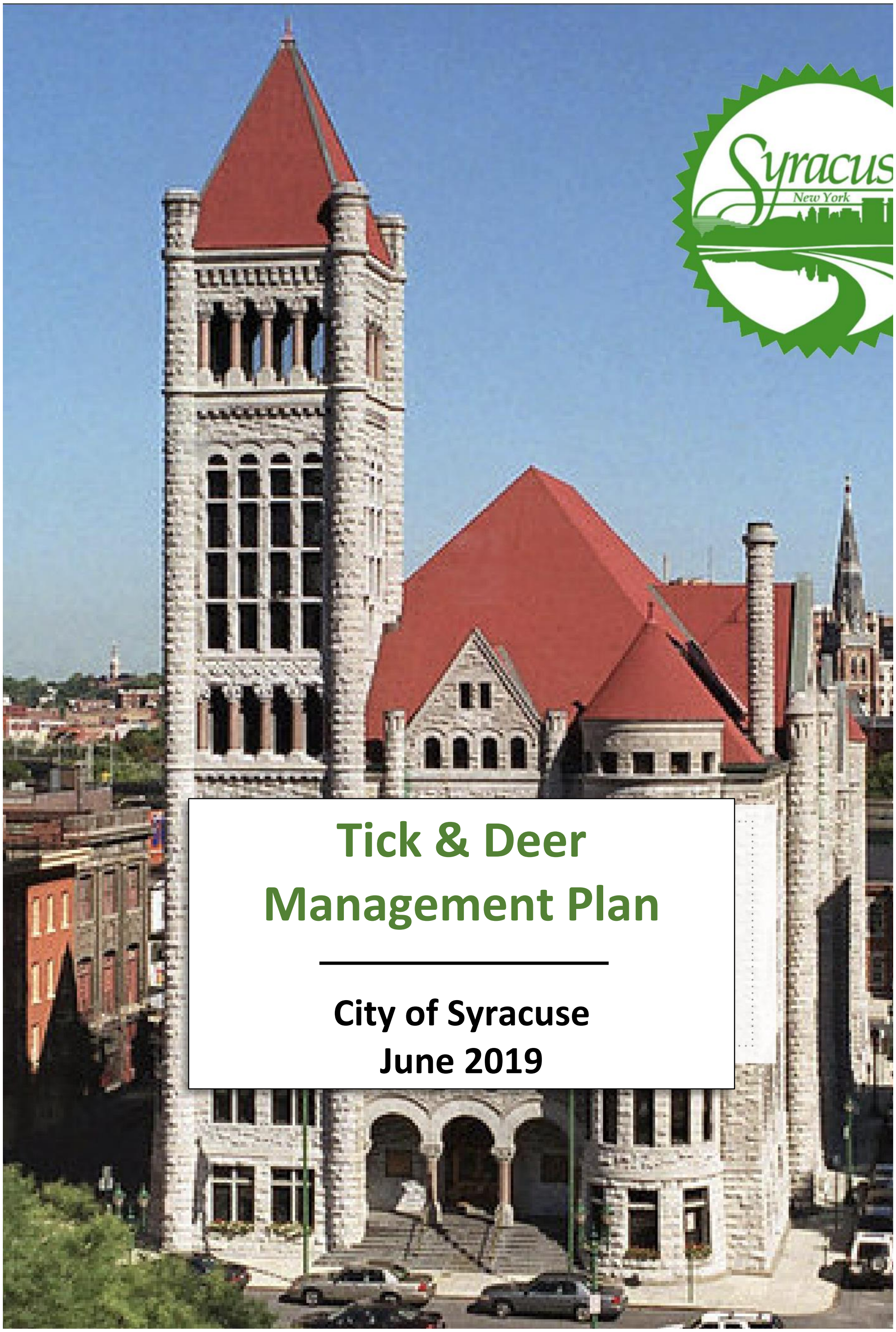


Tick & Deer Management Plan

City of Syracuse
June 2019

Tick & Deer Management Plan

City of Syracuse

Ben Walsh, Mayor

A Report by the Mayor's Advisory Group
June 3, 2019

This report is the work product of the Advisory Group appointed by Syracuse Mayor Ben Walsh on April 15, 2019. He asked the Advisory Group to build on the past efforts of neighborhood groups that have studied tick-borne disease and deer overpopulation in Syracuse.

Mayor Walsh charged the Advisory Group

- to inform residents of Syracuse about the risk of tick-borne diseases and the related problem of deer overpopulation, and
- to recommend a plan for the City of Syracuse to better manage both issues.

The Advisory Group met eight times between April 22 and June 3, 2019 with the able facilitation of Kristina Ferrare, Resource Educator, Cornell Cooperative Extension of Onondaga County (CCE Onondaga).

This report has been researched and written by the Advisory Group with appreciation for the information provided by experts, government officials and advocates who are identified on page 4.

Introduction

For over 30 years the Eastern white-tailed deer (*Odocoileus virginanus*) population in Syracuse, New York has grown, unchecked by natural predators (Underwood, 2019). Recently the New York State (NYS) Department of Environmental Conservation (DEC) recognized that Onondaga County is a part of the state where the overabundance of urban and suburban deer is "most common" (Booth-Binczik & Hurst, 2018).

The impact of an excessive deer population is significant:

- White-tailed deer are the principal hosts for the adult deer ticks (*Ixodes scapularis*), posing a risk to public health through the transmission of Lyme disease and at least five other infectious agents.

- Deer-vehicle collisions pose an increasing danger to public safety.

- Extensive deer foraging harms residential landscapes and urban forests and contributes to soil erosion, stream turbidity, and the invasion of non-native plants.

As these problems have become more apparent, a number of neighborhoods have formed volunteer committees to address them. Tomorrow's Neighborhoods Today (TNT) Eastside formed an Urban Deer Committee in 2012, and the Edgehill Neighborhood Watch has had deer overpopulation on its agenda since then. Neighbors against Ticks & Lyme Disease began in the Winkworth neighborhood (2015), and other neighborhood groups followed: the Westcott Area Deer Committee (2016), the Brookford Bradford Neighbors (2017), Team DeWitt Road (2017), and the Meadowbrook Garden Group (2018). These committees held study sessions, organized public education forums, conducted neighborhood surveys, and engaged elected officials.

Deer and tick populations in Syracuse have been the subject of studies by Brian Underwood, Ph.D., research wildlife biologist at the US Geological Survey's Patuxent Wildlife Research Center, and by Melissa Fierke, Ph.D., chair of the Department of Environmental and Forestry Biology at the State University of New York College of Environmental Science and Forestry (SUNY ESF).

This problem has engaged elected officials, notably Nader Maroun, who served for many years as a member of the Common Council representing District 5; Joe Driscoll, his successor as District 5 representative on the Common Council; Pamela Hunter, representing District 128 in the NYS Assembly, who obtained state funds to support Dr. Underwood's study; County Executive Ryan McMahon and the Onondaga County Legislature, who provided funds for municipal tick and deer management; and Mayor Ben Walsh and the Syracuse Common Council as a whole, who are addressing these issues with funding, ordinance changes, and attention to this report.

Syracuse Tick and Deer Management Advisory Group

Drawing from neighborhood committees, Mayor Walsh appointed a Syracuse Tick and Deer Management Advisory Group in April 2019, and charged the group with recommending a tick and deer management plan for the City on or about June 1.

Between April and June, the group met eight times to confer with experts in wildlife biology and environmental management, to learn from municipalities that have implemented tick and deer management plans, and to study the reports of academics and governmental agencies. Additionally, subgroups met to explore suggestions and develop information for consideration by the Advisory Group.

From deer management programs already active, the Advisory Group learned of the difficulties in measuring plan effectiveness from one year to another. Climate events may affect tick populations. Jurisdictional differences may complicate the compatibility of data reporting. Data may be recorded in varying formats or inconsistent categories by different sources. It is beyond the capability of the Advisory Committee to propose measurement sources or methodologies, but a systematic process for capturing data that are straightforward, replicable, and as easy to use as possible should be an important part of the implementation plan in its first year.

Tick and Deer Management Advisory Group	
City Residents	**City of Syracuse**
Chris Fox	Chris Abbott
Ken Garno	Bob Andrews
Susan Greenman	Ben DeRose
Emilee Lawson Hatch	Joe Driscoll
Kelly McDermitt-Wise	Julie LaFave
Joel Potash, MD	Sarah Lafen
Tom Quinn	Greg Loh
Cornell Cooperative Extension	**Onondaga County**
Kristina Ferrare	Travis Glazer

Presenters to the Advisory Group
Karen Antczak, Animal Alliance of Greater Syracuse
Mitchell Brodey, MD, FamilyCare Medical Group
Paul Curtis, PhD, Cornell College of Agriculture and Life Sciences
Melissa Fierke, PhD, SUNY College of Environmental Science and Forestry
Justin Gansowski, US Department of Agriculture
Vanessa Hulkchanski, Village of Fayetteville
Courtney LaMere, NY Department of Environmental Conservation
Chris Manchester, Town of DeWitt
Jan Markarian, People for Animal Rights
Kristopher Paolino, MD, Upstate Medical University
Brian Underwood, PhD, US Geological Survey

Multiple resources were consulted. A bibliography is included.

Members of the Advisory Group attended TNT meetings during the months of April and May in an effort to engage other neighborhoods with tick and deer concerns. Two public meetings were held: a public education session on May 21, 2019 at Corcoran High School and a public input session to present the management plan on May 28, 2019 at Nottingham High School.

Tick and Deer Overpopulation

The NYS DEC reports that Onondaga County is one of several parts of the state where the overabundance of urban and suburban deer is "most common" (Booth-Binczik & Hurst, 2018). A recent study of Syracuse's Eastside estimated the number of deer at about 50 per square mile. This amount can double about every three years (Meeting Minutes, May 6, 2019).

<u>Lyme Disease</u>

White-tailed deer serve as the primary host for the adult black-legged tick, the vector for Lyme disease and other infections. Accordingly, the deer contribute to a public health risk (Kirkpatrick, et. al, 2014).

Lyme disease is the most common vector borne disease in our state (NYS Department of Health, 2018). Lyme and less common tick-borne diseases have spread to the northern and western areas of our state, and NYS reports the highest number of confirmed cases of Lyme disease in the United States (Brooks & Acquario, 2015).

Tick-borne diseases pose special challenges for medical practitioners and health departments. Symptoms are not always recognized right away, and testing is limited to serologic assays, which require two specimens drawn several weeks apart to confirm infections (NYS Department of Health, 2018). Dr. Indu Gupta, Onondaga County Health Commissioner, and Dr. Quoc Nguyen, Onondaga County Health Department Medical Director, acknowledge that the incidence of Lyme disease is underreported. The US Centers for Disease Control (CDC) estimates that there are ten times more Lyme disease cases than are officially recorded (CDC, 2019).

Lyme disease is endemic in Onondaga County (Gupta & Nguyen, 2017, 2018). It is transmitted to humans by deer ticks, and numerous studies have correlated deer abundance with tick abundance (Kilpatrick et al., 2014). In addition to Lyme disease, deer ticks are also known to transmit anaplasmosis, relapsing fever, ehrlichiosis, babesiosis, and Powassan virus (CDC, 2018).

Adult female deer ticks lay eggs in leaf litter. Tick larvae hatch from eggs and acquire infectious diseases, such as Lyme disease, while feeding on small animals, such as white-footed mice (*Peromyscus leucopus*). Tick larvae develop into nymphs, and the infectious nymphs feed on animals, including humans, potentially transmitting the infection(s) they carry. Nymphs develop into adults, and adult females require a blood meal to reproduce (Public Health Ontario, 2016).

Because they are such large animals, deer provide blood meals for potentially thousands of ticks. One blood meal is necessary for each adult female tick to produce about 2,000 eggs. Ticks themselves may be infected by mice during their life cycle, but large numbers of deer accelerate tick reproduction (Stafford et al., 2014).

A study of 16 Onondaga County sites (about half of which were in the City of Syracuse) has been conducted at SUNY ESF. It showed that the incidence of co-infected ticks is rare in our area. However, the study identified Lyme infection in 14% of nymphs and in 51% of adult ticks in the County (Fierke, 2017).

The number of ticks can be reduced when the number of deer are reduced. To collapse the tick population, however, deer must be fewer than 10 per square mile (Kirkpatrick et al., 2014). This is difficult to achieve by deer population management, at least in the short term. On Syracuse's Eastside alone, deer are estimated at 50 per square mile (Meeting Minutes, May 6, 2019).

<u>Deer-Vehicle Collisions</u>

State Farm Insurance has estimated the number of deer-vehicle collisions in New York State at more than 70,000 a year. The DEC has estimated the cost of such collisions to New York citizens at over $462 million annually (Booth-Binczik & Hurst, 2018). Many Syracuse residents report one or more auto accidents caused by deer in recent years.

<u>Ecosystems</u>

Many City residents have complained about the detrimental impact of deer populations on City parks and neighborhood gardens. There is abundant evidence for this, especially on Syracuse's Eastside, where the situation has worsened in recent years.

The problem of deer overpopulation, however, involves more than damage to neighborhood landscaping. Deer overpopulation harms forest ecosystems, frustrates woodland regrowth, causes excessive water runoff, and fosters the invasion of non-native plant life. In addition, the presence of too many deer may actually damage the herd itself, making it susceptible to parasites and disease.

A recent report by the DEC to the NYS Legislature advises that

> [t]here is a growing awareness of the ecological impacts of deer overabundance. Deer are altering forests across the state, perhaps permanently. Just as livestock can overgraze a range and reduce it to a barren wasteland, deer can over-browse a forest. . . . Browsing by deer at high densities . . . enables invasive species to out-compete natives. It also prevents seedlings of many species from growing into the next generation of trees, ultimately leading to fewer mature trees in a more open plant community with a different and less diverse species composition. . . .
>
> The ecological changes brought about by deer also cascade through forest plant communities into wildlife communities, reducing the abundance and

diversity of songbird species that use the intermediate levels of a forest. . . (Booth-Binczik & Hurst, 2018).

The problems of tick and deer overpopulation are related, are complex, and do not lend themselves to a simple or a single solution. Multiple actions are required, including

- Reducing the size of the deer population,
- Changing local landscape practices, and
- Using protective clothing and insect sprays.

The Advisory Group recognizes that the process of managing tick and deer populations requires a long-term commitment, using adaptive management tools that can be adjusted to changing circumstances and lessons learned.

Management Methods

The Advisory Group reviewed a number of methods for controlling tick and/or deer populations and for reducing exposure to ticks. There is extensive literature as to the advantages and disadvantages of such methods, and this report merely highlights some of them.

<u>Tick Risk Reduction</u>

- Personal Protection

City residents have an opportunity – some might say, a personal responsibility – to help reduce the risk of tick infections. Although personal protection measures are inexpensive, getting individuals to use such measures is challenging (NYS Department of Health, 2018).

When in woodlands or near "tick zones," residents can reduce their risk of exposure by wearing light-colored clothes, long pants, long sleeves, and socks. Shirts and pant legs should be tucked. Reducing access to the skin surface allows more time to locate the tick before it bites and removal is required.

Individuals should perform daily skin tick checks on themselves and their children and know how to safely remove a tick from skin according to the CDC-recommended method. It is encouraged that residents also exercise these personal protection methods and practice tick checks after being outdoors in less obvious "tick zones," like front lawns or park fields. Beyond that, City residents should be aware of safeguards they can take to reduce exposure to tick-borne disease.

Individuals should use repellent containing a 20-30% concentration of DEET on clothes and bare skin. Adults should apply the repellent to their children by first applying the material to their hands and then to the children's skin.

Repellents containing permethrin must be used only on clothing, never on bare skin. Permethrin, an insecticide, may be used to treat clothing, boots and socks but never skin. Permethrin-treated clothing can protect someone for six washes. See: https://tickencounter.org/prevention/permethrin for more information on permethrin.

- Community Education

There are many free information sources to support community education, including websites by Cornell University, the CDC, the NYS DEC, the University of Rhode Island, and more. The bibliography contains excellent information resources. Locally, CCE Onondaga (CCE) has an excellent track record for providing community education about deer, ticks and tick bite risk reduction. CCE provides workshops and facilitates community groups wishing to address deer populations related to tick exposure – such as the Syracuse Tick and Deer Management Advisory Group. In addition, CCE assists tick drag workshops to educate the public and help monitor tick numbers. CCE can also provide materials for school nurses to identify tick bite related symptoms.

- 4-Poster Passive Feeding Station

A 4-poster bait station administers acaricide to a deer as it feeds. Acaricide is a poison that kills ticks, preventing them from attaching to individual deer and depriving ticks of the opportunity to reproduce. Because deer are a primary transporter of ticks, this helps control the spread of ticks into non-infested areas.

Because it is a feeding station, the 4-poster device actually attracts deer (and other nuisance wildlife) into an area and can add hazards for motor vehicle accidents. These devices require daily attention to maintain feed levels. A 4-poster requires a permit from the Special Licenses Unit of the NYS DEC, and a state-registered pesticide applicator must oversee the treated rollers. Additionally, NYS DEC requires municipalities using the 4-poster station to also use lethal management to lower the deer population.

- Tick Tubes

Tick tubes are biodegradable, cardboard tubes filled with cotton balls that are treated with permethrin, an insecticide. Mice collect the cotton to build nests, and the ticks that feed on mice come into contact with the cotton balls, exposing them to permethrin and killing them. These tubes are available locally and provide an environmentally friendly, easy-to-use option. Permethrin can be harmful to cats, however.

Research on tick tubes shows inconsistent results, partially due to variable use of the cotton by the mice. Some studies have shown that systematic use of tick tubes on property of a certain size can reduce the number of ticks on mice. In other cases, the use of tick tubes was seen to have no effect on the number of ticks (Cornell, 2019).

- Tick Box Control System

The Tick Box Control System (TBCS) is a device that lures field mice and chipmunks inside a box with non-toxic food bait where they are treated with a tick-killing product. The active ingredient is fipronil, which is found in some spot-on/topical treatments for pets. One short-term study demonstrated that these boxes can reduce the number of tick nymphs. Several studies are still evaluating the use of these boxes over large areas. TBCS devices must be purchased, installed, and managed by a state registered pesticide applicator (Cornell, 2019).

- Landscaping

Landowners can do several things to reduce the risk of tick bites through landscape management:

  - Identify "tick zones," the areas of forest and brush where deer, rodents, and ticks are common.
  - Maintain three-foot barriers of wood chips or rocks to separate a "tick zone" from the lawn.
  - Maintain a nine-foot buffer between the wood chips and high-areas such as patios, gardens and play sets.
  - Keep children's play areas away from “tick zones” and placed on wood chips or sand.
  - Mow lawns and remove brush often.
  - Avoid conditions favorable to ticks, such as ground cover, leaf litter, and dark and humid spaces.

Tick Risk Reduction	Advantages	Disadvantages
Personal Protection	Excellent information available on many websites CCE provides public workshops at no cost There are low-cost ways to reduce risk of exposure	None
Community Education	CCE provides public education at no cost Classroom education for at-risk school children Helps public recognize symptoms, seek treatment Trains volunteers to monitor, document tick numbers	None
4-Poster Feeding Station	Kills ticks, not deer	More expensive (daily maintenance) Feed station attracts deer, adding to population Attracts other wildlife to food source Requires separate DEC permit Requires certified pesticide applicators
Tick Tubes	Biodegradable tubes help control ticks on mice Adds protection to residents' yards	8-16 tubes per yard, applied twice each season Cost about $2.00 each Permethrin can be harmful to cats
Tick Control Box System	Can reduce the number of tick nymphs	Large-area effectiveness not demonstrated Requires certified pesticide applicators
Landscaping	CCE provides public education Low-cost ways to improve yard safety	None

Non-Lethal Methods of Deer Management

- Fencing

Fencing prevents deer movement by means of a physical barrier. To be effective, fencing must be at least 10 feet high and must not have openings through which deer may enter. Fencing is not feasible due to the large areas of City neighborhoods, municipal zoning restrictions, and installation and maintenance costs.

