate cost over 3 years (See below)
51%
No
49%


10. Follow-Up to 10E: Approximate costs over 3 years
Less than $1000
100%


10. Follow-Up F: Do you allow hunting on your owned farmland?
Yes 58%
No 42%


10. Follow-Up G: Is hunting allowed by the owners of any land you lease for farming?
Yes, hunting is allowed on some of the land I lease 4%
Yes, hunting is allowed on all of the land I lease 6%
No, hunting is not allowed on any of the land I lease 19%
I don't lease any land 71%


10. Follow-Up H: Do you use an agricultural depredation permit?
Yes (all leased farmland)
0%
Yes (some leased farmland)
2%
Yes (owned farmland)
15%
No
83%

An Evaluation of Deer Management Options

Northeast Deer Technical Committee

April 2008

AN EVALUATION of DEER MANAGEMENT OPTIONS

Acknowledgments

This publication was collectively developed by the New England Chapter of The Wildlife Society and the Northeast Deer Technical Committee. The Northeast Wildlife Administrators Association (composed of the Northeastern United States and Canadian Province wildlife agency heads) encouraged, examined and approved this publication.

The first edition (1988) of <u>*An Evaluation of Deer Management Options*</u> was co-authored by Mark R. Ellingwood, a Deer Biologist for the Connecticut Department of Environmental Protection, Wildlife Bureau and member of the New England Chapter of The Wildlife Society and the Northeast Deer Technical Committee; and Suzanne L. Caturano, Public Awareness Biologist for the Connecticut Department of Environmental Protection, Wildlife Bureau and the Chairman of the New England Chapter of the Wildlife Society's Education Committee.

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This second edition was updated in 2007 by the Northeast Deer Technical Committee to accommodate advances in technology and methodology; Susan Predl (NJ Div. of Fish & Wildlife), Carole Kandoth (NJ Div. of Fish & Wildlife), and John Buck (VT Fish and Wildlife Dept.) editors. The committee thanks Bridget Donaldson (Va. Transportation Research Council) for permission to use her data on deer vehicle collisions.

The New England Chapter of the Wildlife Society is an association of professional biologists from Connecticut, Massachusetts, New Hampshire, Rhode Island and Vermont devoted to stewardship and enlightened appreciation of wildlife and its environments.

The Northeast Deer Technical Committee is comprised of professional deer biologists employed by their respective northeastern states and eastern Canadian provinces. The Committee is committed to the study and wise management of the white-tailed deer resource.

Introduction

The white-tailed deer *(Odocoileus virginianus)* is the most abundant and best-known large herbivore in the United States and eastern Canada. They are found anywhere from wilderness areas to urban parks and neighborhoods. Although whitetails are valued by many segments of society, considerable controversy exists concerning white-tailed deer management. Addressing the myriad of public values and often arbitrating the public controversies, state and provincial wildlife agencies have statutory responsibility for management of this invaluable resource. The objective of this booklet is to explain the rationale behind deer management decisions and to discuss the utility of various management options.

A Brief History of Deer Management in the Northeast

During colonial times, extensive tracts of mature forest dominated the Northeast. Early records suggest white-tailed deer were present in moderate numbers at the time. Deer populations were small and scattered by the turn of the 20^{th} century, primarily as a result of habitat loss and unregulated market hunting. In the early 1900s, deer were so scarce in much of the Northeast that sightings were often reported in local newspapers. Concern for the loss of the species brought about laws that regulated the taking of deer. However, habitat protection and management and knowledge of deer biology were not a component of these early efforts until a stable funding source was created.

Hal Korber, PA Game Commission

Passage of the Federal Aid in Wildlife Restoration Act (better known as the Pittman-Robertson Program) in 1937 marked the beginning of modern-day wildlife management in the United States. This act earmarked income from an already existing excise tax on sporting arms and ammunition for use in wildlife management, restoration, research and land acquisition.

Early deer management efforts featured protection from unregulated exploitation. Today, efforts are directed toward the maintenance of deer populations at levels intended to: (1) ensure present and future well being of the species and its habitat, as well as with other plant and animal communities; (2) provide a sustained availability of deer for licensed hunters, wildlife photographers and wildlife viewers and (3) allow for compatibility between deer populations and human land-use practices.

Components of Deer Habitat

White-tailed deer, like all wildlife species, require adequate food, water, cover, and living space in a suitable arrangement to ensure their healthy survival. The white-tailed deer's feeding behavior is best described as that of a 'browser'. Although a lactating doe, or a buck growing new antlers, can consume up to 10 pounds of food per day, they won't do so in one location. Rather, they will slowly walk through an area and eat a little of one plant and then a little of another as, the doe with her offspring and the buck, usually by himself, cover that habitat. They often return to the site at a later time, sometimes the next day or maybe not for several days. From early spring until the first killing frosts of autumn, they feed on the variety of plant species that include grasses, herbs, agricultural crops, and ornamental plants. Water requirements are met through drinking from natural sources such as lakes, ponds, and streams. Water is also obtained through their food that has a high water content. Cover provides shelter from extreme temperatures and precipitation, as well as concealment from predators.

Optimum cover is best described as a mosaic of vegetation types that create numerous interwoven 'edges' where their respective boundaries intersect.

VT Fish and Wildlife

Throughout the northeast examples of good cover is found where forested and suburban landscapes are interrupted by powerlines, logging operations, agricultural activities, roadside mowings, green belts, and community parks. In northern New England and eastern Canada, special wintering habitat, consisting of a mixture of mature conifers, southern aspects, and dispersed deciduous openings, allows deer to reduce their energy loss and enhances survival over the long winter period. Wintering areas are also important because of the fidelity with which deer use them from year to year and generation to generation and is underscored by the fact that it rarely makes up more than 15% of the land base.

VT Fish and Wildlife

Population Growth and the Concept of Carrying Capacity

Deer populations have the potential for rapid growth. This is an evolved response to high mortality often related to predation. Under normal circumstances, does two years old or older produce twins annually, while yearling does typically produce single fawns. On excellent range, adult does can produce triplets, yearlings can produce twins and fawns can be bred and give birth during their first year of life. In the absence of predation or hunting, this kind of reproduction can result in a deer herd doubling its size in one year. This fact was illustrated on the 1,146 acre George Reserve in southern Michigan where biologists at the University of Michigan have been studying the deer population since 1928. The deer herd grew from six deer in 1928 to 162 deer by 1933 [27]. More recently, the George Reserve herd grew from 10 deer in 1975 to 212 deer in 1980 [28].

Hal Korber, PA Game Commission

There are natural limits to the number of deer that a given parcel of habitat can support. These limits are a function of the quality and quantity of deer forage and/or the availability of good winter habitat. The number of deer that a given parcel can support in good physical condition over an extended period of time is referred to as “Biological Carrying Capacity” (BCC). Deer productivity causes populations to exceed BCC, unless productivity is balanced by mortality. When BCC is exceeded, habitat quality decreases with the loss of native plant species and herd physical condition declines. Biologists use herd health indices and population density indices to assess the status of a herd relative to BCC.

The importance of compatibility between land use practices and deer populations in urban, suburban, forested, and agricultural areas justifies consideration of another aspect of carrying capacity. "Cultural Carrying Capacity" (CCC) can be defined as the maximum number of deer that can coexist compatibly with local human populations [13]. Cultural carrying capacity is a function of the sensitivity of local human populations to the presence of deer. CCC can be considerably lower than BCC.

Hal Korber, PA Game Commission

The sensitivity of the human population to deer is dependent on local land use practices, local deer density and the attitudes and priorities of local human populations. Excessive deer/vehicle collisions, agricultural damage and home/gardener complaints all suggest that CCC has been exceeded. It is important to note that even low deer densities can exceed CCC; a single deer residing in an airport-landing zone is too many deer. As development continues in many areas of North America, the importance of CCC as a management consideration increases.

Consequences of Deer Overpopulation

As previously indicated, deer populations have the ability to grow beyond BCC. When BCC is exceeded, competition for limited food resources results in overbrowsing [7,8]. Severe overbrowsing alters plant species composition, distribution, and abundance, and reduces understory structural diversity (due to the inability of seedlings to grow beyond the reach of deer). These changes have a negative impact on other wildlife species, which also depend on healthy vegetative systems for food and cover. In time, overbrowsing results in reduced habitat quality and a long-term reduction in BCC. Coincident with overbrowsing is the decline in herd health. This decline is manifest in decreased body weights, lowered reproductive rates, lowered winter survival, increased parasitism, and increased disease prevalence [14]. In the absence of a marked herd reduction, neither herd health nor habitat quality will improve, as each constrains the other. Such circumstances enhance the likelihood of mortalities due to disease and starvation.