- Habitat Alteration

Habitat alteration means altering the vegetative landscape within large, designated areas to reduce or eliminate plant life that deer use for forage and shelter. Although residents may practice preventative landscaping on individual properties, this method is not feasible due to the size of the City neighborhoods and the extensive habitat alteration that would be involved.

- Capture and Relocation

The practice of capture and relocation to reduce the deer population requires trapping deer and transporting them elsewhere for release. This requires a research permit. Additionally, survival of relocated deer tends to be poor with up to three-quarters not surviving the first year after release.

- Fertility Control

Sterilization (surgical) and immunocontraception (medication) have been used by some municipalities as methods of birth control, in an effort to slow the growth of deer populations. These techniques, however, are not effective in controlling free-ranging deer populations. Municipalities may receive a DEC permit to use surgical sterilization as part of a deer management program, provided that lethal population reduction methods are used concurrently in nearby areas. Immunocontraception can only be performed using a research permit. See: https://www.dec.ny.gov/animals/104961.html

Communities that have tried fertility control as the sole solution have found it inadequate. The rate of deer reproduction may be reduced, but the abundant deer population remains on the landscape. Absent disease, predation, or a motor vehicle accident or other fatal injury, an individual deer can live for two decades.

Fertility control programs are costly and require handling and tagging all deer in the program. Also, fertility programs do not address damage to the environment or the spread of ticks and tick-borne diseases.

It is possible for an adaptive management program to include fertility control. Such a plan would employ surgical sterilization of female deer and be conducted frequently to assure that females moving into the area are treated.

Non-Lethal Methods	Advantages	Disadvantages
Fencing	Prevents deer from enclosed area	Must be a minimum 10 feet tall City law restricts fencing to 6 feet only Fencing is expensive Not feasible for large city areas
Habitat Alteration	Discourages foraging by deer Individuals can alter vegetation in their yards	If hungry, deer eat non-preferred vegetation Not feasible for large city areas
Capture & Relocate	Avoids euthanizing deer	DEC prohibits trapping and relocation Poor survival rates for relocated deer Migrant deer would easily replace the population
Fertility Control (Surgical)	Avoids euthanizing deer	More expensive (vet fees, deer tags) Does not control migrating deer Approved only in combination with lethal method Does not reduce motor vehicle accidents Does not reduce tick numbers Does not reduce ecological damage
Fertility Control (Immunocontraception)	Avoids euthanizing deer	More expensive (repeat vaccinations, deer tags) Does not control migrating deer Requires a DEC research permit Approved only in combination with lethal method Does not reduce motor vehicle accidents Does not reduce tick numbers Does not reduce ecological damage

Lethal Methods of Deer Management

- Predator Control

The introduction of large mammalian predators, although theoretically possible, would generate safety concerns for City residents. Furthermore, the City does not contain suitable habitat for such predators.

- Parasite or Disease Introduction

The risks and uncertainties associated with parasite or disease introduction make it an impractical option for deer population control.

- Poison

There are no toxins, poisons, or lethal baits currently registered for deer control.

- Traditional Hunting

Hunting is not legal in the City. There is no hunting season in Syracuse.

- Controlled Hunting

Controlled hunting occurs during the normal hunting season. It is structured as a formal arrangement between a landowner and hunters. Landowners have the right to impose hunting rules on their land which differ from the restrictions imposed by laws. Since hunting is not legal in the City, controlled hunting is not an option for Syracuse.

- Managed Bait and Kill (Culling)

The bait and kill method involves baiting deer to strategic locations that comply with state law and landowner authorization. This method is useful in large, designated areas where traditional hunting is not allowed.

When a deer is feeding, a qualified sharpshooter kills the animal using a rifle with noise suppression. This method is characterized by careful site selection, trained and experienced sharpshooters, and electronic surveillance to assure a safe cull without damage to human life or property.

Professional sharpshooters are employed by the United State Department of Agriculture (USDA). The NYS DEC issues tags directly to the permit holder, which will be the City of Syracuse. USDA selects individual sites to assure a safe line of fire in consultation with the permit holder. A managed bait and kill operation ensures a quick and humane cull with the best chance for a meaningful reduction in deer population.

Archers sometimes substitute for sharpshooters, using bows or crossbows (regulations differ somewhat). Using non-professional archers, who must be recruited and qualified, adds complexity with respect to certification, scheduling, and oversight. Archery may result in more wounded animals that need to be tracked and killed.

It is the right of landowners to restrict the times and dates individuals are allowed on property, stand locations, bait locations and access routes. An agreement to use one's property may be terminated by a landowner at any time.

A municipality typically contracts with USDA Wildlife Services for the bait and kill method. USDA Wildlife Services oversees the process and conducts culling over a 24-hour period. Actual shooting occurs during the night. Exact times cannot be predicted and are dependent on wind direction, participation schedules and weather. Bait stations are usually established one to three weeks before the start of culling and are maintained daily. All deer are discreetly removed by sled, and the meat is promptly processed and donated to a food bank.

- Trap and Kill

The trap and kill method uses a small box cage, which is baited with corn to attract deer. It is monitored by a live video feed. This method may be used when the bait and kill method is not feasible, due to required setbacks from dwellings and roads.

When a deer is trapped inside a cage, a wildlife professional approaches the cage and kills the deer by using a captive bolt device. This device kills instantly without pain. It is the same method used by the meat processing industry.

Lethal Methods	Advantages	Disadvantages
Predator Control	Does not use firearms or traps Restores a natural predation process	Predator risk for residents, especially children City habitat not suitable for predators Predator introduction not permitted by law
Parasite/Disease Introduction	Does not use firearms or traps	Many risks and uncertainties Not practical for control of deer populations
Poison	Does not use firearms or traps	No toxins or poisons allowed for deer control Venison not suitable for human consumption Special disposal to prevent wildlife scavaging
Traditional Hunting	Takes advantage of interested hunters Provides meat for food	Hunting is illegal in the city Hunters' interest wanes after 1-2 deer
Controlled Hunting	Takes advantage of interested hunters Provides meat for food	Hunting is illegal in the city Hunters' interest wanes after 2-3 deer Significant effort to identify & qualify hunters
Managed Bait & Kill (Firearms)	Humane and most effective Sharpshooters are trained & experienced Exacting site and line-of-sight selection Excellent safety record, using infrared and night vision Firearms equipped with noise suppression Deer removed promptly on sled to minimize urban disruption Supplies meat for food pantry	Bait pile is maintained 1-3 weeks before culling begins Requires setbacks, 500 feet (dwellings), and 300 feet (roads) Waiver of 500 feet setback requires written permission of owner
Managed Bait & Kill (Archery)	Humane and effective Sharpshooters are trained & experienced Exacting site and line-of-sight selection Excellent safety record, using infrared and night vision Setback is 150 feet (bows) & 250 feet (crossbows) -- less than for firearms Deer removed promptly on sled to minimize urban disruption Supplies meat for food pantry	Bait pile is maintained 1-3 weeks before culling begins Requires 300 feet setback (roads) Wounded deer must be tracked and killed
Trap & Kill	Useful in urban areas if firearms not possible Captive bolt is the same device used in the meat processing industry Cage monitored by live video feed Supplies meat for food pantry	Deer panics when trapped, takes minutes to settle

Tick and Deer Plan Management Plan Impact Monitoring

It is important, yet challenging, to assess the effectiveness of a management plan. Direct methods of counting deer, such as aerial surveillance and field studies are expensive. Indications of the tick population are possible using site collection techniques. Indications of the deer population typically involve indirect methods of assessing damage to urban and suburban flora.

- Assessing Vegetation Impacts from Deer (AVID)

AVID is a protocol developed by Cornell University's Department of Natural Resources. This is easy to conduct annually and can be implemented across large natural areas by volunteers trained by CCE Onondaga. The AVID staff collect field data that track tree, shrub, and wildflower response to browsing deer over a period of time. This knowledge can help guide the deer management plan in subsequent years.

- Tick Drags

Tick drags can be performed semiannually by CCE Onondaga, City staff, and/or resident volunteers to determine tick numbers. Persons doing a tick drag capture ticks by dragging a standardized white sheet across an area susceptible to ticks. Captured ticks may be tested for Lyme disease and other infections. Drags are performed in areas with a landowner's permission and typically take place on one day in the fall and one day in the spring. Successful drags are conducted on days without rain with temperatures above 45 degrees.

In addition to the CCE Onondaga or City events, residents can participate in the management plan by helping to collect tick data in back yards or local parks. TNT groups are great sources of community participation and could be sources of good data on tick populations.

Monitoring & Input	Advantages	Disadvantages
AVID Protocol	Low cost, indirect indication of deer density CCE can provide training Objective measure of impact over time	None
Tick Drags	Direct sampling of tick numbers CCE can provide training Ticks may be tested for Lyme disease SUNY ESF can assist, using data for research Objective measure of impact over time	None
Notification & Citizen Input	Provides transparency Facilitates resident input & support Source of qualitative evaluation	None

- Notification and Citizen Input

Citizen input and municipal transparency are important parts of a wildlife management plan. A resident advisory panel can provide ideas and support for a management plan as it is evaluated and updated annually.

The Advisory Group appointed by Mayor Ben Walsh can be a model for an ongoing process of input and review. A standing advisory process will facilitate updates for citizens on the adaptive management plan as it progresses – or needs to change – over time.

Conclusions and Recommendations

The Advisory Committee is sensitive to differing experiences regarding tick and deer overpopulation within a single municipality. Residents may report greater or lesser problems, depending on the local geography.

Syracuse's Eastside has been studied more extensively than other areas of the City. Is that because problems are more acute there? Or is an awareness of the Eastside problem more pronounced because it has been the subject of more study? The Advisory Committee reached out to TNT groups in other parts of the City for indications of tick and deer awareness. This contact was merely preliminary. A multi-year management plan should include monitoring this issue in all sectors so that the management plan, as updated annually, reflects the extent and diversity of the City's experience.

Natural predators for deer are very rare in urban and suburban environments -- and have been so for many decades. A female deer produces two or more fawns annually, and without predators and with ample food supply, a deer population can double in three years. Therefore, just to maintain a stable deer population, the deer herd needs to be reduced by approximately one-third each season. To actually <u>reduce</u> the deer population will require even more aggressive goals (Booth-Binczik & Hurst, 2018).

Many management methods have been tried and tested elsewhere (fencing, pesticides, sterilization, etc.). While there may be a place for such methods in an adaptive deer management program, none of these methods is satisfactory by itself. Deer culling is the only effective way to reduce deer overpopulation in significant numbers, at least in the early years.

Based on its study, its consultation with experts, and its deliberations, the Syracuse Tick and Deer Management Advisory Group makes the following recommendations.

<u>1. Long-Term</u>
Tick and deer overpopulation is a complex problem that has developed over many years. It affects public health, public safety and the quality of City life. A solution will not be achieved in a few years. Starting a tick and deer management program requires a commitment by the City and its citizens for the long-term.

2. Adaptive Management

A tick and deer program should encompass adaptive management – that is, the ability to use a variety of tools to achieve better control of the tick and deer populations. It should assess the effectiveness of the management plan annually, making adjustments as necessary.

3. Cooperation and support

Effective tick and deer management requires informed and supportive citizens, the cooperation of City and County governments, and effective coordination among City departments such as Parks & Recreation and Police.

4. Community Education

An important part of a management plan is community education, so that City residents understand the personal actions they can take to reduce their exposure to tick-borne infections.

5. Community Input and Transparency

A standing advisory committee will help the City provide transparency for its tick and deer management plan, facilitate resident input, and support adaptive changes to the management program as circumstances may change.

6. Culling

After examining both lethal and non-lethal deer management methods, the Advisory Group recommends that the City initiate culling of the deer herd, starting in the fall of 2019.

Advisory Group Recommendations
1. Commit to long-term management program
2. Implement plan using adaptive management methods
3. Keep residents informed about plan and coordinate implementation among City departments and with County, Towns, and Villages
4. Educate residents regarding personal safeguards
5. Use citizens' committee for input and support
6. Cull the deer herd in significant numbers by certified sharpshooters using safe methods
7. Use alternate lethal and non-lethal methods to manage deer population, consistent with law and landowner authorization, as circumstances may require
8. Use public and private property for culling sites
9. Donate all meat to food bank
10. Use qualitative and objective tools to measure program impact annually and update plan as indicated

Culling is most effective when a bait and kill method is used. The use of trained and experienced sharpshooters is essential for reducing deer density in significant enough numbers for a potential impact on the tick population, reducing the incidence of motor vehicle accidents, and beginning the recovery of urban woodlands and neighborhood flora. An effective culling program must employ special tools for safety and must be minimally intrusive on public and private properties.

7. Other Methods of Control

Although the bait and kill method is recommended, other culling and non-lethal control methods may be useful in specific situations and should be considered within the adaptive management approach. The trap and kill method, for example, could be used to reach deer in areas where required setbacks cannot be achieved. Non-lethal methods could be combined in these areas to lower reproductive rates of remaining does.

8. Public and Private Involvement

The tick and deer management program will be most successful if it includes a mix of public and private properties, and if it involves a mix of public action (culling, volunteer impact monitoring) and private behaviors (landscaping changes, use of personal safeguards). Residents can support the program by authorizing use of their own properties where circumstances warrant and by supporting their neighbors who do so.

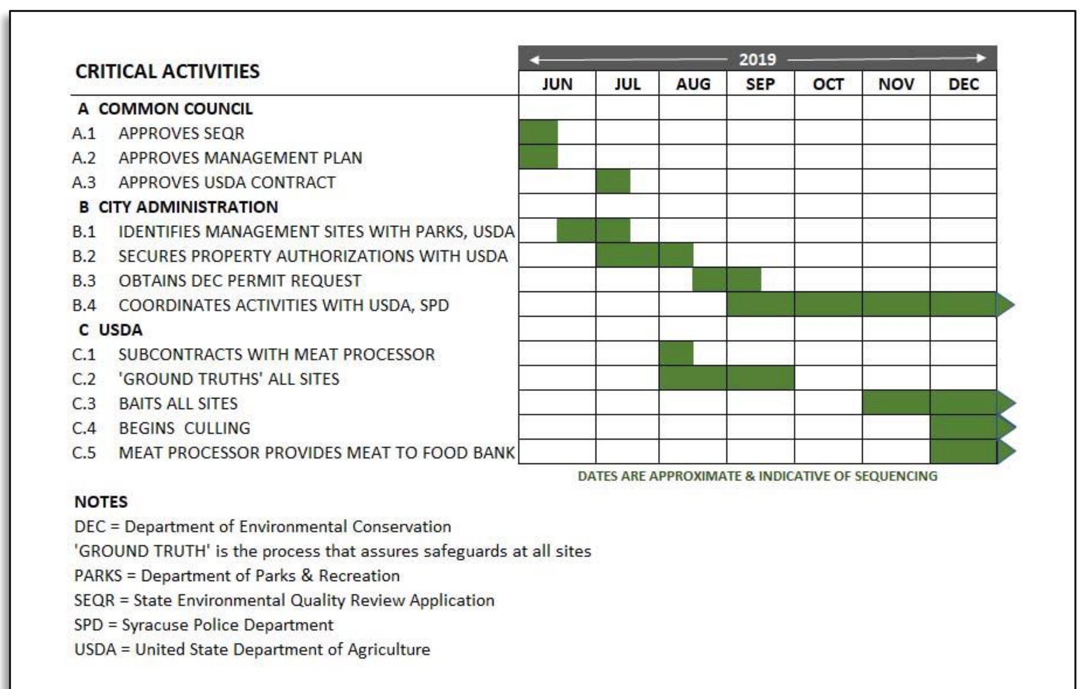
9. Food Bank

Meat from culling will be donated to a food bank.

10. Impact Measurement

Although difficult to measure, the effectiveness of tick and deer population management will be assessed by quantitative and qualitative tools over the long-term. This will require the active involvement of municipal departments and neighborhood residents as well as CCE Onondaga, the NYS DEC, and the USDA.

Next Steps (PERT Chart)



Conclusion

Tick and deer overpopulations are a complex problem with implications for all levels of government: NYS, Onondaga County, and the City of Syracuse.

The Advisory Group has observed excellent cooperation with the County agreeing to reimburse City costs for the management program and with the City convening a residents' group to recommend a path forward.

There is also a fine example of state cooperation, with Assembly Member Hunter having obtained state funds to study the problem on Syracuse's Eastside.

The Advisory Group sees opportunities for additional, meaningful cooperation.

For example, changes in NYS law affecting DEC permits could significantly improve the effectiveness of deer management plans in urban areas. This requires a change to Environmental Conservation Law, which should be supported by all state and local elected representatives.

As another example, the Advisory Committee envisions an active role for the County Health Department – not only in supporting public education about the prevention and diagnosis of tick-borne disease, but also in developing awareness among local medical professionals to support more consistent adherence to diagnostic and treatment protocols, and reporting requirements, for Lyme disease.

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Appendices

A. Management Areas and Program Logistics 2019-2020
B. FAQs
C. Deer Management Handbook for Communities in New York
D. An Integrated Approach for Managing White-Tailed Deer in Suburban Environments: The Cornell University Study
E. Deer Management in Urban and Suburban Areas of New York State, A Report to the New York State Senate and Assembly by the Department of Environmental Conservation

Appendix A

Appendix A
Management Areas and Program Logistics 2019-2020

Management areas will be on private and public land located within the City of Syracuse municipal boundary. A designated representative from the City will work with USDA Wildlife Services to identify areas that meet all local and state laws and Deer Damage Permit requirements. Permission from landowners is required in order for activities to begin.

Site locations will be submitted with the permit application to NYS DEC.

Methods
Managed bait and kill (culling) is the preferred method. USDA Wildlife Services will be used for initial bait and shoot procedures. Professionals will use rifles with sound suppressors for culling. NYS DEC will issue all tags directly to the permit holder, the City of Syracuse.

Trap and kill using box traps may be considered if setback distances for culling cannot be met and the property is located in an area where deer impacts are high.

Dates and Times
USDA Wildlife Services will operate 24-hour shooting. Actual shooting happens during the night. Exact times cannot be predicted and are dependent on wind direction, participation schedules and weather. Bait stations are usually established one to three weeks before the start of culling and are maintained daily.

Safety Considerations
Protecting the safety of property owners, property, pets, other wildlife, bystanders, and participants is of the highest priority for all culling activities.

Establishment of Bait Stations and Stand Locations
Bait Stations and stand locations will be determined by the USDA Wildlife Services.

It is the right of each landowner to restrict the number of individuals on their property, the times and dates participants are allowed on properties, stand locations, baiting locations and access routes. The agreement to use private properties can be terminated by landowners at any time.

Tracking, Field Dressing and Processing of Deer
It is understood that despite all precautions and skill, deer may be wounded, may not expire immediately, may expire on neighboring properties, or may not be found. Every effort possible will be made, including the possible use of

trained dogs, to recover all animals or assure that they suffered only a superficial wound that will quickly heal.

When possible, participants will have pre-authorization to retrieve deer from adjoining properties. All participants will have the names and phone numbers of neighbors should they need to be contacted regarding deer retrieval. In most instances landowners/neighbors will not notice activities or deer harvest because it happens quickly and quietly.

Participants may use flashlights to track deer after they are shot or when traveling to/from trees stands; therefore, property owners may notice slow moving lights. In very rare circumstances, tracking operations may continue the following morning with better light. In the event a deer is wounded and mobile, or has expired on property that lacks pre-approved access, the Onondaga County Sheriff's Department or the Syracuse Police Department will be contacted to assist in locating and/or collecting the deer.

Once a deer is recovered, it will be removed discreetly and field dressed and processed at the processing facility identified by USDA Wildlife Services.