Deer overabundance leads to excessive damage to commercial forests, agricultural crops, nursery stock, and landscape plantings [24,25] as well as a high frequency of deer/vehicle collisions. In addition, some studies suggest that a correlation exists between high deer densities and the incidence of Lyme disease (http://www.cdc.gov/ncidod/dvbid/lyme/), a tick-born disease that, if left untreated, can affect the joints, heart, and nervous system of humans [1].

John Buck VT F&W

A Justification for Deer Population Management

The potential for deer populations to exceed carrying capacity, to impinge on the well-being of other plant and animal species, and to conflict with land-use practices as well as human safety and health necessitates efficient and effective herd management. Financial and logistical constraints require that State and Provincial deer management be practical and fiscally responsible.

DEER MANAGEMENT OPTIONS

Option 1
ALLOW NATURE TO TAKE ITS COURSE

In the absence of active management, deer herds grow until they reach the upper limit at which they can be sustained by local habitat. Herds at the "upper density limit" consist of deer in relatively poor health [8]. High-density herds such as these are prone to cyclic population fluctuations and catastrophic losses [27]. Such herds would be incompatible with local human interests and land-use practices. Disease and starvation problems in the Great Swamp National Wildlife Refuge, New Jersey [40]; damage to ornamentals on Block Island, Rhode Island; vegetation destruction at Crane Beach, Massachusetts; deer-vehicle collisions in Princeton, New Jersey [21], increased abundance of Black-legged, or "Deer" Ticks (Ixodes scapularis)[9] that spread Lyme disease, Ehrlichiosis (a newly recognized bacterial disease that is spread by infected ticks) and Babesiosis (a rare parasitic disease that is transmitted to people by infected ticks) are but a few examples of the negative impacts of a "hands off" deer management policy. Forest regeneration difficulties on Connecticut's Yale Forest is another counter-productive effect that a "hands-off" policy has on industrial forest and private woodlot management. Allowing nature to take its course will result in a significant negative impact on native plant and animal species that readily leads to the loss of these species. In addition, the local deer herd suffers from impaired condition [41].

Deer have evolved under intense predation and hunting pressure. In pre-colonial times many Native American tribes hunted deer year-round and depended on deer as their primary food source [26].

Mountain lions, wolves, bobcats, and bears all utilized the pre-colonial deer resource. The high reproductive capability of present day herds likely reflects an adaptation to intense predation and hunting in the past. As a consequence, it would be inaccurate to describe a deer herd in today's environment, with few or any predators and no hunters, as "natural".

In almost all cases, allowing nature to take its course through deforestation and starvation will not achieve modern deer management goals to ensure sustainable deer populations, sustainable habitats, and compatibility with human land-use practices and values. There are significant costs associated with the "hands off" approach to deer management including local herd decimation and habitat degradation for deer, people, and other wildlife; and a significant increase in deer-vehicle collisions and agricultural damage.

It is important to note that humans have had a dramatic impact on the ecology of North America. Among other things, they have altered landscapes, changed and manipulated plant communities, displaced large predators, eliminated a variety of native species, and introduced numerous exotics. Natural systems and regulatory processes have changed as a result of these impacts. Adopting a "hands off" policy will not restore North American ecosystems to a pristine state.

Option 2
USE FENCING AND REPELLENTS TO MANAGE CONFLICTS WITH DEER POPULATIONS

Fencing and repellents can address site-specific problems. Economic, personal, and aesthetic considerations typically restrict the use of these techniques. When considering fencing or repellents, it is important to understand that effectiveness will vary and what works for one area, may not work in another.

There are many fencing options including woven wire or polypropylene mesh, high-tensile electric fencing, and polytape electric fences. Woven wire fences of 6 or 7 feet are adequate deterrents for most homeowners, but may not provide complete exclusion. An eight-foot woven wire fence would be expected to cost $6 to $8 per foot to install. A polypropylene mesh grid deer netting can be staked around most small gardens at a cost to the homeowner of $2.00 to $3.00 per foot, plus labor. High-tensile electric fencing requires regular maintenance and is best suited to areas of good soil depth and moderate terrain. Electric fences suffer from seasonal problems associated with poor grounding due to heavy snows and dry soil conditions. Electric fences are not appropriate for use in areas where frequent human contact is likely. In 2001, multi-strand, high tensile, electric fence had an initial installation cost of $882 plus $0.31 per foot [31].

Several types of electric fencing provide a less expensive, yet effective alternative to the multi-strand, high tensile electric fence. Polytape livestock electrical fencing coated with peanut butter can be effective for home gardens and small nurseries or truck crops up to 40 acres. This simple, temporary fence works best under light deer pressure during summer and fall. The peanut butter on a poly-tape fence entices deer to sniff the fence. Then, when the deer make nose-to-fence contact they receive a substantial shock and quickly learn to avoid such fenced areas. Polytape fences are portable, and can be installed with an initial installation cost of $365 plus $0.10 to $0.25 per foot [31].

Effective repellent programs require frequent applications because rapidly growing shoots quickly outgrow protection and repellents weather rapidly. Spray repellents can only be applied effectively during mild weather, so their value during winter months is restricted. Potential problems with repellent use stem from plant damage concerns, labeling restrictions, equipment problems (heavy binding agents and repellent slurries clog equipment), and difficulties resulting from noxious and/or unaesthetic product residues. Repellents vary in cost from $25 per gallon to $45 per gallon, which would treat approximately 200 small trees or shrubs. Repellents are usually not recommended for field crops because of their high cost, limitations on use, and variable effectiveness [6].

Maryland DNR

Repellent performance is variable and seems to be negatively correlated with deer density. This seems to result from the fact that repellents are behavior modifiers; they perform well under moderate pressure but may be ignored when alternative deer foods are scarce.

Another option that has been used by some commercial nursery operations is dogs contained by underground fencing. In these situations, a couple of dogs can reduce deer damage across tens of acres. Specific guidelines on how to best implement this type of deterrent are available from a number of commercial vendors.

Fencing and repellents may reduce deer impacts on a particular area, but they do not address deer population abundance. As a consequence, they are best employed within the context of a comprehensive deer management program. Without deer population management, deer damage will increase in severity and the efficacy of abatement techniques will decline.

Option 3
USE OF NONLETHAL TECHNIQUES TO REDUCE DEER - VEHICLE COLLISIONS

Various nonlethal mitigation measures have been studied and techniques continue to be developed to reduce or prevent deer-vehicle collisions (DVCs) where deer population control is considered unacceptable, impractical, or inadequate. The complexity and variability of the DVC problem often create difficulties in designing studies that will provide conclusive results. The following table summarizes the known utility of 16 potential non-lethal techniques in reducing DVCs based on two recent comprehensive reviews [15, 20]. Many measures show potential, but require additional research before deriving conclusions regarding their effectiveness. While these devices may reduce deer–vehicle collisions, they do not reduce deer populations.

Wildlife crossings (underpasses and overpasses) and exclusionary fencing, particularly when used in conjunction with one another, were the only methods with sufficient scientific evidence to be regarded as effective countermeasures. Technology-based deployments, such as animal-detection driver-warning systems, is one area that shows potential in reducing DVC incidents, but that requires further research before becoming applicable for general use. Only two mitigation techniques, deer whistles and deer flagging models, have been studied sufficiently to confidently categorize as ineffective.

Several techniques either appear to be ineffective, or may be somewhat effective in specific situations, but are impractical to implement. Deer repellants and intercept feeding, for example, may be effective over a limited duration in localized areas, but would be difficult to consistently implement and ineffective as a long term strategy.

Effectiveness of DVC reduction techniques (15, 20)

DVC Reduction Technique	Determined Effective	Requires Additional Research	Limited Effectiveness or Appears Ineffective	Determined Ineffective	Comments
In-Vehicle Technologies (infrared vision or sensors)		✓			Potential to reduce DVCs appears to exist.
Deer Whistles				✓	
Roadway Lighting			✓		May have limited effectiveness in specialized situations.
Speed Limit Reduction			✓		Appears ineffective
Deicing Salt Alternatives			✓		May have limited effectiveness in specialized situations.
Deer-Flagging Models				✓	
Intercept Feeding (feeding stations outside roadway)			✓		May have limited effectiveness in specialized situations.
Passive Deer Crossing Signs			✓		
Temporary Passive Deer Crossing Signs and Active Signs and Technologies		✓			Appears promising in specific situations.
Roadside Reflectors or Mirrors			✓		Most studies found little long term effects.
Deer Repellants			✓		Unlikely to be useful.
Public Information and Education		✓			Regular education is necessary, though its effects are difficult to assess.
Roadside Clearing		✓			
Exclusionary Fencing	✓				Effective when combined with wildlife crossings.
Wildlife Crossings	✓				Effective, particularly when combined with fencing
Roadway Maintenance, Design, and Planning Policies		✓			Appears that planning decisions may help mitigate DVC problem.