All harvested deer will be donated to local food banks and pantries.

Program Review Activities
The Advisory Group will meet regularly during the program to review activities and determine if the program should continue or be terminated. The Advisory Group and the City of Syracuse will provide regular updates to the New York State Department of Environmental Conservation.

Public Notification and Citizen Input
The views of citizens, businesses, and interest groups are valuable and will continue to help shape the management program. The development, implementation, and review of this program will be transparent and will involve citizen input at every step. The public is encouraged to attend and participate at tick and deer education meetings and public information meetings.

Success Measurement Procedures
In order to measure the success of tick and deer population control several methods will be implemented.

Annual surveys of neighbors will be implemented to determine impact on deer-vehicle incidents, property damage, and native plant damage.
Tick drags may be performed bi-annually in areas with landowner's permission to monitor tick species and population changes.

A vegetation protocol, such as Cornell's AVID Protocol, may be performed annually on appropriate forested areas to assess impacts on forest vegetation.

The management plan will be reviewed and amended annually (adaptive management) to adjust for these findings and add or subject management areas.

Appendix B

Syracuse Tick and Deer Management Advisory Group
June 2019

Frequently Asked Questions (FAQs)

1. What diseases may be transmitted by deer ticks?

A. The blacklegged tick is known to transmit Lyme disease, anaplasmosis, relapsing fever, ehrlichiosis, babesiosis, and/or Powassan virus.

2. How do ticks become infected and spread disease?

A. Female adult ticks lay eggs in leaf litter. Tick larvae hatch from eggs and acquire infectious diseases, such as Lyme disease, while blood feeding on small animals, such as white-footed mice, who are infected with the Lyme disease bacteria. Tick larvae develop into nymphs, and infectious nymphs feed on animals and humans, potentially transmitting infection(s) they carry. Nymphs develop into adults, and female adults require a blood meal to reproduce. Adult ticks feed on large animals, notably humans and white-tail deer. (Update on Lyme Disease Prevention and Control, p. 5)

3. If white-footed mice carry bacteria that infect ticks, why is it necessary to control the deer population?

A. Deer are large animals. Each deer potentially provides a blood meal for thousands of ticks. One blood meal is necessary for each adult female tick to produce about 2,000 eggs. Ticks themselves are infected by the mice during the life cycle, and the large numbers of reproducing ticks are from feeding on deer. Deer also play a significant role in spreading ticks to new locations. **SEE ENDNOTES CITATION A.**

4. Is deer fencing effective at controlling the tick population?

A. Yes, deer fence can be effective if an entire area is enclosed, and the fence is intact (no openings). This is not practical for a city the size of Syracuse. **SEE ENDNOTES CITATION B.**

5. Is anti-tick pesticide effective in treating ticks on deer?

A. Yes, pesticide is effective. It kills ticks that feed on deer. To apply the pesticide, you need to attract deer to feeding stations, which are expensive to maintain. Feeding stations also attract other animals, such as racoons and even more deer. Therefore, feeding stations do nothing to reduce deer overpopulation or keep it from growing. **SEE ENDNOTES CITATION C.**

6. Is culling the deer herd effective in reducing the risk of Lyme disease?

A. The number of ticks is reduced when the number of deer is reduced. To collapse the tick population, deer must be fewer than 10 per square mile. On the Syracuse eastside alone, deer are estimated at 50 per square mile.

While ticks would be reduced by culling deer, the ticks would not be eliminated. Therefore, other measures remain necessary to further reduce the risk of tick-borne diseases. **SEE ENDNOTES CITATION D.**

7. Is fertility control effective in reducing deer overpopulation?

A. Fertility control/sterilization seems to be a good idea because no killing is involved. But sterilization is not effective where deer are free to roam – the deer population is not reduced and may continue to grow from migrating deer.

Sterilization can be effective in controlled areas where a population is enclosed (an island or fenced-in area). Sterilization does not reduce the density of deer. Consequently, sterilization will not reduce tick numbers, motor vehicle accidents, or environmental degradation.

Sterilization is also significantly more costly than the alternatives. **SEE ENDNOTES CITATION E.**

8. Where are deer overpopulated?

A. The state Department of Environmental Conservation reports that Onondaga County has one of the highest concentrations of deer within the state.

A recent study of Syracuse's eastside estimated the number of deer at about 50 per square mile – and doubling every three years.

There are no formal studies of other sections of Syracuse, although neighborhood anecdotal reports indicate growing deer populations on the southside (Webster Pond, Rand Tract), westside (Sedgwick and Winkworth) and northside (Assumption Cemetery, Court Street). **SEE ENDNOTES CITATION F.**

9. How quickly could a deer management program reduce the deer heard in a meaningful way?

A. Recent computer modeling for the Syracuse eastside suggests the deer herd could be reduced by an estimated 1/3 to 2/3 over five years depending on how many culling sites were involved.

Deer management requires a long term commitment. It cannot be accomplished in a few years. **SEE ENDNOTES CITATION G.**

10. Who is responsible for controlling Lyme and other vector borne diseases?

A. Reducing the risk of tick-borne diseases requires a coordinated management approach.

The government has responsibilities for public health (such as managing tick-borne diseases) and public safety (such as managing the deer herd).

Individuals too have responsibilities for protecting themselves (such as wearing protective clothing) and safeguarding neighborhoods (such as reducing yard leaf clutter). **SEE ENDNOTES CITATION H.**

11. What are the impediments to effective deer population control?

Many things can interfere with the ability to manage the deer population: limited land available to hunters, lack of cooperation among levels of government, lack of long term commitment, inadequate funds, and a lack of community support -- to name several examples.

Deer management can also fail for technical reasons such as not taking advantage of more than one means of control as circumstances change or poor culling methods that train deer to avoid traps or sharpshooters. **SEE ENDNOTES CITATION I.**

12. How long should a deer management program last?

Experts caution that starting a deer management program can be a mistake if the community does not appreciate that a long-term commitment is required.

A program may begin modestly as systems and procedures are put in place, but it needs to ramp up to achieve large reductions in the deer population (50%-75% reduction) over five years. As goals are realized, a maintenance approach may be adopted.

With ready access to food and zero presence of predators or hunting (as in urban and suburban areas), the deer population can double every three years. Experts advise the Mayor's Advisory Group to recommend an initial planning commitment of five or even ten years.

With an open population (deer free to wander and forage anywhere) herd management will be required indefinitely – from this point forward. **SEE ENDNOTES CITATION J.**

13. Besides disease, what are other concerns with deer overpopulation?

In addition to the risk of Lyme and other diseases, deer overpopulation is a leading cause of motor vehicle accidents and damage to ecosystems.

More than causing damage to neighborhood flowers and plants, deer overpopulation harms forest ecosystems, frustrating forest regrowth, causing excessive water runoff, and fostering the invasion of non-native plant life.

Too many deer also harm the herd itself, making it susceptible to parasites and disease. Today's deer overpopulation would accelerate the spread of chronic wasting disease if it were to return to New York State. **SEE ENDNOTES CITATION K**

14. How serious are deer-caused auto accidents?

State Farm Insurance estimates the number of deer-vehicle collisions in New York State at more than 70,000 a year. The DEC estimates the cost to New York citizens of deer collisions at over $462 million annually. **SEE ENDNOTES CITATION L**

15. Is culling truly necessary for control of the deer population?

Deer are a prey species. Their evolutionary survival depends upon escaping predators and producing multiple offspring. Natural predators for deer do not exist in urban and suburban environments. A female deer produces two or more fawns annually.

Just for the deer population to remain stable, it needs to be reduced by at least 1/3 every year – so, actually reducing the population requires even more aggressive goals.

Many management methods have been tried and tested elsewhere – fencing, pesticides, sterilization, etc. While there may be a place for such methods in an integrated deer management program, none of these methods is satisfactory by itself. Deer culling is the only effective way to reduce deer overpopulation in significant numbers. **SEE ENDNOTES CITATION M**

16. Why can't deer be captured and relocated instead of killing them?

A relocation program could injure or kill the deer and it would risk spreading disease.

Capturing and relocating deer is illegal in New York State. **SEE ENDNOTES CITATION N.**

17. Besides Lyme, are there other tick borne diseases?

Lyme disease is the best known tick-borne infection, but ticks can spread multiple other diseases with symptoms that include headache, fever, chills confusion, rashes, gastrointestinal illness and jaundice. A rare disease, although seen more frequently in New York State in recent years, the Powassan virus progresses to encephalitis with significant consequences for those infected. **SEE ENDNOTES CITATION O.**

18. Why isn't there a vaccine for Lyme disease for humans?

There was a vaccine for Lyme disease some years ago, but it was available only for a short time due to concerns about complications and lawsuits. Reportedly, another vaccine is in the works.

FAQ ENDNOTES
Verbatim Citations

CITATION A.
If white-footed mice carry bacteria that infect ticks, why is it necessary to control the deer population?

"While white-tailed deer are not reservoirs for Lyme disease and do not infect ticks with *B. burgdorferi* (Lyme disease infection), these animals are the principal hosts for the adult ticks and overall tick abundance has been closely linked to the abundance of these animals. Deer may have at least 10 to 50 female ticks attaching and dropping off each day through the fall and spring when adult ticks are active. Each female tick lays around 2,000 eggs and then dies.

"While the adult *I. scapularis* (blacklegged ticks) will feed on other animal hosts ranging from dog and cats to opossums, racoons, foxes, coyotes, and skunks. . . . [T]hese other larger animals contribute only a small or modest fraction of the total engorged female ticks to the environment and 50-94% of all engorged female ticks are estimated to come from feeding on deer. It is questionable if *I. scapularis* can be maintained in significant numbers just from feeding on these medium-sized alternate animal hosts. Male *Ixodes* ticks do not require a blood meal and primarily seek female ticks on the animals to mate. Therefore, broadly speaking, deer are responsible for the reproductive success of the tick and mice and other reservoir hosts for the prevalence of infection with tick-borne disease agents." (Stafford and Williams, p. 3)

CITATION B.
Is deer fencing effective at controlling the tick population?

"Deer fencing can be an effective method of excluding or restricting deer from specific areas. This approach is generally limited to relatively smaller areas or around homes because of installation and maintenance costs, depending on the type and length of fence. In Connecticut, the use of a high tensile electric deer fence at two properties of 8 and 15 acres reduced nymphal and adult *I. scapularis* numbers by 85 and 74%, respectively. No larval ticks were recovered farther than 70 yards inside the exclosures. Similarly, blacklegged tick numbers rapidly declined inside a fenced tract in New York with 84% fewer nymphs inside the fenced area." (Stafford and Williams, p. 4)

CITATION C.
Is anti-tick pesticide effective in treating ticks on deer?

"A '4-poster' feeding device consists of a bin to hold corn and 4 rollers to apply a pesticide. . . (10% permethrin) to kill ticks on deer when they feed. Licensed by the American Lyme Disease Foundation (www.aldf.com), use of the 4-poster device is not approved in all states and permits from state wildlife authorities will generally be required. . . . In a five state multi-year project of treated neighborhoods or areas, blacklegged ticks were reduced by roughly 60-70% over 5 years of use (~one 4-poster per 120 ac) and further evaluation of the study in Connecticut found a significant impact on the incidence of Lyme disease." (Stafford and Williams, p. 4)

CITATION D.
Is culling the deer herd effective in reducing the risk of Lyme disease?

“The incremental removal, reduction or elimination of deer has clearly been shown to substantially reduce tick abundance in a number of studies conducted on islands or other geographically isolated areas. Observational studies and computer models suggest that a reduction of deer densities to less than twenty deer per square mile may significantly reduce tick bite risk, while lower levels (~8 deer/mi2) would interrupt the enzootic cycle of Lyme disease and transmission of B. burgdorferi to wildlife and humans. Fewer ticks have been reported at deer densities less than 18 animals/mi2 in one study.” (Stafford and Williams, p. 4)

Also: In discussion with the Mayor’s Advisory Committee, Paul Curtis, PhD, Extension Wildlife Specialist, Department of Natural Resources, Cornell University, said that “[a] dramatic reduction in the tick population should not be expected in the short term. According to Dr. Curtis, a tick population will collapse only when the density of deer is below 10/ mi2.” Based on his study, Brian Underwood, PhD, Research Wildlife Biologist, USGS Patuxent Wildlife Research Center “estimates the density of deer on the eastside at approximately 50/ mi2.” (Minutes, May 6, 2019)

CITATION E.
Is fertility control effective in reducing deer overpopulation?

“People who are disturbed by the idea of killing animals often wish to control deer populations by reducing the birth rate rather than increasing the death rate. Yet, even with effective fertility control, this wouldn’t be a good way to reduce impacts of deer because it would just keep populations from growing; it wouldn’t lower them. Deer can live to be 20 years old, so population reduction would happen slowly, if at all. . . .

“The problem is that deer have such a high reproductive rate that a few fertile individuals can produce enough young to replace the small number of deer that die each year in urban and suburban settings. Wary individuals who are able to avoid capture and treatment, along with immigrants moving in from neighboring areas, provide more than enough reproductive capability to overwhelm fertility control efforts in the majority of cases. . . .

“Surgical sterilization is the most reliable way to render a deer infertile, and it can be accomplished by either ovariectomy or tubal ligation. The latter technique doesn’t prevent ovulation, so sterilized does will still go into estrus and mate. Because they won’t get pregnant, however, they will go through several estrous cycles each year, creating an extended rutting season. This could have a number of negative consequences, including more DVCs (deer vehicle collisions), increased stress and lower overwinter survival, and an increase in the local population due to bucks being attracted from neighboring areas. . . .

“Immuno-contraception is the other fertility control method that is often suggested by those seeking alternatives to lethal population reduction. . . . Unlike surgical sterilization, immuno-contraception is neither effective on all treated animals nor a permanent treatment; does must be re-treated on a regular basis to maintain infertility. This becomes increasingly difficult as experience makes them more wary.

“Although fertility control alone is not a viable method for reducing open populations, it may be useful in conjunction with other methods of population control. A fertility control program might lead to population stability or reduction in a limited area if immigration from surrounding areas could be minimized. . . . Fertility control might also potentially be used to keep a population stable after it has been lowered to an appropriate level through hunting or culling." (Booth-Binczik and Hurst, pp. 18-19)

CITATION F.
Where are deer overpopulated?

"Urban and suburban deer overabundance is most common in the parts of the state that are most developed and have the most restrictions on hunting, including Long Island, New York City and Westchester, Onondaga, Monroe and Erie Counties." (Emphasis added, Booth-Binczik and Hurst, p. 4)

Also: The deer population was studied (2014-2016) on the eastside of Syracuse in the area bordered by I-81 and I-481 by a state grant obtained by Assembly Member Pamela Hunter. The deer density was estimated at 50 per square mile. Without natural predators and with an ample food supply, the deer population grows about 30% a year, doubling every three years. (Underwood)

CITATION G.
How quickly could a deer management program reduce the deer heard in a meaningful way?

Based on 2016 data, a computer simulation forecast the impact of a five-year culling program on Syracuse's eastside using varying control methods and coverage areas. The estimated five-year reduction ranged from 27% to 68%, depending on the assumptions. (Underwood)

Also: "Computer simulations . . . suggest that a 70% reduction in deer density and maintenance level of 19 deer per square mile (7.5/km2) would achieve ~40% reduction in infected nymphs within 4 years. The virtual elimination of deer would result in a 99% reduction in infected nymphs. . . .The time that is required for reductions in the questing tick population is due, in part, to the 2 year life cycle of the tick.

"Any deer population control program would require an initial reduction phase to lower high densities of deer and a maintenance phase to keep the deer population at the desired targeted level. Deer capacity for reproduction is high. . . . Management would be an ongoing process." (Stafford and Williams, p. 8)

CITATION H.
Who is responsible for controlling Lyme and other vector borne diseases?

"Preventing and responding to vector borne disease outbreaks are high priorities for CDC and will require additional capacity at state and local levels for tracking, diagnosing, and reporting cases; controlling vectors; and preventing transmission." (Rosenberg, p. 500)

"Despite your best efforts, you will not avoid ticks 100% of the time." Take steps including daily tick checks, dressing to protect yourself, using pesticides appropriately, recognizing and avoiding tick habitat, and knowing how to safely remove a tick. (https://nysipm.cornell.edu/whats-bugging-you/ticks/how-do-i-protect-myself-ticks/)

CITATION I.
What are the impediments to effective deer population control?

"The failure to achieve lower deer densities desired by communities (e.g., < 26 deer/mi^2) through the use of hunting can be attributed to lack of access to many properties, hunter recreational interests not in line with community goals, lack of appreciation for the number of deer that need to be removed, and failure of hunters to prevent 'educating' the deer to hunter presence. Since most land in the northeast is privately held, homeowner views and hunter access are important to successful deer management. Other methods such as sharpshooting, training hunters to more effectively harvest deer in suburban communities, and more liberal regulations may be needed to achieve community deer management goals." (Stafford and Williams, p. 8)

CITATION J.

How long should a deer management program last?

"Any deer population control program would require an initial reduction phase to lower high densities of deer and a maintenance phase to keep the deer population at the desired targeted level. Deer capacity for reproduction is high. . . . Management would be an ongoing process." (Stafford and Williams, p. 8)

Also: "Under ideal conditions, deer populations can double in size every two to three years. When there is plenty of food available, an average of 30-40% of the deer in a population have to die every year to keep the population from growing." (Booth-Binczik and Hurst, p. 5)

Also: "Tick and deer management is a long term commitment, according to the experts." Five years is a reasonable planning horizon, they said, but ten years would be better. Cornell is in its 12th year. Over five years a plan might expect to reduce deer density to 20/ mi^2. The plan should be situational, employing various approaches at different times, depending upon circumstances." (Minutes, May 6 2019)

CITATION K.

Besides disease, what are other concerns with deer overpopulation?

"[T]he abundance of deer in large parts of the state is causing increasing problems, particularly in suburban and urban areas. Common types of human-deer conflict include deer-vehicle collisions on roads, deer damage to landscaping plants. . . .High densities of deer also threaten the long-term viability of forest ecosystems. . . .

"There is a growing awareness of the ecological impacts of deer overabundance. Deer are altering forests across the state, perhaps permanently. Just as livestock can overgraze a range and reduce it to a barren wasteland, deer can over-browse a forest. . . . Browsing by deer at high densities. . . enables invasive species to out-compete natives. It also prevents seedlings of many species from growing into the next generation of trees, ultimately leading to fewer mature trees in a more open plant community with a different and less diverse species composition. . . .

"The ecological changes brought about by deer also cascade through forest plant communities into wildlife communities, reducing the abundance and diversity of songbird species that use the intermediate levels of a forest. . . .

"High-density populations can also harm the deer themselves by increasing competition for food and transmission of diseases and parasites. Deer in lower-density populations tend to be in better physical condition, all else being equal, because there is more food available to them. Because they don't come in contact with as many other deer, they are less likely to be infected with parasites or diseases. If chronic wasting disease, or CWD, were to reach New York again, its ability to spread within the state could be facilitated by high-density populations." (Booth-Binczik and Hurst, p. 2, 10)

CITATION L.
How serious are deer-caused auto accidents?

"Based on insurance claims, State Farm estimates that there are over 70,000 DVCs annually in New York (data provided by State Farm Insurance®) and that nationally the average property-damage cost per collision is approximately $4,000. Losses are not limited to property; although the federal highway fatality database (National Highway Traffic Safety Administration Fatality Analysis Reporting System) doesn't separate the data by species, 437 people were killed in the U.S. in 2015 in crashes caused by vehicles striking or attempting to avoid an animal, many of which were doubtless deer. Taking into account additional factors, the average total cost of a DVC (deer vehicle collision) has been estimated to be more than $660. DVCs thus can be estimated to cost the citizens of New York over $462 million per year." (Booth-Binczik and Hurst, p. 9)

CITATION M.
Is culling truly necessary for control of the deer population?