Option 4
PROVIDE SUPPLEMENTAL FOOD TO ALLEVIATE CONFLICTS WITH BCC AND CCC

Properly managed deer herds in good physical condition do not need supplemental food to survive winter in temperate climates. In jurisdictions without die-offs due to severe winter weather, supplemental feeding of over-abundant and malnourished deer will encourage additional population growth[7] *which is counterproductive if the goals are sustaining healthy deer and habitats.*

Michigan DNR

Supplemental feeding on a region wide basis is not a practical method to reduce deer mortality.

Michigan DNR

Feeding deer to prevent catastrophic winter mortalities has been tried in many states. Michigan used surplus corn during four separate winters (1961-62, 1964-65, 1968-69 and 1970-71) to help deer survive on over-browsed deer range [(22)]. In these situations, supplemental feeding was not effective. The cost of large-scale, emergency, feeding projects did not offset the increase in deer population due to higher survival and reproduction. It cost $82.69 per deer to supplementally feed deer throughout the year and about $36.75 per deer through the winter [(22)].

A supplemental feeding program for mule deer in Colorado did reduce winter deer mortality, but it failed to eliminate substantial losses. Colorado researchers concluded that supplemental feeding can be justified for use during emergency circumstances (e.g. exceptionally severe winter weather) but not as a routine method for boosting local BCC [(3)].

Michigan DNR

The ineffectiveness of reaching significant portions of the winter deer population is a major factor in reducing the effectiveness of emergency feeding [(35)]. Researchers in Michigan concluded that "nutritional supplementation" had potential value as a management tool but that it would only work within the context of "strict herd control" [(37)]. In many areas of North America, supplemental feeding would lead to conflicts with CCC because it encourages increased deer population growth, negative impacts on habitat and other wildlife, and greater deer-human conflicts. Winter feeding can also lead to the perception that maintenance and protection of quality deer wintering habitat is not important for deer survival

Disease transmission is very real threat to deer in areas where they are being concentrated by artificial feeding activities. Ready exposure to agents responsible for fatal diseases such as Chronic Wasting Disease (CWD) and tuberculosis (Tb) are greatly facilitated through abnormal accumulations of urine, feces, and saliva at the feeding site. Once established in a wild population, a disease is rarely eradicated even after lengthy and costly treatment.

Option 5
TRAP AND TRANSFER EXCESS DEER TO OTHER LOCATIONS

This option would include the use of trapping, netting and/or immobilization for the purpose of capturing and relocating deer. Trap-and-transfer efforts are complex and expensive operations. Attempts to capture deer require substantial financial and logistic commitments in trained personnel and equipment to ensure safety of people and deer. Capture and relocation programs have recorded costs ranging from $400 to $3200 per deer [5, 12, 17].

Trap-and-transfer programs require release sites capable of absorbing relocated deer. Such areas are often lacking. The negative impact that translocated deer could have on BCC and/or CCC and questions of liability concerning translocated deer are additional concerns. For example, what happens if a translocated deer is hit by a vehicle and the driver is injured or killed? Or, if translocated deer are seen damaging crops or ornamental plantings?

Joe Kosack, PA Game Commission

Translocation may not be a "non-lethal" alternative. Deer are susceptible to traumatic injury during handling. Trauma losses average approximately four percent during trap-and-transfer efforts. Capture myopathy, a stress-related disease that results in delayed mortality of captured deer, is thought to be an important (and often overlooked) mortality factor. Delayed mortality as high as 26 percent has been reported [39].

Survival rates of relocated deer are frequently low. The poor physical condition of deer from an overpopulated range predisposes them to starvation. Trap-and-transfer efforts in California, New Mexico and Florida resulted in losses of 85, 55 and 58 percent, respectively, from 4 to 15 months following relocation [36]. A six-year study of translocated deer from the Chicago Metropolitan Area showed a higher annual survival rate of resident adults than for those translocated deer. Deer-vehicle accidents were the largest source of mortality among the translocated does and presumably resulted from unfamiliarity with the release site [18].

An additional concern associated with relocation of deer, especially from an overpopulated range, is the potential for spreading disease. The presence of Chronic Wasting Disease, Lyme Disease, Tuberculosis and other communicable diseases in some areas of North America makes this a timely consideration (http://www.aphis.usda.gov/vs/nahps/cwd/) and possibly an illegal activity depending on state or provincial regulations.

In conclusion, trap-and-transfer options are generally impractical and prohibitively expensive and have limited value in management of free-ranging deer. They may have more value in the control of small, insular herds where deer are tame and/or hunting is not applicable.

Option 6
USE FERTILITY CONTROL AGENTS TO REGULATE DEER POPULATIONS

Recent advances in wildlife contraception have facilitated remote delivery of antifertility agents to deer via dart guns. Immunofertility agents have been successfully employed to control deer reproduction in both captive and free-ranging deer herds. Advances in delivery systems, coupled with improvement in the efficacy of antifertility vaccines, improve the prospect for limited applications of wildlife contraception. The cost of manpower and materials (estimated at $1,000 per deer), and the practicality of treating an adequate number of deer, will likely limit the use of immunocontraceptives to small insular herds habituated to humans.

Joe Kosack, PA Game Commission

The most commonly used method of inducing infertility in deer is by immunocontraception, in which the deer is immunized against a protein or hormone needed for reproduction [34]. Traditional immunocontraceptive research in mammals has concentrated on the use of a vaccine extracted from the ovaries of pigs, called porcine zona pellucida (PZP) [32]. When this vaccine is injected into a doe, her immune system forms antibodies against the PZP. These PZP antibodies also recognize and attack the doe's own ZP. After the doe ovulates, the PZP antibodies attach to her ovum and block fertilization [44], which causes the female to experience multiple estrous cycles and extends the breeding season. An extended breeding season will increase deer activity at a time of year when conservation of calories is important, and may result in increased winter mortality. Lengthened breeding activity of bucks may also lead to an increase in the number of deer–vehicle collisions [34]. The original PZP vaccines required an initial dose followed by a booster dose, and annual vaccines thereafter. The need for annual vaccinations is a significant drawback to the PZP vaccine. A new formulation of PZP, called SpayVac™, developed by ImmunoVaccine Technologies Inc., is a single-dose immunocontraceptive vaccine that has been shown to control fertility in female deer for multiple years.

The National Wildlife Research Center developed a new gonadotropin-releasing hormone (GnRH) immunocontraceptive vaccine, named GonaCon™. GnRH vaccines have an advantage over PZP because they prevent eggs from being released from the ovaries, thereby eliminating multiple estrus cycles. Recent studies demonstrated the efficacy of the single-shot GnRH vaccine as a contraceptive agent for up to four years [33]. Ongoing studies are examining the effectiveness and practicality of administering GonaCon™ to free-ranging white-tailed deer. Preliminary results using free-ranging deer have provided poor results.

An adjuvant is a compound that improves the immune response, causing higher levels of antibodies. Freund's Complete Adjuvant (FCA) was combined with PZP to form the original vaccine. FCA has been popular with immunologists because it is very effective with all types of antigens. The United States Food and Drug Administration (US FDA) has objected to the use of Freund's Adjuvant due to concerns related to target animal safety and human consumption. Because of these concerns, the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) National Wildlife Research Center began testing Johne's vaccine as a replacement for Freund's adjuvant. Mycopar™ is approved for use in food animals and is therefore not a concern for use in deer [(34)].

A new adjuvant, AdjuVac™, contains a small quantity of Mycobacterium (as does Freund's complete adjuvant), which is a bacterium found in many species of domesticated and wild animals. The combination of AdjuVac™ adjuvant and GnRH conjugate produces a much longer-lasting contraceptve effect than was produced by earlier efforts that combined Freund's adjuvant with the same GnRH conjugate. GnRH and PZP vaccines, have been classified by the US FDA as investigational drugs and may only be used in rigidly controlled research studies.

As of February 2008, no fertility control agents have been federally approved for management of wildlife populations in the United States. Results from pivotal studies have provided mixed results. Deer used in contraceptive programs should be identified as an experimental animal until a fertility agent is registered, so that the deer are not consumed. This is a concern in the event of the deer leaving a study area to where it could be hunted, or killed in a vehicle accident. Identification is also important for monitoring deer behavior, movements, and populations. Individually marked deer reduces the possibly of retreating the same doe several times.

Furthermore, this drug is being reviewed by the EPA for use as a nuisance animal control means. Much like controlling rat populations, chemicals (i.e GonaCon™) used to control deer populations will be reviewed under different and less stringent human health standards and will be available to a broad range of users in need of deer damage relief.

Since fertility control has no short-term effect on population size, pre or post treatment culling will be an essential part of the timely resolution of deer problems with fertility control agents.

In conclusion, fertility control in deer is a rapidly advancing technology that continues to require additional research. Fertility control may have value for use on small insular deer populations under carefully regulated conditions, but will not provide an alternative to hunting for the control of free-ranging herds [(19)]. Although effective fertility control agents have been identified, their use on large free-ranging herds would be impractical.

Option 7
REINTRODUCE PREDATORS TO CONTROL DEER POPULATIONS

In moderately fluctuating environments, a complement of effective predators can maintain stability in a deer herd [28]. However, in general terms, predator-prey interactions are highly variable[30], and tend to stabilize populations at relatively high densities [27]. Wolves and mountain lions are examples of efficient deer predators, which have been eliminated from much of the United States and eastern Canada. Both species are frequently suggested as candidates for reintroduction to control deer herds.

Restoration of wolves and mountain lions is infeasible in much of the United States because it is too densely populated by humans to provide suitable habitat for these species. In addition, it is unlikely that rural residents would tolerate large predators at levels dense enough to limit deer populations because such predators also readily consume livestock. Predation of non-target species including other native wildlife, livestock and pets, as well as concerns for human safety, are but a few examples of the conflicts that would arise as a result of predator reintroductions.

VT F&W

Predator-prey relationships are complex and the impact of predators on herbivore populations is variable. Although many answers are lacking, several points can be made concerning deer and their predators. Coyotes, bobcats, and bears are potential deer predators that currently reside throughout much of North America. These species appear to be opportunists that capitalize on specific periods of deer vulnerability. None of these predators has demonstrated a consistent ability to control deer populations. Where coyotes, bobcats and bears are common, deer herds often exceed BCC and CCC. Coyote populations have increased and their range has expanded in North America during the past 20 years. In many areas, deer and coyote populations have increased simultaneously. In some northeast jurisdictions, some biologists do suspect coyotes are partly responsible for declining deer numbers. Yet in other areas, changes in deer populations appear unrelated to coyote density. In many circumstances, coyotes and bears represent serious agricultural pests. As a consequence, they are frequently less welcome than white-tailed deer.

Heavy predation coupled with year-round hunting by Native Americans was the norm for pre-colonial deer herds. It has been estimated that approximately 2.3 million Native Americans occupied the pre-colonial range of the white-tail and that they harvested 4.6 to 6.4 million white-tails annually [26]. The human species clearly constitutes an efficient and natural deer predator. Ecological and social constraints preclude the reintroduction of large predators in much of North America.

Option 8
CONTROL DEER HERDS WITH SHARPSHOOTERS

A typical sharpshooting program involves the systematic culling of deer by skilled marksmen who are highly trained wildlife professionals. Although expensive relative to regulated hunting, sharpshooting programs may be useful in urban and suburban areas by reducing the size of the local deer population where there is not sufficient undeveloped land to support traditional regulated deer hunting programs. Urban deer removal programs conducted in New Jersey cost between $200 and $350 per deer killed. Local taxpayers bear the cost of sharpshooting programs. Venison harvested by sharpshooting programs is generally donated to local food banks.

Hal Korber, PA Game Commission

An evaluation of techniques employed to control an enclosed deer herd in Ohio revealed that sharpshooting was a less efficient method of deer removal than controlled hunting (38). The use of sharpshooters can be controversial in situations where regulated hunting could occur, because it denies citizens access to a renewable public resource. Local economies may also experience a loss of income from hunters.

Option 9
USE REGULATED HUNTING AS A DEER MANAGEMENT TOOL

Regulated hunting has proven to be an effective deer population management tool [16, 27]. In addition, it has been shown to be the most efficient and least expensive technique for removing deer [38], and maintaining deer at desired levels. Wildlife management agencies recognize deer hunting as the most effective, practical and flexible method available for regional deer population management, and therefore rely on it as their primary management tool. Through the use of regulated hunting, biologists strive to maintain deer populations at desirable levels or to adjust them in accordance with local biological and /or social needs. They do this by manipulating the size and sex composition of the harvest through hunter bag limits and the issuance of antlerless permits, season type, season timing, season length, number of permits issued, and land-access policies.

Forest Hammond, VT F&W

Controlled deer hunts are an alternative management technique in areas where people find traditional sport hunting intrusive, or where specific objectives of the landowner/manager require limited or directed hunter activity. Controlled deer hunts limit hunters to a modified season which is usually more restrictive than traditional hunting in terms of hunter density, methods of take, and size of huntable area than do deer hunting seasons in surrounding areas. One example of a controlled hunt involves the Richard T. Crane Memorial Reservation and the Cornelius and Mine' Crane Wildlife Refuge in Massachusetts, which total approximately 2100 acres. A 9-day shotgun season was increased to 90 days for participating hunters. Hunters received a special permit allowing for a two deer, either sex bag limit. Hunters were required to be residents of one of the bordering towns, have 5 years hunting experience, attend a pre-hunt seminar and pass a shooting proficiency test. Between 1985 and 1991, between 49 and 76 hunters participated in the controlled hunt. During the first seven years of the hunt, a total of 443 deer were harvested, reducing the deer population from approximately 350 to 50 deer (10).

Another controlled hunt at the Bluff Point Coastal Reserve in Connecticut required hunters to complete a 12-hour Conservation Education Firearms Safety Course and attend a pre-hunt meeting. Hunters harvested 226 deer and seven additional deer were removed by Wildlife Division personnel in January 1996, thereby reducing the Bluff Point deer population by 80 percent (29). In some cases, simply improving hunter access while restricting participation to bow hunters may satisfy public concerns and deer management objectives within traditional season frameworks.

Values associated with white-tailed deer management are diverse and extensive (23). Ecological benefits derived from regulated hunting include protection of our environment from overbrowsing (2,3), protection of flora and fauna that may be negatively impacted by deer overpopulation (4,11,42) and the maintenance of healthy viable deer populations (16,27) for our benefit and that of future generations. Social benefits that result from regulated hunting include: increased land-use compatibility stemming from fewer land-use/deer conflicts, human safety benefits resulting from reduced deer/vehicle incidents, diverse educational and recreational opportunities, and emotional benefits associated with a continued presence of healthy deer herds. Regulated hunting provides economic benefits in the form of hunting-related expenditures. Researchers estimated the expenditures of the nation's 10,272,000 deer hunters to be nearly $10.7 billion in 2001 (43). An economic evaluation of regulated deer hunting should also include costs that would be incurred in the absence of population management. As an example, the cost of agricultural commodities, forest products, and automobile insurance would likely increase if deer populations were left unchecked.

One hundred years of research and management experience throughout the United States and eastern Canada has shown regulated hunting to be an ecologically sound, socially beneficial, and fiscally responsible method of managing deer populations. Options routinely suggested as alternatives to regulated hunting are typically limited in applicability, prohibitively expensive, logistically impractical, or technically infeasible. As a consequence, wildlife professionals have come to recognize regulated hunting as the fundamental basis of successful deer management.

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Original Article

Evaluation of Organized Hunting as a Management Technique for Overabundant White-tailed Deer in Suburban Landscapes

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ABSTRACT Hunting has been the primary white-tailed deer (*Odocoileus virginianus*) management tool for decades. Regulated hunting has been effective at meeting management objectives in rural areas, but typical logistical constraints placed on hunting in residential and urban areas can cause deer to become overabundant and incompatible with other societal interests. Deer–vehicle collisions, tick-associated diseases, and damage to residential landscape plantings are the primary reasons for implementing lethal management programs, often with objectives of <10 deer/km^2. There are limited data demonstrating that hunting alone in suburban landscapes can reduce densities sufficiently to result in adequate conflict resolutions or a corresponding density objective for deer. We present data from 3 controlled hunting programs in New Jersey and one in Pennsylvania, USA. Annual or periodic population estimates were conducted using aerial counts and road-based distance sampling to assess trends. Initial populations, some of which were previously subjected to regulated unorganized hunting, ranged from approximately 30–80 deer/km^2. From 3 years to 10 years of traditional hunting, along with organized hunting and liberalized regulations, resulted in an estimated 17–18 deer/km^2 at each location. These projects clearly demonstrate that a reduction in local deer densities using regulated hunting can be achieved. However, the sole use of existing regulated hunting techniques in suburban areas appears insufficient to maintain deer densities <17 deer/km^2 where deer are not limited by severe winter weather. Additional measures, such as sharpshooting or other strategic adjustments to regulations and policies, may be needed if long-term deer-management objectives are much below this level.

KEY WORDS archery, deer–vehicle collisions, human–wildlife conflicts, hunting, *Odocoileus virginianus*, sharpshooting, suburban, white-tailed deer, wildlife damage management.