"For deer populations to be reduced, deer deaths must outnumber births. The white-tailed deer is a prey species that evolved under high predation levels, so its natural state includes a high mortality rate. For a healthy deer population to remain stable, on average 30-40% of the animals must die each year; otherwise the high reproductive rate will result in population growth. In undeveloped areas of New York, most of this mortality occurs through predation of fawns, hunting of adults, and malnutrition during severe winters. In residential areas most deer deaths result from collisions with vehicles, and those don't usually occur at a high enough rate to offset reproduction. Hunting and/or culling programs are therefore necessary to increase mortality." (Booth-Binczik and Hurst, p. 16)

CITATION N.
Why can't deer be captured and relocated instead of killing them?

"People who don't want deer to be hunted or culled in their community sometimes suggest capturing the deer and moving them somewhere else or reintroducing large carnivores such as wolves or mountain lions so that they can lower deer numbers. These are not useful methods of reducing deer populations in developed areas. Reintroduction of large carnivores is not ecologically or socially feasible in areas with high human density and no large blocks of natural habitat. Capturing and relocating deer results in significant levels of stress, injury and mortality, and also presents a risk of spreading disease." (Booth-Binczik and Hurst, p. 20)

CITATION O.
Besides Lyme, are there other tick borne diseases?

Typical symptoms of Lyme disease (*Borrelia burgdorferi* and *B. mayonii*) include fever, headache, fatigue, and a characteristic skin rash called erythema migrans ("bullseye rash"). If left untreated, infection can spread to joints, the heart, and the nervous system. Lyme disease is diagnosed based on symptoms, physical findings (e.g., rash), and the possibility of exposure to infected ticks. Laboratory testing is helpful if used correctly and performed with validated methods.

<u>Anaplasmosis</u> (*Anaplasma phagocytophilum*) is carried by the black legged tick is caused by the bacterium, and symptoms will often include fever, headache, chills, and muscle aches.

<u>Tick relapsing fever</u> (*B. miyamotoi*) occurs most commonly in July and August and may be spread by larval blacklegged ticks. After an incubation period of days or weeks, symptoms may include chills, fatigue, severe headache, arthralgia/myalgia and (uncommonly) dizziness, confusion, vertigo, and rash.

<u>Ehrlichiosis</u> is the general name for diseases caused by the bacteria *Ehrlichia chaffeensis*, *E. ewingii*, or *E. muris eauclairensis*. . . . People with ehrlichiosis often have fever, chills, headache, muscle aches, and sometimes upset stomach. Ehrlichiosis is carried by the Lone Star Tick.

<u>Babesiosis</u> (*Babesia microti*) is carried by the black legged tick and is caused by microscopic parasites that infect red blood cells. The incubation period is 1-9 weeks and symptoms may include fever, chills, sweats, malaise, fatigue, myalgia, arthralgia, headache, gastrointestinal symptoms, such as anorexia and nausea; dark urine and sometimes jaundice.

<u>Powassan Virus Disease</u> is carried by the black legged tick and has an incubation period of 1-4 weeks. Symptoms include fever, headache, vomiting, and generalized weakness. This disease usually progresses to meningo encephalitis and may include meningeal signs, altered mental status, seizures, aphasia, paresis, movement disorders, or cranial nerve palsies. (Tickborne Diseases of the United States)

CITATION P.
Why isn't there a vaccine for Lyme disease for humans?

"There used to be one, but it was taken off the market more than 15 years ago. And there's only one new vaccine candidate in the pipeline. . . .

"A vaccine for Lyme disease, called LYMErix, was released by SmithKline Beecham — now GlaxoSmithKline — in 1998. It was found to be 76 percent effective in adults after three doses.

"But the company took it off the market less than four years later, citing low sales, amid lawsuits from patients who said the vaccine caused severe arthritis and other symptoms. Some claimed that the vaccine had provoked an autoimmune reaction.

"Studies never showed a direct link between LYMErix and any chronic side effect or serious complication. But patients' claims about it, and resulting media coverage, were sufficient to make doctors and patients wary. . .

"Dr. Stanley A. Plotkin, an emeritus professor of pediatrics at the University of Pennsylvania, said that the loss of the vaccine was a 'public health fiasco.' He and other researchers said that in the years since, public opposition prevented drug companies from investing in another vaccine that could fail on the market. . . .

"A European company called Valneva says that it is making progress on VLA15, a vaccine that would protect against six strains of Lyme. . . .

"Valneva's chief executive, Thomas Lingelbach, said . . . the new vaccine so that it would not create an autoimmune reaction. . . . [It] is being tested now, and the company hopes to seek licensing in (2023). (Zraick)

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Appendix C

NEW YORK STATE OF OPPORTUNITY. | Department of Environmental Conservation

COMMUNITY DEER MANAGEMENT GUIDE

Division of Fish and Wildlife

2018

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www.dec.ny.gov

Table of Contents

Introduction

White-tailed deer (*Odocoileus virginianus*) play vital roles in the natural and cultural environment of New York and are highly valued for their beauty and grace as well as the utilitarian benefits they provide. However, the abundance of deer in large parts of the state is causing increasing problems, particularly in suburban and urban areas. Common types of human-deer conflict include deer-vehicle collisions on roads, deer damage to landscaping plants, and an increase in diseases carried by ticks that feed on deer. High densities of deer also threaten the long-term viability of forest ecosystems.

Because deer are large, highly mobile animals, there is little that individual property owners in developed areas can do to reduce the deer-related problems they face. Enclosing a property in a fence that deer can't jump over can prevent landscaping damage, but it does nothing to reduce the risk of deer-vehicle collisions. Furthermore, such fences around yards have the effect of pushing the deer onto other properties, thus improving the situation for some residents at the cost of making it worse for others.

Reducing deer problems for community residents as a whole typically requires approaching deer management at a community level. That means making decisions as a community rather than as individuals and taking actions at a large enough geographic scale that they will affect deer throughout the community. This handbook was written to help people understand the deer problems they're experiencing and guide communities through the process of assessing the need for deer management, evaluating possible approaches, and planning a course of action. Community-based deer management is taking place across the country, and another good source of guidance along with information on the experiences of many other communities is the Community Deer Advisor website (deeradvisor.org) developed by Cornell University.

Photo by Bazartseren Boldgiv

Deer Biology and History in New York

Deer numbers in New York increased throughout the 20th century. People encounter deer on a daily basis now in places where they were formerly never seen. Many people who live in urban and suburban areas with high deer densities wonder whether the deer are there because they were displaced from habitat that was destroyed for development. Some people feel that calls for control of deer populations are a sign of intolerance and humans should simply learn to live with high deer densities. A consideration of history and ecology can shed light on these ideas.

Causes of deer overabundance

After rampant deforestation and unregulated hunting wiped out over 95% of the country's deer in the 19th century (McCabe and McCabe, 1984), management in the first half of the 20th century was aimed at increasing deer numbers. New York was highly successful in this effort, as were many other states. Deer have a high reproductive rate; females (does) can produce young at one year of age, and they average two offspring (fawns) per year. Both males (bucks) and females breed with multiple mates each year, so each buck can impregnate several does, and reproductive rates may not be diminished in populations with more females than males. If food is abundant and mortality is low, deer populations can double in size every two to three years.


Photo by Dick Thomas

White-tailed deer are considered a generalist species, which means they can thrive in a variety of habitats and eat a variety of foods. They are found in forested and brushy areas from the Northwest Territories in Canada all the way to South America. Primarily browsers and grazers, they eat both woody and herbaceous vegetation. They normally find the most to eat in edges, or transition zones between forest and more open habitat types, where there is an abundance of both kinds of food available. The current pattern of human land use is ideal for creating and sustaining high-density deer populations because open areas such as residential developments and agricultural fields are interspersed with forested areas, providing plentiful edge habitat as well as a variety of nutritious crops and ornamental plantings that supplement the natural food available to deer. Suburbs have been referred to as "deer factories" because they provide such good conditions for deer populations to grow.

DEER THRIVE IN SUBURBAN ENVIRONMENTS.

In fully functional ecosystems, populations would be controlled by a combination of interacting factors, including food supply, predation, disease and weather. This doesn't mean that population density would be stable; it's normal for animal populations to fluctuate due to variable environmental conditions. High population densities would not be sustained across broad geographic areas, because mature forests don't provide enough suitable deer food to support such populations. However, fully functional forest ecosystems don't exist in New York. Even deer in large wild areas such as the Adirondacks are not living in an intact ecosystem, because wolves and mountain lions, historically their principal predators, have been eliminated. Bears, bobcats and coyotes do prey on deer, particularly fawns, but hunting by humans is currently the primary predatory force acting to control population levels in rural and remote areas. In more developed areas, local laws and landowner opinions have severely constrained hunting, and predators are scarce, so the majority of deer deaths are caused by collisions with vehicles. This relatively low mortality combined with abundant food has allowed suburban and urban deer populations to reach extraordinarily high levels. Even if the full suite of natural predators were to return to New York, significant reductions of deer populations in developed areas would not be expected, because wolves and mountain lions would avoid or not be tolerated in such areas.

Impacts of deer overabundance

By the middle of the last century, wildlife managers across the country recognized that deer populations in many areas, including parts of New York, were outstripping their food supply (Leopold et al., 1947; Severinghaus and Brown, 1956). In the 1940s, agricultural damage by deer was reported as a problem throughout the Southern Tier of the state (Severinghaus and Brown, 1956) and in Albany County (NYSDEC, 1944). In 1959, a law was passed allowing a January deer hunting season with shotguns in Westchester County. The text of that legislation described a "critical overabundance of deer" that was causing "severe damage" to agriculture as well as damage to home landscaping (1959 N.Y. Laws, Ch. 738). At the same time, the state wildlife biologists were noting that deer populations in the Catskills and central Adirondacks were larger than the natural food supply could support and were causing chronic habitat degradation, which, in the case of the Adirondacks, they believed had already been occurring for over 50 years at that point (Severinghaus and Brown, 1956).

Impacts on human activities

The deer-related problems that directly affect human activities are the ones that receive the most public attention. In recent decades, frequently mentioned concerns have included deer-vehicle collisions (DVCs) on roads, deer eating crops in agricultural areas and landscaping plants in residential areas, and the potential role of deer in the increase of tick-borne illnesses such as Lyme disease.

Based on insurance claims, State Farm estimates that there are over 70,000 DVCs annually in New York (data provided by State Farm Insurance®) and that nationally the average property-damage cost per collision is approximately $4,000. Losses are not limited to property; although the federal highway fatality database doesn't separate the statistics by species, 437 people were killed in the U.S. in 2015 in crashes caused by vehicles striking or attempting to avoid an animal, many of which were doubtless deer. Taking into account additional factors, a cost-benefit analysis estimated the average total cost of a DVC at more than $6600 (Huijser et al., 2009). DVCs thus can be estimated to cost the citizens of New York over $462 million per year.

In 2002, New York farmers estimated their deer-related crop damages at $59 million, and about one quarter of farmers indicated that deer damage was a significant factor affecting the profits of their farms (Brown et al., 2004). Lowered property values due to deer browsing of landscaping is a concern in some residential areas.

Many parts of New York are considered high-risk areas for human infection with Lyme disease (Diuk-Wasser et al., 2012), based on the density of infected black-legged ticks (*Ixodes scapularis*). Reducing deer populations to very low levels can reduce tick densities (Kugeler et al., 2015) and probably Lyme disease rates (Kilpatrick et al., 2014), because deer are the primary food source for adult female black-legged ticks. However, less drastic deer population reductions may not lower the chances of human Lyme infection (Jordan et al., 2007; Kugeler et al., 2015). Small mammals such as rodents and shrews, not deer, are the main tick hosts that pass on the Lyme-causing bacteria (*Borrelia burgdorferi*). Several other tick-borne diseases are less common but increasing in frequency. Deer are the principal hosts for the lone star tick (*Amblyomma americanum*), which can cause an allergy to the consumption of mammalian meat (Commins et al., 2011) as well as transmit ehrlichiosis and other diseases to humans (Childs and Paddock, 2003).

Impacts on forest ecosystems

There is a growing awareness of the ecological impacts of deer overabundance. Deer are altering forests across the state, perhaps permanently. Just as livestock can overgraze a range and reduce it to a barren wasteland, deer can over-browse a forest. Because mature canopy trees aren't affected, deer impacts on a forest may not be immediately evident, but they are profound and long-lasting. Browsing by deer at high densities reduces diversity in the forest understory (Horsley et al., 2003; Nuttle et al., 2014), enables invasive species to out-compete natives (Knight et al., 2009), and prevents seedlings of many species from growing into the next generation of trees (Tilghman, 1989), ultimately leading to fewer mature trees in a more open plant community with a different and less diverse species composition (White, 2012). In areas with long histories of high deer impacts, reducing deer population density or removing all deer may not be sufficient for plant diversity to recover (Nuttle et al., 2014; Royo et al., 2010; Webster et al., 2005), even as much as 20 years later. Some species are so thoroughly eliminated by deer that they may have to be planted if they are to be restored to such areas. Impacts on endemic species can be devastating. For example, evidence suggests that current deer population densities in eastern North America will result in the extinction in the wild of ginseng, a valuable medicinal herb, within the next century (McGraw and Furedi, 2005).

DEER IMPACTS ON FORESTS ARE PROFOUND AND LONG-LASTING.

The ecological changes brought about by deer also cascade through forest plant communities into wildlife communities, reducing the abundance and diversity of songbird species that use the intermediate levels of a forest (deCalesta, 1994). Furthermore, high-density deer populations interfere with habitat management efforts. Because browsing by deer counteracts the regenerative effects of natural forest disturbances such as fire (Nuttle et al., 2013), attempts to promote forest health through restoration of such disturbances and to increase populations of wildlife species that depend on young forest stands may fail unless deer populations are reduced. Regenerative processes are impaired in many parts of New York, particularly for tree species that are economically valuable (Shirer and Zimmerman, 2010). Even in the Adirondacks, where deer densities are lower than in much of the rest of the state, both direct and indirect impacts of deer browsing must be counteracted for a diverse forest to regrow (Behrend et al., 1970; Sage et al., 2003). Ecosystem impacts may be magnified in urban and suburban parks and natural areas, which provide important habitat for migrating birds and other wildlife but are often subjected to the highest deer densities.

Two forested parks in New York City. The photo on the left shows severe deer damage; the photo on the right shows a healthy understory. Photos by Ken Scarlatelli.

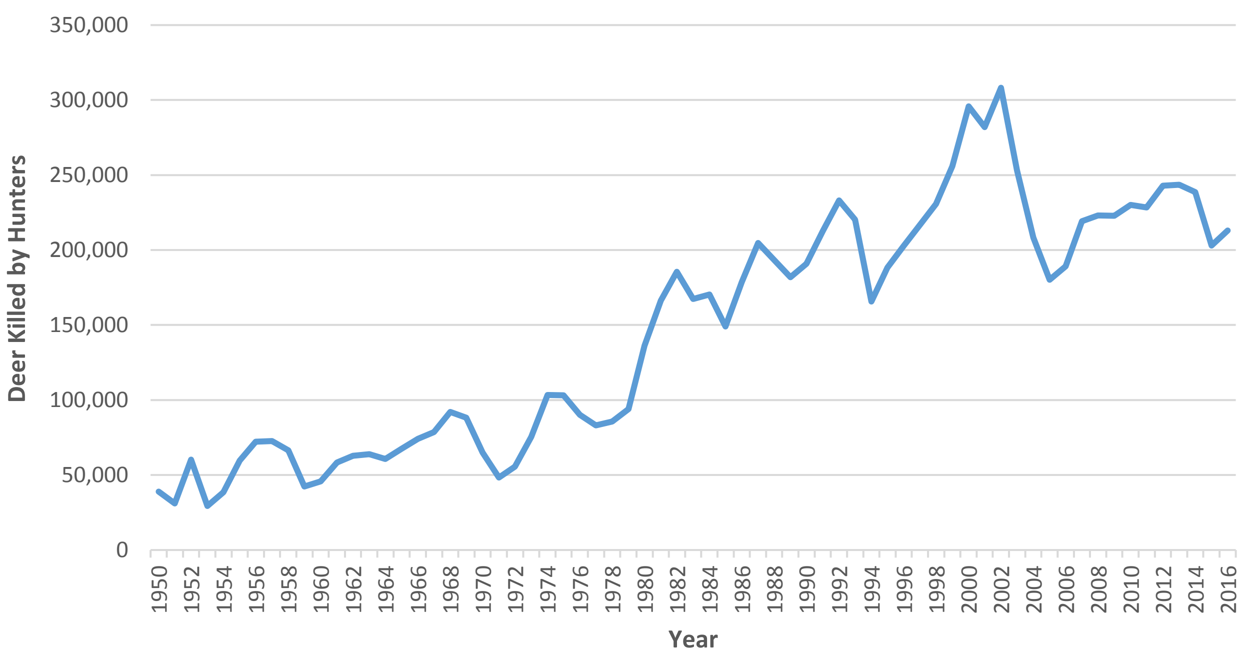
High-density populations can also harm the deer themselves by increasing competition for food and transmission of diseases and parasites. Deer in lower-density populations tend to be in better physical condition (Keyser et al., 2005), all else being equal, because there is more food available to them. Because they don't come in contact with as many other deer, they are less likely to be infected with parasites or diseases (Storm et al., 2013).

A browse line indicates that deer have eaten all the foliage growing within their reach. Photo by Tom Rawinski.

Deer Management in New York

Deer population levels in most areas are managed with regulated recreational hunting. For the past twenty-five years, target population levels in New York have been set primarily through a public input process. Because public awareness of the issues surrounding high-density populations has remained low until quite recently, changes in those target levels have often not adequately reflected deer impacts on habitat, or even on people. The Department of Environmental Conservation (DEC) is implementing a new process in 2018 for setting population goals, taking into account both social and ecological impacts of deer.

Increasing the mortality rate of does is the key to controlling deer populations, so DEC increases the number of Deer Management Permits (DMPs), also known as antlerless deer tags or doe tags, made available to hunters in areas where populations are above target levels. In some parts of the state there has been virtually unlimited availability of DMPs in recent years, but even so, the desired harvest levels are not being achieved. DEC is working to find ways to increase the effectiveness of population management strategies in these areas.



This graph shows the estimated annual deer harvest in New York, providing an indication of how dramatically the statewide deer population has grown over the past 40 years.

The highest deer densities in the state can be found in urban and suburban areas, and many communities are experiencing severe impacts. Due to local firearms ordinances and restrictions by landowners there is typically little land accessible to recreational hunters in developed areas, so localized strategies developed and applied at the community level are usually necessary for effective deer management. Many communities are finding ways to address their problems with overabundant deer, but it's important to recognize at the outset that it's a complicated process requiring a long-term commitment. Steps that are taken to reduce deer populations must be maintained, or the problems will quickly return.

Communities, individual landowners, or groups of landowners experiencing negative impacts from deer can pursue intensive population reduction on their land or within their boundaries through two special permit programs:

- The Deer Management Assistance Program (DMAP) provides antlerless deer harvest tags that a landowner, organization or municipality can distribute to licensed hunters for use on specific parcels of land. The hunters can use the tags on those properties during deer hunting seasons in addition to the tags they receive with their licenses.
- Deer Damage Permits (DDPs) allow taking of deer outside of hunting seasons under certain conditions, and may allow the use of specialized techniques to increase success. These permits are issued in situations where adequate population control and damage reduction cannot be achieved through hunting, even with DMAP.

There is no fee associated with either of these programs.

Unless individual properties are very large, community-level action rather than individual landowner action is probably necessary for effective reduction of impacts. Municipalities are required to submit a deer management plan with a DDP application (downloadable from website) but not with a DMAP application (downloadable from website). Before any such application is prepared by a municipality, there should be a thorough community-wide decision-making and planning process so that the problem the community is trying to solve can be identified, all available management strategies can be considered, and community members can select the best approach together.