The most significant conflicts that arise when white-tailed deer (*Odocoileus virginianus*) become overabundant in suburban environments are concerns of increased risk of tick-borne infections, particularly Lyme disease (Stafford 2007), deer–vehicle collisions (DVCs; DeNicola and Williams 2008), and repeated damage to residential landscape plantings (DeNicola et al. 2000). Additionally, impacts of elevated deer densities on plant diversity and forest regeneration are well-documented and of serious concern to ecologists and biologists (Alverson et al. 1988, Frankland and Nelson 2003, Horsley et al. 2003, Carson et al. 2005). There is a positive correlation between white-tailed deer and black-legged tick (*Ixodes scapularis*) abundances and associated risks of contracting Lyme disease and other tick-borne pathogens (Stafford 1993; Stafford et al. 2003; Rand et al. 2003, 2004). There are >1,000,000 DVCs estimated to occur in the United States annually and >200 human deaths attributed to these events (Conover et al. 1995, Luedke 2011). Earlier studies reported that DVCs increased as local deer populations increased (Hygnstrom and VerCauteren 1999, Etter et al. 2000), and another reported that a reduction in deer abundance resulted in a corresponding decline in DVCs (DeNicola and Williams 2008).

The only way to efficiently and effectively reduce deer abundance is through removal of deer from a local population (DeNicola et al. 2000, Rutberg et al. 2004). In most states, live-trapping and relocation is not an option because of high costs, pathogen transmission risks (e.g., chronic wasting disease) unavailability of suitable release sites, and concerns over stress to captured deer. Furthermore, most relocated deer do not survive a year in their new environments (Conover 2002). Therefore, only lethal management options (i.e., hunting, sharpshooting, and live-capture followed by euthanasia) can potentially reduce deer densities in the short term.

Hunting is often recommended in suburban communities to address conflicts associated with overabundant deer, and as

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a result, many communities and parks have used managed hunts to control deer numbers (Deblinger et al. 1995, Hansen and Beringer 1997, Kilpatrick et al. 2002). Several case studies have documented the challenges of managing deer in developed settings. Archery hunting was effective and safe on a small scale, but antlerless harvest had to be repeatedly emphasized, and intensive wildlife agency involvement was necessary to meet management goals (Kilpatrick and Walter 1999, Kilpatrick et al. 2004). Following the implementation of a coordinated hunting program in developed suburban environments, there are few examples that document population reductions that have sufficiently met community or landowner goals. The inability to reduce densities of deer to meet management objectives can be particularly true when communities desire long-term reductions to address ecological damage and Lyme disease concerns, typically to about 8 deer/km^2 (Rand et al. 2003, Stafford 2007).

In most cases, hunters have limited access, legal restrictions (i.e., firearm discharge limitations), or may not prefer to see deer densities reduced below a level of recreational interest (Storm et al. 2007, Weckel et al. 2011). Given that most hunters are only interested in harvesting about one antlerless deer annually (Riley et al. 2003), there is some concern whether hunters can meet management goals even if access is not limited. For instance, in 4 ecoregions of New York, USA, if hunters in an unlimited tagging system filled as many antlerless tags as they predicted, they would exceed harvest levels needed to stabilize the population in one ecoregion, equal needed harvest in another, and be below needed harvest in the other two (Brown et al. 2000). Therefore, there is some doubt about the actual population impact hunters can have in many suburban and urban environments.

Currently, the most effective mechanism for controlling overabundant white-tailed deer is lethal removal and most commonly, controlled firearm-hunting and sharpshooting. Sharpshooting was used to reduce a herd in a community in Minnesota, USA; it was reported to have the highest kill rate, and was the most adaptable method in urban scenarios (Doerr et al. 2001). Sharpshooting techniques were used to extirpate deer from the 237-ha Monhegan Island, Maine, USA (Rand et al. 2004). Sharpshooting has also been used successfully to reduce deer abundances in many other instances (Drummond 1995, Jordan et al. 1995, Stradtmann et al. 1995, Curtis et al. 1997). Archery hunting may be ineffective at reducing deer densities to low levels because many deer learn of the threat of humans during a prolonged harvest season (Kilpatrick and Lima 1999). Deer subjected to such efforts become educated and may behave differently during removal, and surviving deer may alter behaviors, potentially limiting efficacy of future removal efforts (Williams et al. 2008). There appears to be a threshold where hunters can no longer reduce deer densities because deer become too elusive and diminishing returns keep hunters from putting forth additional effort, as seen in many states where late-season (post-Jan 1) harvest totals are typically <10% of total (Anonymous 2011, Kilpatrick et al. 2011).

Our objective was to determine the deer population management potential of modern traditional hunting under extremely liberal state regulations and hunting opportunities in areas of the mid-coastal eastern United States with initial deer overabundance ($\geq$35 deer/km^2). We present 4 case studies to demonstrate the relative effectiveness of regulated hunting in reducing deer densities to levels consistent with community goals regarding public concerns about tick-borne illnesses, ecosystem health, and DVCs.

STUDY AREAS

Princeton Township (Princeton), New Jersey, USA (40.348722°, −74.659029°) was in Mercer County and had a human population of 16,265 during the 2010 Census. Unorganized hunting, using all regulated hunting seasons, occurred from the late 1980s through the present. The incidence of DVCs had grown to unacceptable levels (Anonymous 1998), and therefore controlled archery hunts were implemented on both private and public properties beginning in autumn 2006 through late winter 2011. Additionally, supplemental sharpshooting and live-capture with euthanasia was implemented after hunting seasons from 2001 through 2010. Management efforts occurred throughout the majority of Princeton Township (36.3 km^2).

Bernards Township (Bernards), New Jersey (40.718846°, −74.568659°) was in Somerset County and had a human population of 26,652 during the 2010 Census. Because of increased DVCs and intolerable damage to gardens and landscape plantings (Anonymous 2009), the Township repeatedly sought and received a Community-Based Deer Management Permit from the New Jersey Department of Environmental Protection that extended the hunting season an additional 4 weeks. In addition to the post-season permit, coordinated deer-management efforts occurred throughout Bernards (63.5 km^2) on both public and private lands during the 4.5-month autumn–winter archery-hunting seasons from autumn 2001 through 2011.

Upper Makefield Township (Upper Makefield), Pennsylvania, USA (40.291944°, −74.924167°) was a suburb of Philadelphia in Bucks County and had a human population of 8,190 during the 2010 Census. Because of increased DVCs, landscape damage, and concerns about tick-borne diseases, a private firm was hired to conduct a coordinated deer-management effort, using archery hunting, on up to 92 private properties throughout Upper Makefield (51.8 km^2; Maddock et al. 2009). Management efforts started in autumn 2007 and ended late winter 2010.

These 3 communities were typical suburban landscapes for the area, composed of a matrix of residential and commercial developments, with intermingled wetlands, woodlands, and agricultural lands. They were almost exclusively single-family residential communities with property sizes ranging from 0.4 ha to 2.0 ha with some properties >8 ha. Hunting access was limited to properties with written permission, and as a result, numerous non-hunted refugia were available to deer.

Duke Farms was a 1,110-ha tract located in Hillsborough, New Jersey (40.554896°, −74.634247°). The property was a mix of natural habitat types as well as a 259-ha designed park that was surrounded by a 2.5-m deer exclusion fence. The habitat types included 445 ha of agricultural grasslands, 422 ha of woodlands, 214 ha of floodplain, and 29 ha of open water. This mix of habitat types provided wildlife refuge, as Duke Farms was surrounded by industrial areas to the south, commercial properties and residential developments to the east and west, and the Raritan River to the north. A portion of the property was designated by the New Jersey Department of Environmental Protection as part of the Orchard Drive Grasslands Natural Heritage Priority Site, which was considered one of the state's most significant natural areas. Due to increasing DVCs and chronic damage to forest understory and ornamental plantings, management efforts were conducted at Duke Farms during autumn–winter beginning in 2004 through 2011. Management activities, using both archery and shotgun hunting, were focused on the 800-ha unfenced area of Duke Farms.

The management goals of Princeton, Bernards, and Duke Farms were to reduce deer densities to $\leq$10 deer/km^2. Upper Makefield did not have a specific goal except to reduce DVCs and other local conflicts (T. Waterbury [Princeton Township attorney], W. Allen [Chair, Bernards Township Deer Management Advisory Committee], G. Huntington [Duke Farms Foundation] personal communications; Maddock et al. 2009).

METHODS

Deer Removal

All sites had extended archery seasons (4–5 months), and hunters could use bait to attract deer. All hunters were tested for shooting proficiency to various degrees and attended local orientations. Successful hunters were issued replacement tags, so they could potentially remove an unlimited number of antlerless deer. The 3 communities and Duke Farms used the following approaches to try to meet their management objectives: 1) maximal access to huntable property, 2) full cooperation of the township administration and its residents, 3) proper screening of the participating hunters, and 4) close management of hunters' actions and locations.

Princeton used select archers on public and private lands and sharpshooting and live-capture with euthanasia after the archery hunt (DeNicola et al. 1997). Participating archers had access to 4 public properties in 2006 and 2007, 5 public properties in 2008 and 2009, and 8 public and 5 private properties in 2010. Non-participating hunters had the opportunity to obtain access and hunt any private property during all regulated hunting seasons in Princeton. The local animal-control officer was responsible for oversight of proficiency testing and daily hunter activities. Deer densities were reduced with sharpshooting after the hunting seasons from 2001 to 2009. In 2010–2011, Princeton only permitted archery hunting and opted not to sharpshoot.

Bernards Township hired a small group of shotgun hunters in 2002, but results were limited and expensive and, therefore, lasted only 1 year (Snyder and Allen 2011). Concurrently, a group of 15 archers were used to kill deer. Additionally, in 2003, another organization consisting of 39 hunters using archery, shotguns, and muzzleloaders participated. The 2 groups hunted throughout the township through 2010–2011. Local law-enforcement department personnel were responsible for oversight of proficiency testing and daily hunter activities. Harvest data were not differentiated between archery, shotgun, or muzzleloader, but organizers estimated half of all deer were taken with archery (W. Allen, Chair, Bernards Township Deer Management Advisory Committee, personal communication).

Upper Makefield used 27 archery participants on 65 private lands in Year 1, 35 archers on 81 properties in Year 2, and 39 archers on 92 properties in Year 3. A private wildlife management company (Eccologix, Inc., Bedminster, PA) was responsible for obtaining access to private properties, oversight of screening of hunters, proficiency testing, and daily hunter activities at a cost of approximately US$55,000/year.

Duke Farms used a combination of both archery- and shotgun-hunting. The first year (2004–2005), over 70 participants used only shotguns. Each hunter was placed in an approximate 2-ha designated area to ensure complete coverage of all wooded areas to prevent deer refuge (Williams et al. 2008). During shotgun hunting, groups of >100 deer were observed congregating in the center of large fields (>100 ha; A. J. DeNicola, personal observation). Deer seeking refuge were dispersed to hunters in tree stands by non-hunting participants on foot or in off-road vehicles to increase the likelihood of harvest. In each subsequent year, archery- and shotgun-hunting were used (12–33 participants) with no shotgun-hunting occurring in 2005–2006 and 2008–2009. A private wildlife management company (White Buffalo, Inc., Moodus, CT) was responsible for initial oversight of screening and proficiency testing and daily hunter activities. Duke Farms' staff allocated hundreds of hours to subsequent program management and paid for bait and carcass donation. To assess the effectiveness of dispersing deer from non-hunted refugia to hunters after the first year, the number of deer harvested from such efforts was added to the end of year forward-looking-infrared counts and densities were recalculated. This calculation assumes that none of the deer harvested during dispersal efforts would have been taken by a sitting hunter, so it is likely an overestimate.

Density and Abundance Estimation

Deer density and abundance in Upper Makefield and Princeton were estimated using road-based distance sampling (LaRue et al. 2007) in March 2010 and February 2011, respectively. Distinct clusters were determined using the nearest-neighbor criterion and by observing behavior and proximity of individuals (LaGory 1986). Routes were surveyed for 3 consecutive nights to ensure $\geq$60 deer clusters were recorded (Buckland et al. 1993). We used the Program DISTANCE 4.0 to estimate deer density near roads (Thomas et al. 2002). We used recommended protocols for analysis of line-transect data (Buckland et al. 1993:139–140).

Population estimates were derived using forward-looking-infrared techniques (Naugle et al. 1996) annually at Duke Farms and twice at Bernards. Aerial infrared counts were conducted using a single-engine Cessna 182 with a fuselage-mounted high-resolution Mitsubishi M-600 thermal imager

(Mitsubishi Electric, Irvine, CA). Transects were spaced at 100-m intervals and flown 500 m above ground. At this height above ground, 100% coverage was achieved and verified with global positioning system moving map software. Flights were conducted after 2200 hours to ensure adequate ground cooling and good thermal contrast. The thermal imaging output was routed through a video encoder-decoder (Model VED-M, V-data, Inc., Lottsburg, VA) and recorded on digital media for later review. From previous experience, forward-looking-infrared counts that do not estimate imperfect detection rates result in an underestimate of deer abundance, so actual reported densities at Duke Farms and Bernards are likely to be conservative (Drake et al. 2005).

Understanding that raw count data can provide unreliable indices (Anderson 2001), we used multiple lines of evidence to assess deer population densities and trends. Population estimates, including initial population estimates, were corroborated by conducting simple population projections based on observed demographics (DeNicola et al. 2008). We estimated that 1) 60% of the populations were female, 2) 33% of females were fawns, and 3) recruitment rate to autumn was 1:1 (doe:fawn ratio). We then included approximations of non-culling mortality (i.e., DVC data and hunter-harvest data when available), and approximate mortality rates for urban deer from the literature to estimate pre-hunt densities (Etter et al. 2002). Immigration and emigration were assumed to be equal because deer typically do not shift established home ranges into areas of lower density (McNulty et al. 1997, Williams and DeNicola 2002) or even to accommodate temporary bait sites (Williams and DeNicola 2000, Kilpatrick and Stober 2002).

We estimated population size of deer at Princeton using an aerial count in winter 2002 with snow cover. We attempted to correct for imperfect detection of deer by using a double-observer method (Beringer et al. 1998, Potvin and Breton 2005). We used a Robinson 44 helicopter (Robinson Helicopter Company, Torrance, CA) with a pilot and experienced observers on both sides of the aircraft. We flew 200-m-wide transects that were pre-established in the geographic-information-system program ArcView (version 3.3). We provided the pilot with starting and ending global positioning system coordinates of each transect prior to the survey. Once airborne, the pilot hovered at an altitude of 60 m, at which time observers placed a piece of tape on the window, which corresponded to orange traffic cones on the ground 100 m to the side of the aircraft. Observers maintained this search distance throughout the survey while the pilot maintained an altitude of 60 m and air speed of 40 km/hour, though altitude and air speed varied somewhat throughout the flights. When deer were sighted, their numbers and location were recorded on a topographic map. Based on previous research, we assumed that 2 experienced observers had an 80% detection function and adjusted the data accordingly (Beringer et al. 1998). Aerial surveys may be a more reliable technique to estimate deer population size compared with distance sampling from roads (Naugle et al. 1996), but financial limitations precluded another aerial survey of Princeton in 2011.

We realize that there are inherent complexities in deer density estimation and that there may be some variation between techniques due to differing calculations, observer bias, or animal behaviors such as habituation to human-altered landscapes (Haskell et al. 2009). Although we cannot say how accurate our surveys were, we are confident in our ability to assess broad-scale population objectives over time.

Deer–Vehicle Collisions

Deer–vehicle collisions were tallied through a combination of police reports and roadkill collection records by animal control officers or private contractors. Data collection methods were consistent among years at all locations.

Data Analyses

We used linear regression to determine whether estimated densities for each study area had been significantly reduced over time (SigmaPlot 12.0). We also categorized the pre-hunt density estimates of deer by Years 0–3 and Years 3–11 to analyze similarly.

RESULTS

Deer Removal and Density and Abundance Estimation

A total of 10,525 deer were documented as being removed from the 4 areas over the study period with 1) 4,785 (45%) removed by archery hunting, 2) 3,224 (31%) removed by shotgun or muzzleloader hunting, 3) 314 (3%) were not differentiated as being taken by either archery or shotgun, and 4) 2,202 (21%) removed by sharpshooting (Table 1). An additional 3,527 deer were documented as being killed by DVCs.

Princeton Township

The initial (pre-2001) population estimate exceeded 43 deer/km^2. Over the 11-year program, 4,563 deer were reported taken by sharpshooting, DVCs, or archery hunting.

Table 1. White-tailed deer (*Odocoileus virginianus*) harvest totals for the 4 study areas (Upper Makefield Township, Pennsylvania, USA from 2007 to 2010, Bernards Township, New Jersey, USA from 2000 to 2011, Princeton Township, New Jersey, USA from 2000 to 2011, and Duke Farms, New Jersey, USA from 2004 to 2011) by method of take. Densities are reported as number of deer per km^2.

	Seasons	Archery	Gun	ND	S.S.	Initial den.	Final den.
Upper Makefield	3	828	61	314	188	≈35	≈18
Bernards Township	11	2,602	2,603	—	N/A	≈34[a]	≈18
Princeton Township	11	1,077	N/A	—	1,986	≈43	≈17
Duke Farms	7	278	560	—	28	≈80	≈12
Totals	32	4,785	3,224	314	2,202		

ND, not differentiated between archery and shotgun; S.S., sharpshooting, N/A, not attempted.
[a] Initial density was determined after 1 year of limited coordinated hunting.