Photo by Dick Thomas

Community Deer Management Planning

A community that is considering deer management should begin with information-gathering, education and outreach. Community leaders should educate themselves and other community residents about deer biology, the ecological and social impacts deer are causing in their area, and possible methods for reducing those impacts. This provides the foundation for an informed decision-making process. To aid in these efforts, DEC biologists can provide information, advice and resources and give presentations at public meetings convened to discuss deer issues. In addition, the Community Deer Advisor website (deeradvisor.org), which provides recommended best practices, examples from other communities, and a suite of valuable resources, can serve as a guide through the entire planning process.

Important Steps in the Planning Process

- Educate community members about deer biology and impacts.
- Determine whether most community members want deer impacts to be addressed.
- Develop a transparent and inclusive decision-making process.
- If the community wants deer impacts addressed, identify objectives (not methods) for impact reduction.
- Educate community members about methods for reducing impacts.
- Assess community preferences for methods and select methods to implement.
- Develop a written management plan and share it with community members.
- Collect data on pre-management impact levels so that progress toward objectives can be tracked.
- Apply for any necessary permits.
- Begin management actions.

One of the initial steps is often to conduct a survey of community residents. This can be an efficient way to learn about the type and severity of deer-related impacts being experienced, locations in the community where problems are most severe, and opinions on whether some community-level action should be taken to reduce these problems. It's best not to include questions in the survey about specific types of action that might be taken, as they would only be a distraction. The goal at this point is simply to define the issue and assess the need for action.

Often a committee is formed to lead the information-gathering, decision-making and planning efforts. Municipal leaders should ensure that a variety of perspectives are represented on the committee and that extensive outreach takes place to involve all segments of the community in the planning process. Whatever decisions are reached, it's unlikely that everyone in the community will agree with them, but everyone should be able to agree that the decision-making process was valid and that the decisions are supported by the majority of the community. Committee members should therefore be dedicated to conducting an inclusive and respectful process that allows all opinions to be heard and considered.

If public opinion data indicate that most people feel deer problems aren't so bad that the community should take action, the process is likely to stop at this point, although education efforts may continue. Periodic re-surveying of residents is useful to identify any change in public sentiment over time.

If most of the community feels some action is warranted, the next step is to set measurable objectives. These objectives will guide management decisions, so they should be defined before any consideration of management methods takes place. Objectives should be based on the impacts that have been identified by the community, rather than deer numbers or densities. The focus needs to be on the problems the deer are causing, because that's the only way to know whether things are improving. For example, objectives might be to reduce deer-vehicle collisions to a certain number per year, to reduce to a certain level the number of landscaping plants that residents report killed by deer, or to allow a certain percentage of tree seedlings in forest patches to survive.

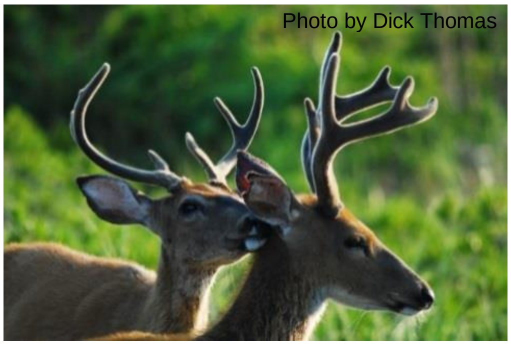
Progress toward objectives can be tracked by monitoring the chosen impact measures. Impact monitoring methods should be identified during the planning process. Ideally, data collection on impacts will start before management actions are implemented so that the initial conditions can be documented as a baseline. This will make it possible to measure the effect of management activities on impact levels, and can also help identify target levels to use as objectives.

There is a common misconception that it's necessary to count the deer in the community. In actuality, knowing the number or density of deer in the community is not necessary or even useful, except possibly in coming up with cost estimates for some management actions. By definition, the problem is the impacts the deer are causing, not the deer themselves, so knowing the severity of impacts is all that's necessary to make decisions about whether to take action. Similarly, there would be no clear way to set a target population number as a management objective, because a multitude of variable factors determine the number of deer that can sustainably live in an area, and every location is different. Finally, it's very difficult to get an accurate count of deer, particularly in urban areas. Communities that try it typically end up spending a lot of time and money and often obtain confusing, possibly meaningless numbers.

MONITORING DEER-RELATED IMPACTS IS NECESSARY FOR EVALUATING PROGRAM SUCCESS.

After objectives have been clearly defined, the process of selecting methods for attaining those objectives begins. The experiences of other communities (Doerr et al., 2001; Hygnstrom et al., 2011; Kilpatrick et al., 2010; Kilpatrick and Walter, 1999; Rudolph et al., 2011; Stewart et al., 2013; Wiggers, 2011) can be tremendously helpful in developing management strategies and evaluating the pros and cons of various courses of action. Some communities that provide detailed information online regarding their deer management programs include: Cayuga Heights, NY; Trumansburg, NY; Southold, NY; Hopewell Township, NJ; East Goshen Township, PA; Mt. Lebanon, PA; Howard County, MD; Baltimore County, MD; Burnsville, MN. Others are described as case studies in the community-based deer management guide published by Cornell University (Decker et al., 2004). Communities should consider reaching out to neighboring communities and public land managers to promote cooperation and coordination as they develop their deer management plans. Simultaneous action over a larger area will tend to increase the success of each program. Before carrying out or funding deer management activities, municipal governments should consult their legal counsel regarding any obligations they may have under the State Environmental Quality Review Act.

Choosing which actions to implement is the most difficult and time-consuming part of the planning process for many communities. DEC staff can help by providing information on deer biology and management options. Bringing in a trained facilitator to guide discussions may also be useful and even necessary. Deer management can become a contentious and controversial issue, as community members may have widely varying perspectives on deer and be passionate about their opinions and priorities. County Cornell Cooperative Extension offices, universities and government agencies may all have skilled facilitators among their staff, and professional facilitators can be found online.



It's important to thoroughly publicize planning efforts to ensure that all members of the community have an opportunity to participate and voice their perspectives. Insufficient outreach increases the likelihood of negative backlash from groups or individuals who disagree with a plan that was formulated without their participation. An inclusive process provides valuable information to community leaders on deer impacts and stakeholder opinions, allows stakeholders to increase mutual understanding by educating each other on their differing perspectives, and establishes a strong foundation for defending deer management decisions and actions in the event of a subsequent challenge. A high level of communication and transparency should be maintained throughout program implementation, to keep community members informed and engaged.

Because deer management is a long-term undertaking, periodic evaluation of the program is an important component. Evaluations should incorporate as much diversity of stakeholder participation as did the initial planning process. Progress toward the program goals should be assessed and a determination made on whether modifications to the program are needed. Such modifications may be stimulated by lessons learned during program implementation, data gathered through monitoring, technological advancements, shifts in community priorities, or other causes.

In most cases programs run more smoothly after the first year or two, as residents become accustomed to the management activities and begin to see results. However, controversy can still resurface, and if periodic evaluations and modifications are not conducted, over time the program may become out of sync with the community's needs and desires. Because a deer management program should outlast the tenure of the people making decisions when the program is initiated, it is valuable to have a written management plan. Such a plan provides an opportunity for the community to document their decision-making process and reasoning and establish guidance for future decisions.

Management plan structure

The purpose of a management plan is to present the problem to be solved, the desired results of management, and the proposed approach. Any community that applies to DEC for a DDP is required to submit a management plan. The plan should not be an extensive review of deer ecology and management; it should simply outline the need and strategy for addressing deer impacts in the community. Structurally, a concise management plan consists of three basic sections: an introduction or background, a list of management objectives, and a description of the methods that will be used to achieve those objectives and evaluate success. The plan should not focus solely on aspects of management that are meant to reduce deer abundance; it should include all ways in which the community intends to address deer-related impacts (e.g. public education efforts, installation of road-crossing structures for wildlife, fencing of sensitive plant communities) so that individual activities can be considered in an integrated context.

The introductory section should describe the situation that has created a need for management action. This should include a discussion of what is known about the local deer population and its impacts, followed by an explanation of why a DDP is needed to address those impacts. If any actions were undertaken previously to address the impacts, those actions and their outcomes should be described. Planners may also wish to include in this section a description of the process through which the plan was developed and a list of people who participated or contributed. This type of process documentation may help facilitate aspects of community review and plan implementation.

The objectives should relate directly to the impacts that were identified in the introduction. General goals that are more broadly stated may also be included in this section, but only to provide context for the specific, measurable objectives that are the focus of the plan. Objectives should be defined such that it will be possible to determine clearly whether they have been attained. “Reduce deer-vehicle collisions in the Village to fewer than ten per year” is an appropriately defined objective; “Reduce deer-vehicle collisions” is not.

The methods section should cover two separate categories of methods: those designed to reduce deer-related impacts and those designed to monitor deer-related impacts. All impact reduction approaches to be used, including education and activities aimed at modifying human behavior, should be described. A justification, or explanation of why that particular technique was chosen, should be included for each method. Planners may wish to include discussions of methods that were proposed or considered but not selected, so that the decision process is transparent and thoroughly documented. If lethal methods are going to be used, the system by which venison will be distributed for utilization should also be described. With respect to monitoring, at least one method should be included for each impact for which an objective has been defined. If baseline data have been collected before plan submission, they should be provided with the plan.

A map should be provided that shows the locations of all field-based activities proposed in the plan (e.g. stretches of road where traffic control efforts will be implemented or DVCs will be monitored, properties where bait-and-shoot sites will be located, forest stands where ecological impact indicators will be measured). If there are concerns about the possible public release of sensitive information, alternate arrangements can be made with DEC.

The plan should be detailed and specific, but not rigid. An adaptive management approach should be used, meaning that the situation should be reassessed periodically to determine whether changes should be made to methods or objectives. The plan should specify how these reassessments will be conducted and how often they will occur.

Photo by Paul Curtis

Management Tools

Actions a community can take to reduce deer-related impacts fall into two broad categories: those that reduce residents' vulnerability to the negative effects of deer, and those that reduce deer populations. Communities should pursue both approaches to maximize the likelihood of success and engage all residents in the impact reduction effort.

Reducing vulnerability to deer impacts

Deer feeding

Feeding wild deer is illegal in New York, but some residents are reluctant to obey the prohibition. They mistakenly believe that providing food will be helpful, or they simply enjoy seeing the deer on their property. However, deer feeding contributes to unnatural concentrations of deer, which exacerbates deer-related impacts and increases the risk of disease transmission. It also alters deer behavior in ways that can create hazards for people and property. Over time, deer feeding will act to increase deer populations, leading to even greater impacts. Furthermore, deer can die from eating large quantities of high-calorie food, such as corn, in the winter, when their complex digestive system is set up to deal with lower-calorie natural forage.

Community residents should be educated on the problems deer feeding causes for the community, the ecosystem and the deer. Violations of state law and regulation can be reported to local Environmental Conservation Officers. Municipalities may wish to pass their own bans on deer feeding so that they can establish penalties and conduct enforcement.

Deer-vehicle collisions

There are several steps local governments and residents can take to reduce the risk of DVCs. Residents should be educated on deer behavior, the need to drive more slowly and be especially vigilant at dawn and dusk and during the rut (mating season), and the importance of watching for additional deer following when they see one crossing in front of them. A public-awareness campaign each fall as rut begins might be especially helpful.

Photo courtesy of New York City Dept. of Transportation

If municipal officials can identify areas or stretches of road where collisions are most common, they can install warning signs and lower the speed limits. Mobile lighted temporary warning signs that appear in the fall may be more effective than permanent signs. If there is tall vegetation close to the road, creating a wider mowed border to increase visibility may be helpful. Erecting deer fences along both sides of the road could be helpful, but only if there are some barriers to movement that would prevent the deer from simply going to the end of the fence and crossing there. An investment-intensive option that has been used successfully in other parts of the country is a wildlife underpass created by elevating the road in a problematic location and building fences to funnel deer and other animals safely under the road to the other side (Beckmann et al., 2010; McCollister and Van Manen, 2010). Because of the expense, this method is only likely to be used on sections of road where collisions are very frequent or there are additional reasons to construct wildlife crossing structures. To minimize cost, underpasses can be created during regular road and culvert maintenance and repair activities.

Numerous products have been developed to help prevent DVCs, such as whistles on cars and reflectors along roadsides, but research has not shown any of them to be effective (Mastro et al., 2008).

Tick-borne disease

Until vaccines are available, individual vigilance is the best way to reduce the risk of contracting a tick-borne disease. Tucking pant legs into boots or socks can help keep ticks on the outside of clothing, and wearing light-colored clothes makes them easier to spot. Clothing that has been treated with permethrin can kill ticks before they have a chance to bite. An approach for those who want to avoid using pesticides is to inspect oneself frequently when outside and remove any ticks from clothes with duct tape or a lint roller (to permanently remove them from the environment). Head-to-toe inspections should be conducted after coming inside and removing clothes, and any embedded ticks should be removed using fine-tipped tweezers without squeezing the tick's body. Anyone who develops symptoms of a tick-borne disease after being bitten by a tick should contact their doctor and tell him or her about the tick bite and the symptoms. Community leaders should work to educate residents on techniques to reduce ticks in their yards, tick-bite prevention measures, tick removal methods, and disease symptoms.

Municipalities may consider using pesticides to decrease tick numbers. Applying pesticide to the ground or vegetation can provide effective short-term reduction of tick populations (Eisen and Dolan, 2016), but will also kill many other invertebrates. Combining multiple methods, including devices that treat small mammals with pesticide, can control tick populations while reducing pesticide use (Schulze et al., 2007; Williams et al., 2018). Treating deer with pesticide via devices called 4-Posters™ can control tick numbers under certain circumstances (Wong et al., 2017). 4-Posters™ are bait stations designed to attract deer and treat them with permethrin while they are eating the bait. Maintaining 4-Posters™ is expensive, and many communities that have tried them have abandoned their use because of the cost. The constant availability of extra food for deer and other animals can also lead to many negative consequences. Municipalities wishing to use 4-Posters™ must apply to DEC for deer feeding permits and implement deer population control programs to prevent some of these consequences.

Plant damage

Deer browsing can create problems in many different contexts, from ecological degradation to crop losses to ornamental plant damage. Information on various ways to reduce plant damage by deer is available from Cornell Cooperative Extension and many other sources. The only sure way to keep deer from eating plants is to enclose the plants in a sturdy fence that deer can't jump over, which usually means at least eight feet high. As an alternative to fencing the entire planted area, small cage-type enclosures can be placed over individual plants that are small enough, and netting can be draped over shrubbery. Such barriers of course have an aesthetic impact, and the cost and labor involved typically make them useful only for small areas with highly valued plants,


Photo by Paul Curtis

either cultivated or natural. Electric fencing may be cheaper for larger areas, but it requires substantial maintenance, poses a hazard to people and non-target animals, and is only temporarily effective because deer can learn to get past the fence without being shocked.

Most other possible methods for deterring deer from eating plants suffer from the same problem of temporary effectiveness. Various devices that are meant to scare deer with motion, sound, light, or spraying water have been developed, but over time the deer will get used to any of them and will no longer be scared away. There are also many types of chemical repellents that can be applied to plants and are meant to prevent browsing, due to their noxious taste or smell. They can be effective, but they must be reapplied frequently as rain washes them off and the plants produce new growth, and if deer density is high or the plants are highly desirable, they will not prevent deer from feeding on the plants.

Plants do vary in attractiveness to deer, and many homeowners take the approach of choosing less palatable species to plant in their landscaping. Of course, this isn't a strategy that can be used to reduce deer damage to vegetable gardens, crops, or natural ecosystems, but it can work for landscaping if there are ample alternative food sources available to the deer. Recommendations on deer-resistant planting are available from Cornell Cooperative Extension, along with many other sources. However, individual tastes vary, so even species that are considered generally unpalatable may still be eaten by specific deer, and if deer densities are high enough, virtually all plants will be vulnerable. Some non-native plants that are rarely eaten by deer are invasive in natural areas and will escape from gardens to create tremendous ecological problems, so care must be taken to avoid planting invasive species.

THE ONLY WAY TO REDUCE PLANT DAMAGE THROUGHOUT THE COMMUNITY IS TO REDUCE THE DEER POPULATION.

The final method for preventing damage to plants is hazing, which requires a DEC permit in New York. Hazing is active physical harassment of the deer, and it usually takes the form of shooting at them with non-lethal projectiles such as rubber buckshot or beanbag rounds. The other common type of hazing is chasing by a dog that is prevented from leaving the area it is protecting, for example by an underground electronic fence. These are labor-intensive techniques that require the hazer to be on watch constantly, and they are not likely to receive widespread use.

The most significant difficulty with reducing deer damage to plants by any of these methods is that only individuals will benefit, not the whole community. Any action that decreases one resident's likelihood of damage will increase the pressure on everyone else's plants. The only way to reduce plant damage throughout the community is to reduce the deer population.

Reducing deer populations

Lethal removal

For deer populations to be reduced, deer deaths must outnumber births. The white-tailed deer is a prey species that evolved under high predation levels, so its natural state includes a high mortality rate. For a healthy deer population to remain stable, on average 30-40% of the animals must die each year (Matschke et al., 1984); otherwise the high reproductive rate will result in population growth. In undeveloped areas, most of this mortality occurs through predation of fawns, hunting of adults, and starvation during severe winters. In residential areas most deer deaths result from collisions with vehicles, and those don't usually occur at a high enough rate to offset reproduction.

Just as an understanding of reproductive characteristics can help clarify how deer overabundance develops, an understanding of the realities of deaths from natural sources such as predation, disease and starvation and from human-caused sources such as vehicle collisions and shooting can help clarify the ramifications of various courses of action and inaction by communities. Natural deaths of wild animals, including deer, typically involve suffering in the form of pain, fear, or both. Deer-vehicle collisions (DVCs) may result in a quick and painless death when they occur on high-speed highways, but on lower-speed roads they are more likely to cause considerable suffering followed by slow death or permanent crippling.

Photo licensed on Wikimedia Commons by John O'Neill-

Killing deer intentionally and humanely is the only reasonable way to increase the death rate in developed areas. This is best accomplished by shooting them in a vital organ. Deer that are shot in the brain with a powerful gun, the usual method of professional culling, die instantly. In hunting situations, the preferred target area is the lungs and/or heart, because they are less likely to be missed than the brain. Either a bullet or a broadhead-tipped arrow shot through those organs typically kills a deer within seconds, but the deer may run 50-100 yards in that time.

NATURAL DEATHS OF WILD ANIMALS TYPICALLY INVOLVE SUFFERING.

Public safety should be the highest priority in any deer population reduction effort. Guns and bows (including crossbows) can both be used safely in community deer management programs with appropriate controls. New York state law prohibits the shooting of guns within 500 feet of a house (without the owner's permission), school building or playground, public structure, or occupied farm structure, factory or church, whereas the corresponding distance (called a setback distance) for crossbows and vertical bows is 250 feet and 150 feet, respectively. Due to these shorter setback distances for archery equipment, bowhunting is by far the most common type of hunting in urban and suburban settings. With the ability to operate in areas as small as suburban yards, bowhunters can be active throughout more of the available habitat and potentially encounter more of the deer than if they were using guns.

Hunting

Bowhunting for deer is typically done from a tree stand: a platform attached to a tree 10-20 feet above the ground. Being elevated improves the hunter's ability to detect deer, reduces the likelihood that deer will detect the hunter, and most importantly, establishes a downward shot trajectory so that arrows never travel far from the shooter's location. This makes bowhunting extremely safe for the public and non-target animals. Most shots are taken at deer that are less than 20 yards away from the shooter, which means that he or she can very clearly and easily identify the target and the arrow is likely to be shot at a steep downward angle. If the arrow passes completely through the deer or misses, it will end up sticking into the ground within sight of the hunter. Bowhunting can and does safely occur simultaneously with other recreational land uses such as hiking, cross-country skiing, horseback riding and mountain biking.