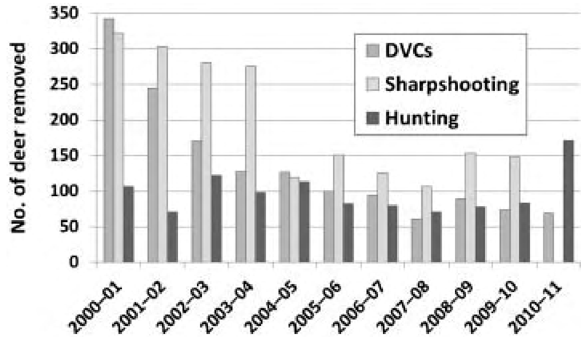

Figure 1. White-tailed deer (*Odocoileus virginianus*) harvest totals for coordinated removal efforts in Princeton Township, New Jersey, USA, from 2000 to 2011. DVCs, deer–vehicle collisions.

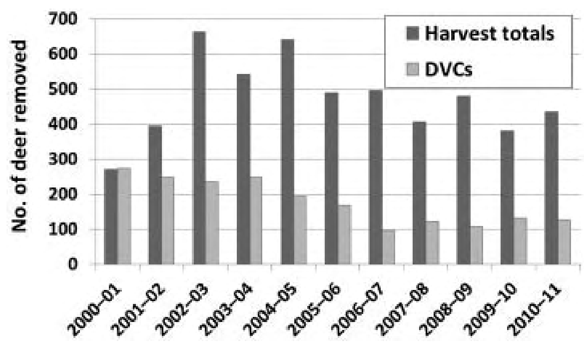

Figure 2. White-tailed deer (*Odocoileus virginianus*) harvest totals for coordinated removal efforts in Bernards Township, New Jersey, USA, from 2000 to 2011. "Harvest totals" include deer taken during the hunting season and the extended Community-Based Deer Management Permit program.

From 2003 through 2010, hunters averaged 86.0 deer/year (SE = 5.4) with no trend (Fig. 1). Deer–vehicle collisions decreased annually, but averaged 96.0/year (SE = 9.4). Sharpshooting harvests were fairly consistent after 2003 and averaged 154.0 deer/year (SE = 21.4). In 2011, sharpshooting did not occur because hunters said that they would increase effort in an attempt to reduce the herd. Two-hundred forty deer were reported removed, 171 via archery and 69 via DVC in 2011. In winter 2002, the aerial survey revealed that there were an estimated 16 deer/km^2, and the distance sampling estimate in 2011 was approximately 17 deer/km^2 (SE = 3.0).

Bernards Township

The deer population estimate at Bernards was about 34 deer/km^2 after 1 year of limited coordinated hunting in 2002. The removal of a reported 7,166 deer, including DVCs, reduced estimated density to about 18 deer/km^2 in 2011. Over the course of the program, annual DVCs were reduced by about 50%, from 275 in 2008 to 128 in 2010 (Fig. 2).

Upper Makefield Township

Initial (pre-2007) population estimates likely exceeded 35 deer/km^2. There were limited DVC data for Upper Makefield, but those available did show a decreasing trend with increasing number of deer removed (Table 2). Over the 3 seasons when hunting occurred (2007–2010), 1,414 deer were removed, including DVCs. Distance sampling efforts estimated a remaining deer density of about 18 deer/km^2 (SE = 5) after coordinated harvest efforts concluded in 2010.

Duke Farms

Initial (pre-2004) population estimates exceeded 80 deer/km^2 at Duke Farms. After removal of 866 deer by shotgun, archery, and limited sharpshooting (Fig. 3), the population estimate was about 12 deer/km^2 in 2011. After adding the number of deer harvested during staff-coordinated dispersal efforts back into the original forward-looking-infrared counts, the resulting estimated density without staff dispersal would have been about 18 deer/km^2.

Data Analyses

Deer densities for all study areas were significantly different over time; hunting reduced deer densities ($n = 15$, $F_{1,13} = 5.59$, $P = 0.034$, $y = -2.96x + 35.04$, $r^2 = 0.30$; Fig. 4). Additionally, from Year 0 to Year 3, there was a precipitous decline in deer densities at all sites ($n = 9$, $F_{1,7} = 8.84$, $P = 0.021$; Fig. 5). However, from Year 3 outward through Year 11, deer densities stabilized, and may have increased slightly ($n = 9$; $F_{1,7} = 1.27$, $P = 0.296$; Fig. 6).

DISCUSSION

Case Studies

Based on our data, traditional hunting in suburban settings was effective at reducing deer densities, but was unable to get densities below about 17 deer/km^2. This level was more than double the recommended densities of <8 deer/km^2 suggested for reductions of blacklegged ticks and associated incidents of Lyme disease (Rand et al. 2003, Stafford 2007) and maintenance of forest regeneration and biodiversity (Anderson 1984, Tilghmann 1989, deCalesta 1994, deCalesta and Stout 1997). Despite extended hunting seasons (up to 5 months), permitted use of bait, and no harvest limits, it appears that 17–18 deer/km^2 is within the range of diminishing returns for deer reduction in some suburban areas using traditional hunting. Once this density was achieved, there were fewer shot opportunities, deer likely became educated and retreated to non-hunted refugia (Williams et al. 2008), or hunters may have lost interest. This appeared to

Table 2. Upper Makefield Township, Pennsylvania, USA, harvests of white-tailed deer (*Odocoileus virginianus*) during archery and shotgun hunting seasons, sharpshooting, and deer–vehicle collision (DVCs) totals for 2006–2010.

Year	Archery	Shotgun	ND	Sharpshoot	DVCs
2006–2007	N/A	N/A	N/A	N/A	43
2007–2008	510	37	21	38	15
2008–2009	318	24	—	55	8
2009–2010	—	—	293	95	N/A

ND, not differentiated between archery and shotgun; N/A, not attempted.

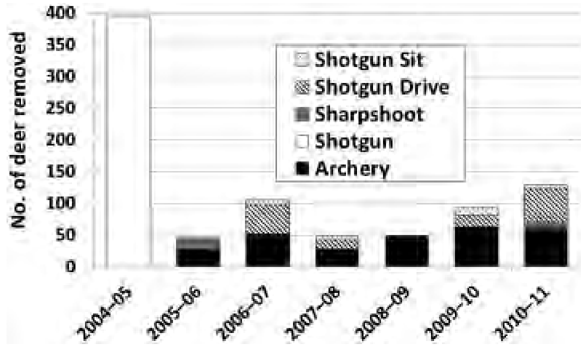

Figure 3. White-tailed deer (*Odocoileus virginianus*) harvest totals for coordinated removal efforts at Duke Farms, Hillsborough, New Jersey, USA, from 2004 to 2011.

occur around Year 3 of deer management efforts. After Year 3, hours/harvest increased to a point at which hunters maintained enough interest to keep the population stable, but further reduction was not achieved. This was likely the result of a majority of hunters dropping out of the program, while the more dedicated and efficient participants remained.

Historically, controlled hunting with firearms was effective at significantly reducing deer populations (Deblinger et al. 1995). Controlled hunting was highly effective and efficient at reducing deer populations on large open spaces in Massachusetts, USA (McDonald et al. 2007). This is likely the case for populations of white-tailed deer that are affected by severe winter weather, where deer managers at state wildlife agencies attempt to regulate deer abundance by carefully allotting permits for antlerless deer to hunters (Diefenbach and Shea 2011). In Connecticut, USA, local densities in a private community were reduced by 92% in 6 days using a shotgun–archery deer hunt, but that population initially consisted of <30 animals (Kilpatrick et al. 2002). Firearms-hunting was successful in reducing the deer herd at the George Reserve in Michigan, USA (McCullough 1984) and on a National Wildlife Refuge in Illinois, USA (Roseberry et al. 1969). Such controlled hunts can be successful with diligent oversight by managing agencies, near complete access by hunters, and primary use of firearms; conditions that rarely exist in most suburban environments.

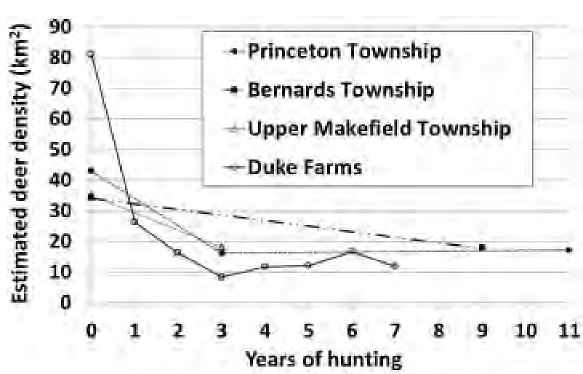

Figure 4. Scatter plot of white-tailed deer (*Odocoileus virginianus*) density and the number of years of hunting for Princeton Township, Bernards Township, and Duke Farms, New Jersey, USA; and Upper Makefield, Pennsylvania, USA. "Years of hunting" indicates duration of the program with year 0 representing the pre-hunt population estimate.