Photo by Dan Aitchison

BOWHUNTING FROM A TREE STAND IS EXTREMELY SAFE FOR THE PUBLIC AND NON-TARGET ANIMALS.

Many municipalities have passed ordinances forbidding weapons discharge or hunting. Because DEC has authority over hunting in New York, local ordinances specifically limiting or prohibiting hunting are contrary to state law and legal precedent unless they only apply to land owned or managed by the municipality (Kalbaugh, 2015; M. Sanza, pers. comm.). Broad restrictions on weapons discharge in the name of public safety may or may not be valid under state law, depending on the history of the municipality and its original governance documents (M. Sanza, pers. comm.). Regardless, all of these types of ordinances can act to prevent hunting of overabundant deer populations on land where hunting could be conducted safely and in full compliance with state laws. Communities working to address deer impacts often find themselves hindered by their own ordinances, which they then must rescind, revise, or grant variances to.

Photo by Dan Aitchison

Allowing recreational hunters access to as much land as possible in a community is the simplest approach to deer population reduction. Many landowners, including municipalities, currently prohibit hunting on their land, and since hunting is the principal mechanism for deer population control in the absence of large predators, this practice allows populations to grow to unsustainable levels. In communities that are trying to reduce deer-related impacts, opening more private and public properties up to hunting and encouraging hunters to shoot as many does as they legally can will provide additional recreational opportunities for local hunters while benefiting the entire community. To increase the success of such an effort, communities may wish to conduct outreach to increase local non-hunters' understanding of hunting and the excellent safety record of New

York hunters and raise hunters' awareness of the negative impacts of overabundant deer and the importance of reducing populations.

If community residents are uncomfortable with the idea of simply opening up land to hunting under state regulations, a "controlled hunt" may be a way to address their concerns while still accomplishing population reduction through recreational hunting. A controlled hunt is just a way to formalize the authority that all landowners have to restrict how hunting occurs on their land. Individual property owners can choose whether they want their property to be included in a municipal controlled hunt. A set of rules is established that applies to all participating properties and places limits or requirements on hunting on those properties that are stricter than state law requirements. Appendix 1 contains detailed information on types of rules that are often used in controlled hunts. DEC staff can help municipalities identify structures for controlled hunts that balance community concerns and management needs. Some municipalities opt to run controlled hunts themselves, but others collaborate with a local sportsmen's organization. In this type of collaboration, the municipality and/or landowners set the rules for the hunt and the sportsmen's organization administers the hunt: managing the hunters, applying the rules, and serving as the communication conduit between landowners and hunters. Some ecological consultants also offer community deer hunt management as a commercial service.

Municipalities (and landowners) can increase the ability of hunters to reduce local deer population densities by enrolling in the Deer Management Assistance Program (DMAP), which provides an allotment of antlerless deer tags to be used during deer hunting seasons on designated lands within the municipality. The municipal applicant is

Recommendations from The Wildlife Society

The Northeast Section of The Wildlife Society recommends the following progression of actions that communities may implement to address deleterious impacts from overabundant deer. Actions progress from those that are more general to those that are more specialized.

1. Modify human behavior, which may include bans on deer feeding, changes in speed limits, or zoning considerations to limit or isolate deer habitat within community centers. Consider use of exclusion fences to protect high-value commercial or natural resource areas.

2. Address municipal projectile discharge ordinances and other local bylaws that may prevent regulated hunting by the public as otherwise authorized by state laws and regulations.

3. Identify lands within the community used by deer where management action may be targeted. The lands may include residential neighborhoods, parks and preserves, riparian areas, cemeteries, golf courses, industrial areas, or transportation corridors.

4. Implement controlled public hunts in defined areas within state-regulated hunting seasons and implement public safety limitations as needed.

5. Where needed, coordinate managed hunting using a participant selection process, safety and shooting proficiency test, and personal interviews, with preference to more skilled and cooperative hunters.

6. Facilitate access to private and public lands for managed hunts.

7. Train hunters in suburban deer hunting techniques.

8. Seek special provisions to make regulated hunting more effective, such as: use of crossbows, muzzle-suppressed firearms from elevated locations, use of bait, and increased antlerless permit allowance combined with incentives for additional permits for antlered deer.

9. Consider financial incentives to increase hunter effort such as equipment, butchering, or transportation cost reimbursement.

10. Employ professional sharpshooting where regulated hunting options have been insufficient to solve identified problems or are otherwise not feasible.

This list is not all-encompassing, and later options are not intended to replace early options; options can be pursued inclusively in sequential order. In any case, the specific management actions undertaken will be largely dictated by the current biological and social conditions in the affected community.

responsible for equitably distributing the tags to the hunters who will be hunting on those properties. This allows those hunters to shoot more does than they would be able to using just the tags they receive with their hunting licenses.

Culling

In many cases, even with DMAP, hunting may not increase the deer mortality rate enough to meet community goals for impact reduction. The next step for these communities is to pursue culling, which is the term for killing deer outside of a hunting framework. A DEC-issued Deer Damage Permit (DDP) is necessary for a culling program to occur, and such permits typically allow the use of methods that are not available to hunters, which is why culling is usually more effective for rapid population reduction than hunting is. For example, nearly all culling programs involve the use of bait to attract deer to locations where they can be shot safely and efficiently, and most of the shooting occurs at night, when deer are out searching for food and spotlights can be used to temporarily induce them to “freeze,” providing a good opportunity for a shot. Culling usually occurs at a different time of year than hunting, for example in mid-winter, when deer have less natural food available and can be more easily attracted to bait.

DDPs can be issued to private individuals and representatives of businesses, municipalities and organizations. The permittee can designate agents who will do the shooting, and those agents can be volunteers, employees of the permittee, or wildlife control professionals. A cull that is conducted by volunteers is managed essentially the same way as a controlled hunt, except that training the volunteers in the most effective use of bait and lights may be a valuable step. Only a DEC-licensed Nuisance Wildlife Control Operator (NWCO) can be paid for the primary purpose of killing deer on a DDP. However, an employee whose primary duties are not removal of nuisance deer (e.g. property management, maintenance or security personnel) is not required to have a NWCO license to occasionally kill deer on a DDP. Licensed NWCOs can be hired specifically to conduct deer culls, and there are companies that specialize in nuisance deer removal in urban and suburban situations. The Wildlife Services branch of the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture can also be hired to conduct deer culls.

Culling by volunteers is most likely to be done with archery equipment, because of the ability to be quiet and unobtrusive and utilize small habitat patches throughout the community. Professionals often cull using rifles. They may have considerable experience selecting safe shooting zones in developed areas and typically also have specialized infrared equipment that enables them to detect people and other animals from a distance at night.

If there are only a few places in a community where deer can be safely shot, or if community members are unwilling to support methods that involve shooting, alternative approaches to population reduction will be necessary. Professionals can be hired to capture deer with traps, nets or anesthetic darts and then kill them with either a captive-bolt gun or injection of potassium chloride. However, there are several negative consequences of these methods. Trapping causes stress and possible injury for the deer, use of a captive bolt on a wild, unsedated animal is challenging for the operator, and use of chemicals renders the carcasses unsafe for consumption, so the meat is wasted.

If the deer have not been injected with anything, every effort should be made to ensure that the venison resulting from community hunts or culls gets eaten. Hunters who are given access to private land can promote positive relationships by offering to share meat with the landowners. In a controlled hunt or cull situation, the community may wish to require that some or all of the meat be donated to charity. There are organizations (e.g. Venison Donation Coalition, Farmers

& Hunters Feeding the Hungry) that get donated deer butchered and the meat distributed to food banks and other assistance agencies. This low-fat meat is a tremendous boon for needy community members. Some municipalities (e.g. Town of Southold) develop their own programs for collecting and distributing donated deer, and may opt to make the meat available to all residents. The locavore movement has increased interest nationwide in eating local wild game meat. No matter how venison is distributed, if firearms have been used the community should make sure recipients have information on how to avoid ingestion of lead from bullet fragments, and all shooters should be encouraged to use lead-free ammunition.

Fertility control

People who are disturbed by the idea of killing animals often wish to control deer populations by reducing the birth rate rather than increasing the death rate. Even with effective fertility control, this wouldn't be a good way to reduce impacts of deer because it would just keep populations from growing; it wouldn't directly reduce them. Deer can live to be 20 years old, so population reduction would happen slowly if at all, and without hunting or culling most deaths would be from vehicle collisions, which isn't a prudent or humane method of removing deer. Meanwhile, the negative social and ecological impacts of deer would continue at levels which were found to be unacceptable by the community when they decided to initiate deer management efforts.

REDUCING DEER NUMBERS BY SHOOTING IS MORE HUMANE THAN RELYING ON VEHICLE COLLISIONS.

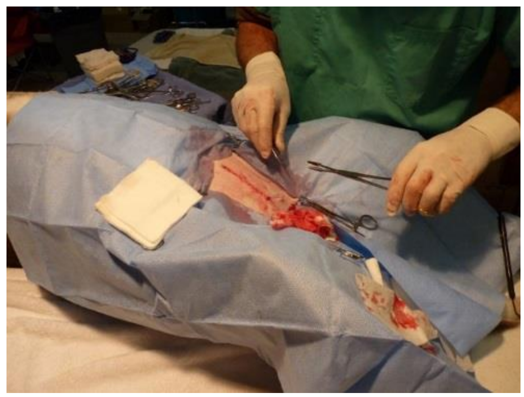
Currently, however, the lengthy delay in potential impact reduction is a secondary consideration, because effective fertility control on a population-wide scale has not been achieved except in small isolated populations in enclosures or on islands. The problem is that deer have such a high reproductive rate that a few fertile individuals can produce enough young to replace the small number of deer that die each year in urban and suburban settings. Wary individuals who are able to avoid capture and treatment, along with immigrants moving in from neighboring areas, provide more than enough reproductive capability to overwhelm fertility control efforts in the majority of cases (Merrill et al., 2006). Even on an island of less than 9 mi^2, a fertility control program that continued for 16 years was hampered by an inability to capture a high enough percentage of the deer, and meaningful population reductions only occurred in certain areas that provided the best access to the animals (Underwood, 2005; National Park Service, 2015).

Surgical sterilization is the most reliable way to render a deer infertile, and for does it can be accomplished by either ovariectomy or tubal ligation. The latter technique doesn't prevent ovulation, so sterilized does will still go into estrus and mate. Because they won't get pregnant, however, they will go through several estrous cycles each year, creating an extended rutting season. This could have a number of negative consequences, including more DVCs, increased stress and lower overwinter survival, and an increase in the local population due to bucks being attracted from neighboring areas (Boulanger et al., 2014). An ovariectomy program is not likely to have these consequences.

Photo by Paul Curtis

Immuno-contraception is the other fertility control method that is often suggested by those seeking alternatives to lethal population reduction. ZonaStat-D is a contraceptive agent for deer that has recently been approved at the federal level by the Environmental Protection Agency. It contains porcine zona pellucida (PZP), which prevents fertilization, not ovulation, so it has the same potential for negative consequences as tubal ligation. GonaCon™, a contraceptive agent developed by the U.S. Department of Agriculture, prevents does from going into estrus, but in field trials it seems to have a slightly lower success rate than PZP. Unlike surgical sterilization, immuno-contraception is neither effective on all treated animals nor a permanent treatment; does must be re-treated on a regular basis to maintain infertility. Contraceptive treatment can only be performed under a research permit in New York, because there are no contraceptive agents for deer commercially registered with the state and continued development is needed before they can be effective management tools.

All fertility control methods are extremely labor-intensive and expensive, because deer must be captured for treatment and virtually all does must be treated to prevent population growth. Capture, anesthesia and surgery also create stress and may result in injury or death of treated deer. If a community decides that these costs are acceptable to them and they wish to pursue fertility control in a small highly developed area where shooting deer doesn't seem feasible, they may receive a DEC permit to use surgical sterilization as part of a deer management program. However, because of the ineffectiveness of fertility control for reducing populations or impacts, lethal population reduction methods must also be used concurrently in nearby areas. The combination of a core sterilization area surrounded by a lethal control zone reduced the deer population in Cayuga Heights, New York by almost 40% in two years (P. Curtis, Cornell University, pers. comm.).



Other techniques

There are currently no other useful methods of reducing deer populations in developed areas. Reintroduction of large carnivores is not ecologically or socially feasible in areas with high human density and no large blocks of natural habitat. Trying to move a population of deer to another location is not a reasonable option, because capturing and relocating deer results in significant levels of stress, injury and mortality (Beringer et al., 2002), and also presents a risk of spreading disease.

Impact Monitoring

The principal considerations in the development of impact monitoring protocols are relevance and ease. Monitoring must provide data that are directly relevant to stated objectives and protocols must be easy to understand and apply. In many cases monitoring data may be collected by volunteers or non-specialist municipal employees, and over time there will probably be substantial turnover in the individuals collecting data, so accuracy and consistency will be maximized by simple, easy-to-use protocols.

Deer-vehicle collisions

DVCs are one of the principal impacts of concern to most communities. Lowering DVC frequency is therefore a goal of most community deer management plans. The relevant plan objective should include a numerical target, and it should specify the geographic area in which DVCs are to be tracked.

Data on DVCs are often compiled by municipal police or transportation departments. Tracking changes in DVC frequency can be complicated by the fact that different levels of government have responsibility for different roads. Village police, town highway personnel, and state Department of Transportation staff may all be removing deer carcasses from public roadways. Initial DVC frequency is often unknown and difficult to determine because there is no central repository for the data, different government agencies may treat information on DVCs differently, and many DVCs that don't incapacitate the vehicle or result in a carcass on the road are not reported to authorities.

During plan development one agency should be identified to take the lead on DVC monitoring, and someone within that agency should be designated as the contact for compiling DVC data. Each relevant agency should develop a process for detecting, recording and reporting to this person the DVCs that occur within their scope of responsibility. Community outreach efforts should include a plea for widespread participation in reporting DVCs. A hotline number or dedicated e-mail address could be set up to facilitate reporting by the public, or they could be asked to report all DVCs, no matter how trivial, to the police. If there is concern about relying on the accuracy and consistency of citizen-reported information, data collection could be restricted to those collisions that result in a deer carcass on the roadway and can therefore be verified by agency personnel. Although some DVCs will not be counted with that approach, as long as the method remains consistent over time it will accurately show changes in deer impact levels.

Ecological damage

There is increasing awareness of and concern about the impacts of deer on biodiversity in forested parks, urban greenspaces and ecological preserves. Many communities have a goal of reducing ecological damage, but identifying or developing a monitoring protocol that adequately measures deer impact without requiring scientific training to implement can be a challenge. The basic concept is simple: as population reduction measures are carried out, declining deer density should result in increased growth and survival of plants that deer like to eat. However, identifying which plants those are requires knowledge and training. This is the biggest hurdle to overcome for communities wishing to monitor ecological damage. Because deer browsing of native plants can lead to increased growth of invasive species, distinguishing native species from invasives is critical. Furthermore, data collection methods must be standardized and consistent to ensure accurate detection of changes over time. Among other things, this usually means marking permanent plots so that the same sites will be evaluated each year (or whatever the data collection interval is).

ASSESSING VEGETATION IMPACTS FROM DEER

http://aviddeer.com

DEC has worked with the Cornell University Department of Natural Resources and the State University of New York College of Environmental Science and Forestry to develop a monitoring protocol called Assessing Vegetation Impacts from Deer, or AVID. It focuses on specific wildflower and tree species that are eaten by deer in New York and includes a guide to identifying those species. The AVID protocol, which is available online and via mobile app, also includes instructions on identifying good monitoring sites. For this monitoring method, at least 6 permanent plots of 113 ft^2 each are measured out and marked in each forest patch or stand to be monitored. Data collection involves counting and measuring the height of individuals of the selected species in those plots. Each plant measured is marked with a tag so that it can be found and measured in subsequent years. The smartphone app provides paperless data collection and easy access to the species identification information in the field.

MONITORING METHODS MUST BE CONSISTENT OVER TIME TO SHOW CHANGES IN IMPACTS.

A similar method that was recently developed by a forest ecologist with the U.S. Forest Service is being implemented at various locations around the Northeast. It involves establishing plots of 1075 ft^2, selecting one or more species of interest in each plot, counting or estimating the number of individuals of each focal species in the plot, and measuring the heights of the ten tallest seedlings under 4 feet tall (if the species is a tree or shrub) or the ten tallest individuals (if the species is a wildlflower). For wildflowers, the number of individuals in flower or fruit is also recorded. In this method, the tallest individuals are measured each year, so marking specific plants is not required.

A different type of approach that has been used in New York and neighboring states is to plant red oak (*Quercus rubra*) seedlings each year and count the number that have been browsed by deer after a certain period of time (Blossey et al., 2017). This eliminates the need to learn to identify species, but requires identifying forest sites where red oak can grow, purchasing seedlings annually (or whatever the data collection interval is), and planting the seedlings properly so they survive the process. Other tree species could be used instead of or in addition to red oak. This method may be particularly useful in places where deer impacts are so severe that native wildflowers and tree seedlings are essentially absent from forest understories.

Photo courtesy of Cornell University

Simpler methods that involve just counting tree seedlings in plots or estimating the percentage of a vertical board that is visually obscured by plant growth when viewed from a specific distance are less time-consuming and may require less training, but field personnel still need to be able to distinguish exotic species from natives. Otherwise, growth of invasive species could be misinterpreted as recovery of forest health.

Appendix 2 contains protocols or links to protocols for the methods mentioned here.

Cultivated plant damage

One of the primary deer-related problems experienced by landowners is damage to gardens, landscaping or crops. This can result in considerable financial loss and an inability to use land for desired purposes. Monitoring this type of damage can be complicated by changes in landowner behavior, such as planting different species, fencing, or using repellents. Relying on landowner reports of the extent or severity of damage, in addition to these potential complications, raises the possibility that perceptions of damage may change at a different rate from actual damage. For example, after a deer population reduction program has begun, optimism, relief or wishful thinking may lead landowners to perceive less damage in their gardens even before deer browsing has decreased.

Taking an experimental approach to monitoring this impact should result in more reliable data. For example, potted plants of a species that is frequently eaten by deer can be purchased and distributed to homeowners throughout the community each spring. Participating homeowners must commit to placing this plant in their yards, caring for it appropriately, and measuring its height or counting its leaves on a regular (daily or weekly) basis during the growing season. The data should be reported to a designated community official who will compile them and look for trends over time. The intensity of deer browsing in the community will determine what data points might be most useful for comparison. For example, if browsing is very heavy, the percentage of plants that still have any leaves remaining two weeks after placement might be the value chosen for between-year comparisons. In a community with lighter levels of browsing, a value such as the average height of the plants two months after placement might be a more informative indicator.

Photo by Dick Thomas

On the other hand, if residents' satisfaction or perception of damage level is considered an adequate indicator of program success, mail or internet-based surveying can be a relatively simple assessment method.

Tick-borne disease

Although tick-borne disease, particularly Lyme disease, is a major concern throughout much of New York and is often cited as a principal impetus for initiating a community deer management program, it is a difficult index to monitor for evaluating the success of the program. There are several reasons for this: in many cases deer population reduction is not likely to reduce Lyme disease incidence (Jordan et al., 2007; Kugeler et al., 2015), measuring tick abundance and testing ticks for the presence of the Lyme-causing bacteria is expensive, and other methods for estimating Lyme prevalence may not provide reliable data. Rates of human infection can be estimated from public health records, but a decrease in those rates may be a result of improved tick bite prevention practices, which should be a focus of the education component of the community's program. The other tick-borne diseases are less common and less well studied than Lyme and therefore would be even harder to use as indicators. A community that wishes to pursue tick testing should contract someone with expertise in tick-borne disease.

Measuring tick abundance without testing to determine Lyme infection rates doesn't provide an accurate indication of disease risk. However, communities interested in just monitoring tick abundance can find descriptions of various methods online.

Tick-covered sampling cloth. Photo by Moses Cucura.

Conclusion

Deer overabundance is a challenging issue for communities to confront, but many have succeeding in developing management programs that have decreased their deer-related problems. The Community Deer Advisor website (deeradvisor.org) provides detailed examples that should be very useful for any community searching for an effective solution. DEC can offer information and advice specifically tailored for communities in New York.

Due to the nature of biological systems, reducing deer populations is necessary for long-term impact reduction on a community-wide scale. A review of the examples on the Deer Advisor site demonstrates that successful programs include hunting, culling, or both. Continued research on fertility control methods may produce additional useful options in the future. All deer impact management methods have to be continued and/or repeated year after year.

To maintain community support and justify municipal expenditures, monitoring is an important component of every deer management program. Monitoring the deer-related impacts of concern to the community is the only way to establish whether the program has successfully addressed those impacts.


Photo by Dick Thomas

Frequently Asked Questions

Isn't "deer overabundance" just a matter of perception? Aren't the deer living in our neighborhoods because development has crowded them out of the places where they used to live?

Actually, white-tailed deer do better in the suburbs than they do in more wild places. They have become so abundant in many developed areas because their reproductive and survival rates are both very high in those areas. High deer densities have serious ecological and public safety consequences, but people differ in their willingness to tolerate those impacts, which can affect a community's perception of overabundance.

What happens if we don't manage the deer? Won't they come into balance with the environment?

Deer are prey animals that in a "balanced" state have a high level of mortality from predators. Without that high mortality, the population will continue to grow until there isn't enough food available to support them and death by starvation becomes a significant factor. Long before that point, high rates of vehicle collisions and severe damage to landscaping and natural ecosystems make it clear to most people that letting the population continue to grow is bad for the deer, the environment, and the community.

Why not bring back natural predators and let nature take its course?

People would probably be less willing to tolerate large predators like wolves and mountain lions in their neighborhoods than deer. Also, those predators would not be as willing to live in developed areas as deer are. Research has shown that in states where mountain lion populations have recently become established, deer-vehicle collision rates dropped in rural areas but not urban areas.

We don't want to hurt the deer; why can't we just move them somewhere else?

Translocation, or moving deer, can't really be considered a humane procedure. Deer are very susceptible to capture stress, and research has shown that a high percentage of translocated deer die of stress-related causes shortly after release. In addition, moving deer increases the risk of spreading disease.

Will reducing the deer population cause the remaining deer to have more offspring to compensate?

Deer in urban and suburban areas are typically reproducing at or near maximum rates because they have access to plenty of food. A jump in reproduction would only occur in a situation where lack of food had led to malnutrition and lowering deer numbers allowed the remaining deer to regain health. But even in that situation, the increased reproduction would be mathematically outweighed by the deer removed, so the population would still decrease.

If we start population control, is there a chance we won't have deer anymore?

Not unless there's a severe disease epidemic. Community deer management activities are not capable of wiping out a deer population under modern laws and land-use patterns, nor is that ever the intent.

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APPENDIX 1. Controlled Hunt Structure

Controlled hunts occur within the normal hunting seasons and provide a mutually beneficial formal arrangement between hunters and landowners. DEC staff can help communities identify suitable controlled hunt structures and provide guidance for successful and safe implementation. As part of organizing such a hunt, it may be helpful to provide training to hunters on the special nature of urban/suburban hunts and ways to facilitate positive interactions with non-hunters.

A common barrier to hunting in urban and suburban areas is discharge ordinances. Many municipalities have passed ordinances prohibiting weapons discharge. To allow a controlled hunt to occur, such municipalities can issue a special permit or temporary waiver for the time period and location of the hunt if they are unwilling to rescind the ordinance.

What makes a controlled hunt possible is that landowners always have the right to impose rules on hunters they allow on their land, narrowing the boundaries of what is permitted more than the restrictions imposed by laws. In a community hunt, all participating landowners agree to a common set of rules. This ensures that both landowners and hunters know what to expect and allows all parties to feel comfortable with the hunt. Following are many of the aspects of hunting that are often subject to limitation in controlled hunts:

Hunter characteristics

Number of hunters – Because urban/suburban hunts typically take place in highly developed areas with relatively small properties, the number and distribution of hunters is usually tightly regulated. Hunt coordinators or landowners will specify how many hunters are allowed to hunt on a particular property and may schedule different hunters at different times to maximize effectiveness and efficiency.

Experience – Landowners may feel more comfortable with established hunters who have many years of hunting experience and have encountered and dealt with a wide variety of situations.

Proficiency – There is usually a shooting accuracy and consistency requirement for participating hunters. The municipality or a local sportsmen’s club may administer a shooting test and set the qualification level. Hunters may be required to re-qualify each year that they wish to participate.

Performance – A hunt coordinator may compile data on time spent hunting, number of shots taken, number of deer killed, and number of arrows or wounded deer unrecovered. Hunters who don’t devote enough time, don’t kill enough deer, or display problems with accuracy may be removed from the program. In smaller or less formal hunts, landowners may just require that hunters kill a certain number of deer on their property each year or they will be replaced. In all cases, a landowner who is dissatisfied or uncomfortable for any reason can at any time rescind permission for a given hunter to use his/her property or remove his/her property from the program entirely.

Record – Hunters may be required to pass a criminal background check.

Monitoring

Identification – Hunt coordinators may provide ID cards or armbands for participating hunters. Landowners may request the contact information and vehicle license plate number of hunters using their property. Permits and ID tags may be provided for vehicles and tree stands.

Notification – Communication is an extremely important aspect of conducting hunts in developed areas, and there are many types of notification that may be required. There may be a hunt coordinator who receives notifications from hunters whenever they enter the field, shoot a deer, recover a deer and leave the field. In some cases, the local police department may wish to receive these notifications as well. Especially for a hunt focused on one property, like a park, there may be a centralized check-in/check-out location. A hunt coordinator or individual hunters may notify landowners whenever a hunter enters or leaves their property or shoots a deer on their property. Landowners should always be notified if a hunter loses an arrow on their property or is unable to recover a shot deer. To ensure accountability, hunters may be required to label all arrows with their names or assigned numbers.

Hunt details

Day and time – Hunting may be allowed only on certain days of the week and at certain times of day. Landowners may choose times when hunting activities are less likely to conflict with their use of their land.

Equipment – The types of hunting implement that are allowed may be specified. Due to safety considerations and discharge setback law, most hunting in urban and suburban areas is accomplished with archery equipment (typically compound bows and/or crossbows), but it may be possible to use firearms in larger green spaces such as parks. Safety equipment may be specified as well, such as with a requirement that all hunters wear full-body harnesses in tree stands.

Location – For hunts in parks, hunters may be prohibited from hunting within a certain distance of trails. Landowners may approve specific locations for tree stands or ground blinds and require that hunters only shoot from those locations. In many urban/suburban hunts, shooting is only allowed from tree stands to ensure that arrows have a downward trajectory and hit the ground within a short distance. The minimum height of tree stands may be specified. Landowners may also specify where hunters are permitted to park and what route hunters may use to enter their property.

Direction – In some cases, a landowner who is concerned about the proximity of a shooting location to other activities may wish to specify that a hunter is only allowed to shoot in a certain direction. Particularly if ground blinds are used, hunt coordinators may establish safe shooting directions for each location. Hunters who wish to cut branches or brush to clear shooting lanes should always obtain landowner permission first.

Distance – Hunters may be required to only take shots at deer that are closer than a certain distance.

Visibility – There may be a requirement to avoid shooting when a person is within sight or within a certain distance of the shooting location. There may be a requirement to cover deer carcasses completely when transporting them by vehicle.

Deer sex – Since deer population reduction is typically a principal goal, doe harvest is strongly emphasized in urban/suburban hunts. In some cases, only does are to be shot. In other cases, hunters may be allowed to shoot a buck after shooting a certain number of does.

Field dressing – Landowners may require hunters to remove all entrails from their property after field dressing a deer, or remove the carcass whole and dress it at another location.

Other

Venison disposition – Most of the venison is usually donated to local food banks. Landowners or municipalities may defray the butchering costs. A venison allocation system may be established to ensure that hunters, landowners and food banks all receive a predetermined share. To eliminate the risk of lead contamination of meat, the use of lead-free ammunition may be required. If lead ammunition is allowed, the potential for meat contamination should be carefully evaluated and communicated to recipients.

Conflict resolution – A procedure may be agreed upon for bringing any dissatisfaction or conflict between participants to a third party such as a hunt coordinator. This may permit many issues to be resolved while avoiding confrontation.

In addition to the rules established by the community, there should be a clear understanding that all federal, state and local laws, regulations and ordinances must be followed. Relevant New York State laws that all stakeholders should be made aware of include:

Discharge setbacks - Shooting a firearm within 500 feet, a crossbow within 250 feet, or a vertical bow within 150 feet of a school, playground, public structure, or occupied factory, church or farm building is prohibited. Shooting within those distances of a dwelling is prohibited unless the shooter owns or leases the building or has the owner's permission. With permission, it is legal to shoot even from within or on a dwelling. Where properties are fairly small, options for potential shooting locations will be expanded if neighboring homeowners grant permission for shooting within discharge setback distances.

Trespass – It is illegal to be on someone else's land without permission. Having shot a deer that then moved across a property boundary does not change this. Landowner permission must be obtained before a hunter can cross property lines to follow a wounded deer or recover a deer carcass. Landowners are not required to grant such permission. Hunters should seek all permissions they anticipate needing well in advance, and plan their shooting locations to avoid the likelihood that a shot deer will cross onto land where they have not been granted permission.

Interference – It is illegal to interfere with someone who is hunting lawfully and attempt to prevent them from killing game. Hunters should avoid confrontation, but should call 911 or DEC Dispatch if someone is interfering with their hunting.

Liability – The New York State General Obligations Law protects landowners from liability for non-paying recreationists hunting on their property. Participating hunters or a hunter organization coordinating a controlled hunt may wish to obtain liability insurance.

Sale of meat – Venison from wild deer cannot be sold.

If a Deer Damage Permit is obtained from DEC, a cull using volunteer shooters can be operated using a very similar structure and set of rules to a controlled hunt. The principal differences are that the permit allows deer to be shot outside of hunting seasons, hunting bag limits don't apply, and baiting and shooting at night with lights can be used to increase success. There must be a coordinator who is responsible for supervising the volunteers and ensuring that the terms of the permit are adhered to. The coordinator will probably need to provide training on the most effective use of bait and lights.

It's important to remember that even a well-run hunt with dedicated hunters won't effectively reduce a population if the hunters don't have access to the land holding most of the deer, so achieving adequate landowner participation is the key to a successful program.

APPENDIX 2. Ecological Monitoring Methods

Numerous options exist for communities to monitor ecological impacts of deer, though methodologies vary in complexity and effort necessary. DEC has partnered with research universities to develop the AVID protocol as a technique for the public and professionals to monitor deer impacts. Data collected through AVID, in addition to informing community deer management efforts, will be used by DEC deer managers to assess trends in deer impacts across the state. However, some communities may find alternative techniques to be helpful.

AVID

The Assessing Vegetation Impacts from Deer (AVID) protocol, developed by the Cornell University Department of Natural Resources, the State University of New York College of Environmental Science and Forestry, and DEC, can be found online at aviddeer.com. Training sessions are held periodically at various locations for people who want hands-on instruction.

AVID is a method for volunteers, foresters, landowners and others to monitor deer impacts on forests. It focuses on specific wildflower and tree species that are eaten by deer in New York. The AVID website and mobile app guide users through laying out monitoring plots, plant identification, and data collection. Within the plots, individual plants of the focal species are counted, marked and measured. Measuring these same individuals each year will show whether browsing pressure from deer is changing over time and may help communities, landowners, and managers make decisions on appropriate changes in deer abundance.

Ten tallest

The ten-tallest protocol uses the height of seedlings and/or wildflowers as indicators of forest health and browse impact. It involves laying out plots and then finding the tallest individuals of the focal species in the plots each year. Detailed instructions are being developed for publication, and in the interim may be obtained from protocol author Tom Rawinski, a U.S. Forest Service forest ecologist, at trawinski@fs.fed.us.

Seedling count

Background – A forest with overabundant deer will have very few tree seedlings that survive their first season of growth. As deer density is reduced, more seedlings will be able to survive. Once a seedling reaches 6' tall, deer shouldn't be able to reach the top, so deer browsing should no longer prevent it from growing.

Materials needed –

- Measuring tape.
- Marking materials such as posts or stakes to set plot corners.
- Compass to help you construct rectangular plots.
- GPS unit to record locations.
- String

Plot design – At least ten rectangular 6'x18' plots should be established. Strive to have enough plots to capture whatever variability there is in local forests. Avoid extremely rocky areas, steep slopes, and areas where the foliage is so dense that virtually no sunlight reaches the forest floor in the summer. If possible, plots should be at least 50 yards apart and at least 50 yards from any forest edge or manmade structure. Permanently mark the corners of the plots with posts or stakes. Record GPS coordinates of each plot to make it easier to find in future years.

Data collection – At the same time each year, count the native tree seedlings that are between 1' and 6' tall in each plot. The shape of the plots should make it possible for one person to make a single survey pass down the length of the plot tallying seedlings without losing track of which ones have been counted. Before starting a survey, lay out string along the two long sides of the plot so you can tell what's in and what's out. When you're done, pick up the string and take it to the next plot.

Evaluation – Natural ecosystems are too variable for there to be hard and fast rules about what densities are necessary for adequate regeneration, but as a rough lower limit guideline, an average count below five seedlings per plot (equating to approximately 2000 seedlings/acre or 5000 seedlings/hectare) would probably be cause for concern. Some forests in New York have more than four times that density of seedlings (>20,000 seedlings/hectare).

The species that are present should also be taken into consideration when assessing these results. If most of the seedlings are species that deer don't like to eat, like American beech (*Fagus grandifolia*) and eastern white pine (*Pinus strobus*), even though there are mature trees of other species around, that may indicate that deer browsing pressure is too high to allow the other species to grow.

Sentinel seedlings

Background – This method involves planting red oak (*Quercus rubra*) seedlings in upland forest areas and measuring the percentage of plants that have been browsed by deer after six months. Red oak is a common species in eastern North America. Green ash (*Fraxinus pennsylvanica*) can be substituted in wetland areas. Planting seedlings allows the assessment of deer browsing pressure without the need to find sites that have an adequate number of suitable plants growing naturally.

Materials needed –

- 1'-3'-tall red oak seedlings. Look for a nursery that offers bulk discounts.
- Measuring tape.
- Marking materials such as flagging, tree tags and stakes to help you find the seedlings.
- Planting tool such as a garden trowel or spade.
- GPS unit to record locations.

Sample size – To obtain accurate results, it's best to have at least 10 sites with 10 seedlings at each site.

Site selection – Avoid extremely rocky areas, steep slopes, young forests without mature trees, and dense conifer stands. If possible, sites should be at least 100 yards apart and at least 50 yards from any forest edge or manmade structure. The same sites should be used on each planting occasion. If there are surviving seedlings from the previous planting, they should be removed so they don't affect how attractive the site is to deer.

Timing – Plant seedlings in early winter (November - December) while they are dormant. Data collection should take place six months later. This covers the winter-spring time period when deer tend to do the most browsing on woody plants because there is little else available.

Planting – Plant seedlings at least 3' apart in a systematic pattern. Mark individual seedlings in an unobtrusive but durable manner, such as with a tree tag attached to a stake sunk in the ground 1' north of each seedling. Marking is necessary because if a seedling has been browsed, spotting it or identifying where it was can be difficult. Markers that are more visible might attract the attention of deer, because deer are curious enough to investigate things that look different. Record GPS coordinates for the site. Tie flagging around several trees at the edges of the site to make it easier to find in future years.

Data collection – Data interpretation can be improved if you count the number of leaf bud clusters on each seedling immediately after planting. Assuming you have a method of numbering the seedlings so you can match up the data, when you return in six months to look for leaves you will have a better idea of whether what you see shows browsing. Deer most commonly tear off leaves or parts of leaves. A stem torn by a deer will have a rough, jagged, frayed-looking end. In contrast, rabbit or rodent browsing usually results in a stem end with a clean-looking cut at about a 45º angle, because they bite it through rather than tearing.

Evaluation – Deer damage on more than 10% of the seedlings probably indicates that browsing pressure is too high to allow the forest to regenerate itself.

Appendix D

An Integrated Approach for Managing White-Tailed Deer in Suburban Environments:

The Cornell University Study

Jason R. Boulanger, Paul D. Curtis and Bernd Blossey

A publication of Cornell University Cooperative Extension and the Northeast Wildlife Damage Research and Outreach Cooperative

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Photo credits:
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Back cover: P. Curtis (top left, top right, bottom left, bottom center), C. LaRow (bottom right).

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Executive Summary

Based on decades of growing deer impacts on local biodiversity, agricultural damage, and deer-vehicle collisions, in 2007 we implemented an increasingly aggressive suburban deer research and management program on Cornell University lands in the Town of Ithaca, New York. We also coordinated a bowhunting program in the nearby Village of Lansing (VOL). Our experiences and recommendations will benefit other communities challenged with deer-related impacts. We also describe an experimental approach for planting red oak (*Quercus rubra*) sentinel seedlings to assess the intensity of deer damage to vegetation.

Cornell's Integrated Deer Research and Management (IDRM) Program strived to reduce deer numbers and associated impacts through use of surgical sterilization (tubal ligation and ovariectomy) on core campus (an unhuntable area), and an Earn-a-Buck (EAB) hunting program on surrounding lands, designed to increase the harvest of female deer. We chose to complement these approaches with assessments of deer abundance, monitoring of deer behavior, assessment of ecological outcomes, and a science-support program using harvested deer to enhance other Cornell research. Despite our efforts during the first five years of this study, it became clear that we could not reduce deer numbers on Cornell lands to a level that alleviated negative impacts, such as deer-vehicle collisions and overbrowsing. By winter of 2013, we stabilized the campus deer herd to approximately 100 animals (57 deer/mi^2), a density much higher than project goals (75% reduction =~14 deer/mi^2). Despite these numbers, we did see a decrease in does and fawns appearing in photographs on campus during the five-year study period. This decrease was offset by an increase of bucks that appeared on camera during our population study. Bucks from outside the core campus sterilization zone may have been attracted to the does that received tubal ligation surgery and continued estrus cycling through February or March. Also, we did provide protection for some bucks in the early years as a result of our EAB program focusing on doe harvest. In the last two years of the Cornell study, we implemented use of deer damage permits (DDP) with participants using archery equipment over bait. Concurrent with these activities, we removed additional deer using collapsible Clover traps and deer euthanasia with a penetrating captive bolt. Our efforts demonstrated that these methods can be safely and effectively conducted in densely populated areas with high public use. In concert with sterilization and hunting, the expanded use of DDPs and deer capture resulted in a herd reduction of approximately 45% in just one year on core campus. Based on our experiences, we discontinued use of surgical sterilization and EAB hunting on Cornell lands in 2014. On core campus, we will continue use of deer damage permits given a new statewide law that relaxes archery discharge limits to 150 feet. On adjacent lands, we will continue use of a controlled, public hunting program without EAB restrictions.

We also describe our experiences implementing and expanding a suburban bowhunting program in the VOL. Although hunters safely harvested several hundred deer over a period of seven years, browsing of red oak sentinel seedlings indicates that ecological damage still occurs on these lands. More aggressive deer removal will be needed to reach management goals of reduced plant damage.