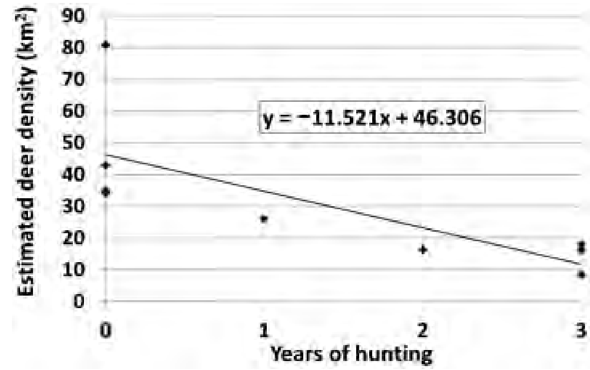

Figure 5. Scatter plot of pooled white-tailed deer (*Odocoileus virginianus*) density and the number of years of hunting for Princeton Township, Bernards Township, and Duke Farms, New Jersey, USA; and Upper Makefield, Pennsylvania, USA, from Year 0 to Year 3. "Years of hunting" indicates the duration of the program with year 0 representing the pre-hunt population estimate. Trend-line represents the least-squares estimate of linear relationship.

Recently, some managing agencies have witnessed the limitations in the ability of traditional hunting to significantly reduce deer densities. Agency sharpshooters in Wisconsin, USA, were 9–17 times more effective at removing deer infected with chronic wasting disease than were hunters, despite financial incentives for hunter-harvested deer that tested positive and a state-funded food pantry program for donating harvested deer that tested negative (Langenberg et al. 2009). Six years of extended hunting seasons (Sep–Mar) with no bag limits resulted in little cumulative change in deer density in chronic wasting disease–affected areas in Wisconsin (Samuel et al. 2009). Additionally, resistance by deer hunters themselves eroded this chronic wasting disease management strategy, and surveillance data suggested increased prevalence of chronic wasting disease during this time (Samuel et al. 2009).

Limitations in the Organized Use of Hunters

Homeowner communities and municipalities often use public health threats (e.g., DVCs and tick-associated diseases) to justify lethal deer-management programs to reduce over-

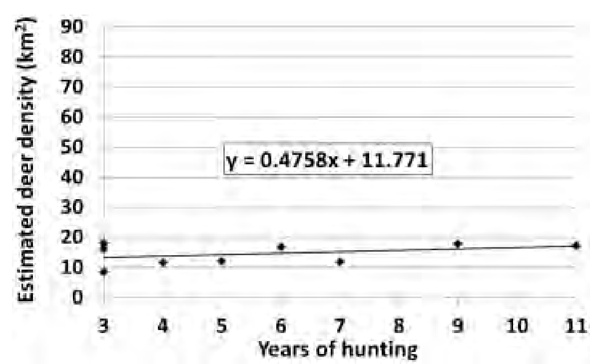

Figure 6. Scatter plot of pooled white-tailed deer (*Odocoileus virginianus*) density and the number of years of hunting for Princeton Township, Bernards Township, and Duke Farms, New Jersey, USA; and Upper Makefield, Pennsylvania, USA, from 3 to 11 "Years of hunting." Trend-line represents the least-squares estimate of linear relationship.

abundant deer populations (DeNicola et al. 2000, Stafford 2007, DeNicola and Williams 2008, Magnarelli et al. 2010). In such circumstances, hunting is the tool most often recommended by state wildlife agencies due largely to its minimal financial cost to stakeholders (Kilpatrick and LaBonte 2007, Anonymous 2008). However, we found that hunting in its present form is limited in its potential to reduce deer densities to levels desired by local communities (e.g., 10 deer/km^2 in the case of Bernards and Princeton) for the following reasons: 1) there were community members that would not allow hunting on their properties, resulting in only a portion of the local community accessible for hunting; 2) some hunters may desire greater densities for recreational interests and willing participation compared with objective levels set by community landowners (Anonymous 2010); 3) even with pre-hunt estimates of deer densities derived using sound methodology, landowners and hunters alike may not comprehend the number of deer that need to be harvested to achieve and sustain significant population reductions; and 4) hunters did not always take suitable precautions to prevent educating other deer to their presence, which is imperative for deer population-reduction efforts, particularly at high initial densities (Kilpatrick and Lima 1999, Williams et al. 2008).

The 3 suburban case studies (Bernards, Princeton, Upper Makefield) are good examples of concerted attempts to reduce deer densities. Though concerted, these efforts were limited in that 1) hunter density was only 1/1.2 km^2 in Bernards; 2) only 92 properties ($\approx$10%) of the 51.8-km^2 Upper Makefield were available to hunters; and 3) approximately 20% of Princeton was actively hunted. Though such hunter density might seem low for traditional hunting, it is appropriate when baiting to avoid effects of bait-site overlap (i.e., allowing deer access to multiple bait sites, thus reducing effectiveness of baiting). Unmanaged hunter activity occurred in all 3 locations, because there were no local restrictions on hunting. The scope of hunter access outside the structured programs was unknown.

Hunting was more successful in reducing densities at Duke Farms apparently because it was a smaller, non-residential area where hunters had full access, and refugia were actively eliminated by actions of non-hunting coordinators. Alternatively, when deer are hunted within only a portion of a residential community or municipality, there can be too many non-hunted refugia available, thus making reductions to objective levels, with traditional hunting only, difficult and unlikely. Even when hunters had complete access to the 800-ha Duke Farms and used intensive effort, deer retreated to neighboring suburbia, resulting in population reduction to about 12 deer/km^2.

An Enhanced Approach to Using Hunters to Manage Suburban Deer

We believe that regulated hunting, with some modifications, can be used to successfully further reduce deer densities. Often, a few skilled hunters with the interests of landowners in mind, can be more effective than many untrained hunters focused on recreation. Educating hunters regarding how to avoid negatively conditioning deer should increase harvest, but unconventional incentives may also need to be considered to retrain dedicated hunters. These incentives might include 1) making legal exceptions to typical hunting regulations to allow practices such as night-hunting from elevated positions using silent weapons and artificial illumination or light-gathering sights, 2) community assistance with carcass retrieval and delivery to the processor, 3) the community or landowner paying for carcass processing, or 4) partial reimbursement for hunter expenses (e.g., US$50/deer for fuel, hunting equipment, etc.).

One untraditional potential incentive, in modern North America at least, would be permitting the sale of deer killed beyond the needs of the hunters and other willing recipients. In the instance of overabundant deer, it might be necessary to provide this incentive to achieve densities in balance with the general public and natural ecosystems (VerCauteren et al. 2011). This goal-driven, carefully monitored harvest should bear little resemblance to the poorly regulated market-hunting of the late nineteenth century. Also, the traditional model of providing hunter education, which primarily focuses on safety, does not seem adequate to teach hunters how to more effectively harvest deer in overabundant suburban environments to meet density goals often set by local communities and landowners.

Many states have adopted harvest policies that are inconsistent; that is, they continue to acknowledge that urban and suburban deer populations are increasing, but nevertheless believe that their management efforts are working (Urbanek et al. 2011). Our experience is that suburban deer-management programs need to be administered and monitored rigorously, beyond simple harvest statistics, to determine whether goals are being met. We suggest that alternative, non-traditional methods, in addition to advanced hunter training, be considered if population densities $<$17 deer/km^2 within suburban settings are desired. Other tools, such as professional sharpshooting and reproductive control, may possibly have an additive or complimentary effect to hunter harvest through increased mortality and a reduction in recruitment.

MANAGEMENT IMPLICATIONS

Managing state agencies should play an active role in guiding members of the public and municipalities toward specific techniques, as described above, that will achieve deer density objectives rather than simply advocating for hunting in the name of deer management. State agencies should provide outreach information regarding what is required to manage hunters in a way that will result in meaningful population reductions. This effort could be facilitated by professional organizations, such as The Wildlife Society, by establishing an overabundant deer position statement, which would advise best management practices for state agencies and municipalities alike to achieve the difficult long-term goal of maintaining suburban deer densities at $<$10 deer/km^2. As management objectives for deer become more impact-oriented, state agencies will need greater resources to track public opinions about deer and their impacts on humans and to manage both public perception and long-term densities of deer. If suggested actions are heeded, we believe that hunters can help depress deer densities closer to community-desired densities, while also maintaining hunting as the preferred and primary deer-management technique. If hunters cannot, or will not, meet the density objectives of the general public, then hunting alone is not a solution to the management of overabundant deer. Ultimately, we suggest alternative methods for lethal removal of deer be considered to augment legal hunting programs where further reductions of deer are warranted.

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