Finally, we describe current deer management options and present recommendations for agencies, communities, landowners, and policy-makers to better manage deer impacts. Moreover, we review fertility control, and argue that attempting to manage a suburban deer herd using this method alone will likely not be successful in areas with free-ranging deer. Even with 90% or more of female deer sterilized, the best we could do was stabilize herd growth on core campus lands. Some form of lethal deer management (e.g., hunting, sharp-shooting, capture and euthanization) will be needed to reduce deer numbers in an acceptable time frame (<5 years).

Cornell Integrated Deer Research and Management Program Mission Statement

To improve the health and safety of Cornellians and residents in surrounding communities by reducing threats of deer vehicle collisions (DVCs) and tick-borne diseases; to preserve teaching and research lands by improving tree regeneration and biodiversity for the perpetuity of University lands as outdoor classrooms; and to reduce the burden of economic impacts. As a leader in the field of deer damage mitigation, we carry out this mission through a strong foundation of science, partnership, field demonstration, and novel techniques to reduce deer impacts on University lands and nearby properties.

Introduction

New York's most popular game animal, the white-tailed deer (*Odocoileus virginianus*), is found throughout the eastern U.S., and as a valuable resource, generates over $650 million each year in hunting revenue in the state (Fig. 1). Deer also provide enjoyment for nature watchers, photographers, and residents throughout their range. In recent years, however, the increase in white-tailed deer and their impact on forests, other wildlife, agriculture, and human health, have resulted in increasing conflicts with humans, costing approximately $2 billion per year in the U.S.

This publication provides a summary of deer management on Cornell University and surrounding lands, and highlights current options for mitigating overabundant deer populations. We anticipate that wildlife agency staff, community leaders, and other stakeholders can learn from our experiences, saving valuable time and money.

The white-tailed deer is a keystone herbivore of forest ecosystems. At high population densities, deer can have disproportionately large impacts on biodiversity and forest dynamics. Their feeding, on a wide variety of plants, can prevent forest regeneration, endanger native plants, and facilitate non-native plant invasions. Furthermore, deer impacts cascade through food webs and impact other native wildlife, including small mammals, birds and amphibians. In addition, white-tailed deer may damage crops, resulting in substantial financial loss. At high abundance, deer are often associated with negative impacts in suburban landscapes, where deer find ideal habitat, ample food sources, limited or no hunting, and few wild predators. Deer-human conflicts such as deer-vehicle collisions (DVCs) and tick-borne diseases pose safety and health concerns.

Although the effect of deer on Lyme disease incidence is debated in the scientific literature, recent work suggests a correlation between deer densities, tick abundance, and resident-reported cases of Lyme disease.

Figure 1. An Earn-a-Buck hunter with a deer harvested on Cornell University lands. *Photo – J. Boulanger.*

Sustainability of the white-tailed deer resource has always been a goal of regulated utilization in the U.S. since early game law implementation. However, limitations on hunting and the behavior of hunters, the primary method used by wildlife managers to affect deer populations in rural areas, pose challenges for suburban deer management.

Hunting may be impractical in some communities due to the density of residential neighborhoods and buildings, and legal, safety, or social concerns. Moreover, data from suburban landscapes where regulated hunting was the sole method used to affect deer populations suggest that hunting was insufficient to reduce deer densities to <44 deer/mi^2, well above common management objectives (<8 deer/km^2 or <20 deer/mi^2). To restore biodiversity in areas that have been overbrowsed, or reduce tick populations and associated Lyme disease risk, deer densities may need to be <4 deer/km^2 (<10 deer/mi^2). However, hunting may be sufficient to reduce DVCs depending on community needs or means. We caution the reader that no single density estimate translates to deer impacts in all cases. Throughout this publication we stress the importance of local deer impact reduction vs. arbitrary number reduction goals.

Alternative options for managing deer abundance in areas where hunting is impractical may include sharpshooting, or capture and euthanasia. In most states, deer fertility control (surgical sterilization or immunocontraception) is experimental, requiring research permits from state wildlife agencies. Moreover, there is no peer-reviewed, published evidence to suggest that use of non-lethal methods alone can reduce deer populations to target levels. Deer translocation is not recommended because it is hazardous to managers; expensive; deer may not survive the process; may further spread disease; and many areas are already well above acceptable deer densities. Sharpshooting deer over bait can be very effective in quickly reducing populations in suburban areas. However, this technique is controversial in some communities. Landowners and municipalities are often unprepared for vehement opposition from residents with safety concerns (some justified, some misconstrued), activists opposed to killing animals, or from hunters who either oppose deer herd reduction or believe all deer reduction should be done through hunting. The ensuing controversy often results in lawsuits, extended public debates, and inaction, allowing deer-related problems to persist or worsen.

The last decade has seen an upsurge in local deer management proposals and actions due to the frequency of deer-related conflicts that now increasingly exceed tolerance levels of ecologists, conservationists, and suburban communities. The most important factors that drive communities to embrace more aggressive management efforts often include: 1) rapid rise of tick-borne diseases; 2) DVCs; and 3) unacceptable levels of plant damage (e.g., landscape ornamentals, crops, tree regeneration, or sensitive plant communities and resulting effects on local biodiversity).

In Ithaca, New York, after decades of increasing deer impacts on local biodiversity and agricultural damage, Cornell faculty and staff, community leaders, and stakeholders, developed **Cornell's Integrated Deer Research and Management (IDRM) Program** in 2007. The university responded to the articulated need to reduce deer-human conflicts and evaluate management options on campus. Objectives for similar programs often include reducing deer numbers, but it is more important to consider deer-related impacts when setting management objectives.

> The key to the Cornell program is that it integrates lethal and nonlethal techniques to manage deer populations, paired with assessments of deer abundance, and development of new assessment tools to survey the extent and potential reductions in ecological damage due to deer browsing.

As such, this program is unique in the country. However, this program also exceeds the capabilities of most communities due to the level of funding and scientific expertise it requires.

Study Area

We conducted the IDRM study on the Cornell University central campus, surrounding residential communities, agricultural land, natural areas, and woodlots in the Towns of Dryden, Ithaca, and Lansing, Tompkins County, New York (Fig. 2). Within this area, we identified: 1) a sterilization zone (~1,100 acres) containing core campus areas where building density, human activity, and unsafe shooting zones precluded hunting as a management tool, and 2) a hunting zone (~4,000 acres) containing Cornell-owned agricultural and natural areas adjacent to core campus that had been open to hunting for decades. Within the hunting zone, we identified 20 disjunct hunting areas ranging in size from 14 to 190 acres. Approximately 63% of these lands, those adjacent to suburban communities, are restricted to bowhunting (Fig. 3).

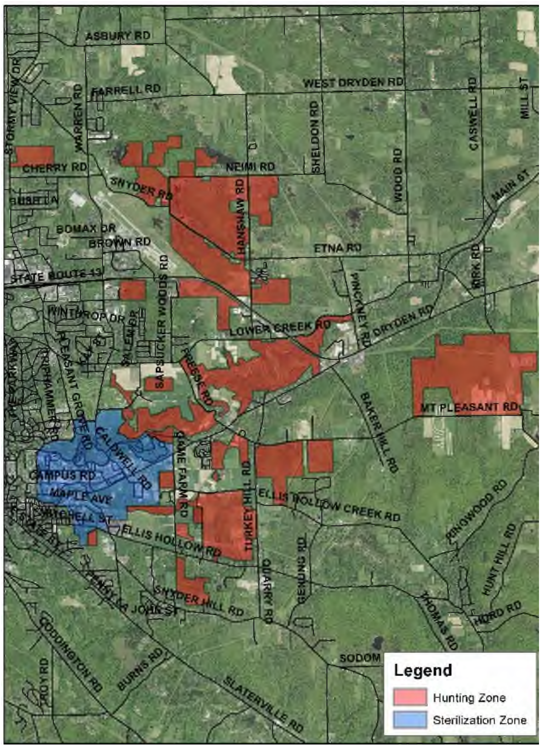

Figure 2. Cornell University properties included in sterilization and hunting zones within the IDRM Program.

In addition to IDRM, we assisted the Village of Lansing (VOL; Lansing, New York) with the implementation of a deer management program using bowhunting. The VOL is not immediately adjacent to Cornell campus, but a number of Cornell properties are located within VOL boundaries. We hunted on small private properties (often less than 5 acres), and landowner participation has increased from one to >40 properties over a period of seven years.

Due to continued concerns and complaints in surrounding communities, and with assistance of staff and faculty, the New York Department of Environmental Conservation (DEC) established a 60,000-acre Deer Management Focus Area (DMFA) in 2012 centered on Cornell campus, but including many outlying areas. Almost all Cornell lands in the study area, and properties in the VOL, are contained within the DMFA. In the DMFA, DEC liberalized antlerless bag limits (two antlerless deer per hunter per day) and created additional hunting opportunity (three-week season for antlerless deer in January).

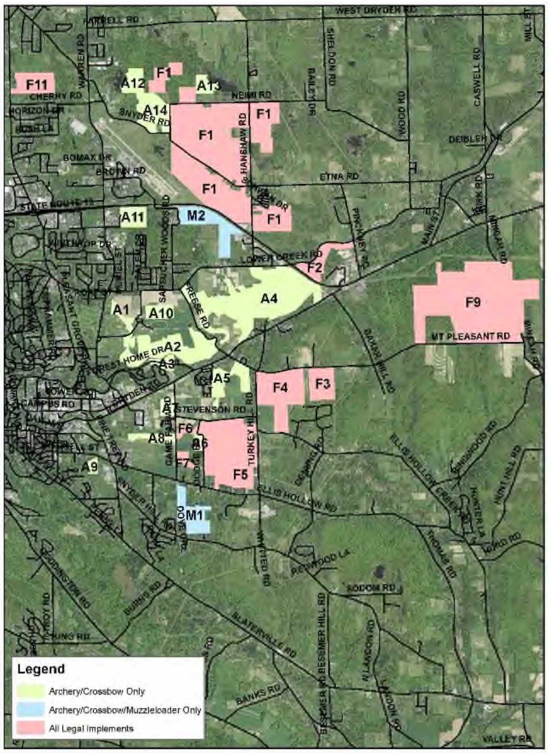

Figure 3. Cornell University hunting properties included in the IDRM Program and permitted use of bows, crossbows, and firearms by property.

IDRM Core Components

Various theoretical studies suggest that sterilization may reduce deer numbers, but in practice this method has resulted in inconclusive results or failed in open deer populations in suburban landscapes. Other studies suggest that sterilization will be more effective if combined with some form of lethal control. We chose an integrated approach with various components focusing on increased harvest of female deer. We anticipated that this integrated approach would help accelerate a decrease of deer numbers and impacts on campus, along with adjacent natural areas, agricultural lands, and suburban neighborhoods. We chose to complement implementation of deer reduction approaches with assessments of deer abundance, monitoring of deer behavior, assessment of ecological outcomes, and a science support program using harvested deer to enhance other Cornell research.

Deer Capture and Sterilization

The number of students and staff, building density, and expressed safety concerns precluded hunting as a tool in the core campus area. We instead chose deer sterilization (using tubal ligation and ovariectomy) for core campus because of the nearby convenience of Cornell University's Hospital for Animals (CUHA), and because this method only requires handling a deer once. Deer treated with immunocontraceptive vaccines require annual booster shots. To assess the impact of capture and surgical procedures on deer behavior and survival, we captured and collared additional females, but without sterilizing them (control group).

The initial goal of the sterilization program was a reduction in deer numbers and associated impacts on core campus by 75% in five years.

Earn-a-Buck Hunting

The total area of University-owned land involved in the hunting program was approximately 4,000 acres of non-contiguous parcels (Fig. 3). Although hunting has been allowed on Cornell lands for decades, it did little to curb increasing deer populations and conflicts. For safety reasons, we restricted hunting zones close to Cornell campus or nearby suburban neighborhoods to archery equipment, but allowed firearms and/or muzzleloaders further away (Fig. 3). Deer hunting occurred during New York State's Southern Zone archery, regular firearms, and muzzleloader/late archery seasons. We implemented an Earn-a-Buck (EAB) deer hunting program (Fig. 4) designed to increase female harvest by requiring hunters to take two females before they were able to take a buck. In 2012, EAB rules were relaxed, requiring hunters to take one antlerless deer before being able to take a buck. Beginning in 2012, DMFA regulations allowed for a three-week season in January for antlerless deer only.

The initial goal of the controlled hunting program was a reduction in deer numbers and associated impacts in hunted areas by 50% in five years.

Population Monitoring

The IDRM Program included monitoring of deer fitted with radio collars to track movements, birthing rates, and survivorship. We also used infrared-triggered cameras to estimate herd size and density.

Figure 4. Adult male deer on Cornell lands exceeding 200 pounds, measured after harvest. *Photo – IDRM Program.*

Ecological Assessments

Traditionally, articulated deer management needs concern lessening deer impacts, yet the debate has centered on the number of deer per square mile or kilometer that would be acceptable or desirable. There is no reliable translation of deer abundance to deer impacts, and the often articulated goal of <20 deer/mi^2 assumes greatly reduced deer impacts based on questionable historical deer abundance at time of European settlement of the continent. We chose an experimental approach, the planting of red oak (*Quercus rubra*) sentinel seedlings to assess deer browse intensity. We chose this method for ease of implementation for researchers and landowners, concerns over oak regeneration failure throughout the Northeast, and the intermediate browse preference of deer for red oak. Most existing woodlots on and near the Cornell campus, and in the region, have been over-browsed by deer for many years (Fig. 5).

Basic Suburban Deer Biology

- White-tailed deer are named for their characteristic white tail that is held erect when alarmed. They have grey-brown coats in winter that turn red-brown in summer. Males (bucks) begin to grow antlers in the spring that are complete in the fall; antlers are used for fighting and establishing rank among other males. In New York, weights average about 100 pounds for females (does) and 150 pounds for males (bucks), and height averages 36 inches at the shoulder (Fig. 4).
- Deer perceive a different color spectrum than humans and have a supreme ability to see movement. They also use excellent scent cues and hearing to navigate through their habitats and daily routines. When frightened, deer can attain speeds of 36 miles per hour over short distances and jump over an 8-foot-high obstacle.
- White-tailed deer can thrive in suburban areas. A combination of increased safety from some predators (including hunters), ample high-quality foods in gardens, ornamental plantings and parks, and feeding by residents (although illegal in New York) maintains their fertility and reduces their mortality.
- Under ideal conditions, adult deer commonly produce twin fawns and sometimes triplets. Deer that can survive suburban traffic may live to be well over 12 years (we have records of tagged suburban deer reaching at least 13 years of age in the southern tier of New York).
- Young deer, particularly males, will disperse from their birth areas to establish home ranges sufficient to fulfill requirements for food, water, shelter and reproduction. Suburban white-tailed deer generally have smaller home ranges than their rural counterparts. Female home ranges (averaging ~140 acres in suburban areas) are generally smaller than those of males.
- Hunter harvest is the primary cause of white-tailed deer mortality in rural landscapes, while deer in suburban landscapes are more likely to die in deer-vehicle collisions.

Deer Damage Permits

After the first five years of the experimental IDRM Program, an internal, university-formed Deer Management Committee (DMC) reviewed program goals, achievements, and methods, and decided to increase effectiveness of our IDRM Program through use of DEC deer damage permits (DDPs). After an initial successful test in March 2013, a small group of trained and proficient bowhunters with suburban deer hunting experience (see VOL below) continued to harvest deer over bait, at night with supplemental light during winter 2013/2014.

Science Support Program

Throughout the Cornell and VOL programs, hunters collected scientific samples from harvested deer (blood, liver, hair, bladder, and kidneys) aiding other Cornell researchers at the College of Veterinary Medicine (CVM) and the Department of Ecology and Evolutionary Biology.

Figure 5. Overbrowsed forest in our region (top) with no herbaceous vegetation or tree seedling recruitment, compared to a healthy forest with multiple layers of herbs, shrubs, and trees of different heights and ages (bottom). *Photos – B. Blossey.*

Concurrent with the February 2014 DDP archery activities, we applied for and received a DEC permit for additional collection of deer to augment management efforts and scientific sampling using collapsible Clover traps and euthanasia via penetrating captive bolt (Fig. 6). This technique is approved by the U.S. Food and Drug Administration, the American Veterinary Medical Association and by Cornell's Institutional Animal Care and Use Committee (Protocol No. 2007-0102). This humane population management technique works well in developed areas where other forms of lethal control, such as sharpshooting, may be inappropriate. In contrast to fertility control, capture and euthanasia yields immediate reduction of the deer population and associated impacts.

Figure 6. Collapsible clover traps used to live-capture deer. Door open ready to release a deer (top), and collapsed with captured deer (bottom). *Photos – P. Curtis.*

Village of Lansing

Although the VOL program is separate from the Cornell IDRM Program, we include it here given shared property boundaries, the experiences are informative within the context of this publication, and because two of us (Blossey and Boulanger) have coordinated efforts in the VOL as volunteers. Furthermore, a number of suburban archery hunters participated in both programs, and the experience hunters gained in the VOL helped inform the aforementioned Cornell DDP deer activities in 2013 and 2014.

The VOL, approximately three-square miles, represents a transition zone from suburban to rural landscape. The VOL deer management program has continued to expand as more landowners open their properties to this program, and VOL trustees sanction new properties annually. Hunting occurs from fixed treestand locations during regular hunting seasons, and equipment is restricted to vertical bows (e.g., no crossbows).

IDRM Implementation

Over the past seven years, we have attempted integrated approaches, but have also revised this program based on annual estimates of deer populations, performance of biological and ecological indicators, deer-vehicle collisions on campus, deer reduction goals, and availability of funding. The following is a more detailed summary of our approaches and experiences. Because we are located in New York, we fall under the rules and obligations governing wildlife management in the state. Regulations and approaches may be quite different from state to state, and we caution the reader not to assume that regulations are similar elsewhere. Furthermore, state regulations are in flux. Two examples include the establishment of the DMFA (unique to the Cornell area in New York), and the recent reduction of bow discharge distance in New York from 500' to 150' in spring 2014, a change that will greatly facilitate access to deer in suburban neighborhoods. The experiences we detail here are based on the 500' discharge distance, yet we will update this publication as we gain more experience with recent discharge changes.

Deer Capture and Sterilization

We obtained a DEC-issued License to Collect or Possess (LCP) and captured deer using modified Clover traps (named after its inventor; Fig. 6), drop nets, or with dart rifles, during late summer or winter from October 2007 through September

2013 in the core campus sterilization zone (~1,100 acres). Using dart rifles, we captured deer using blinds and bait, or opportunistically while patrolling campus lands. We established Clover traps in undisturbed woodlots on private property or Cornell lands, and habituated deer to the traps with daily baiting. All traps were set at dusk, when surgery time was available the following morning to prevent deer from being inside traps for extended periods. In addition to deer slated to be sterilized, we captured control female deer just outside the border of the core campus sterilization zone from 2008–2010 to compare fawning rates between groups. These control deer were captured and anaesthetized using the aforementioned techniques. We fitted all captured deer with numbered livestock ear tags, and all control does (n=26) and a proportion of sterilized does (n=69) with VHF radio collars to estimate deer populations, home range, mortality and fawning rates (Fig. 7). We captured, ear-tagged, and released most bucks without sedation.

Figure 7. Radio collared and ear-tagged white-tailed deer on Cornell lands. *Photo – P. Curtis.*

Upon capture, we anesthetized and hobbled the deer, fitted it with a blindfold and then transported it to the CUHA for surgery (Fig. 8). Most pregnant deer received tubal ligation surgery resulting in does giving birth in the spring, but with no further pregnancies thereafter. Unlike surgical procedures that remove ovaries (ovariectomy), veterinary surgeons preferred tubal ligation because it was less invasive. Tubal ligation also maintains normal hormone function, but results in repeated estrus cycling of females through February or March during subsequent years. Typically, most female deer are pregnant by the end of December and stop estrus cycling.

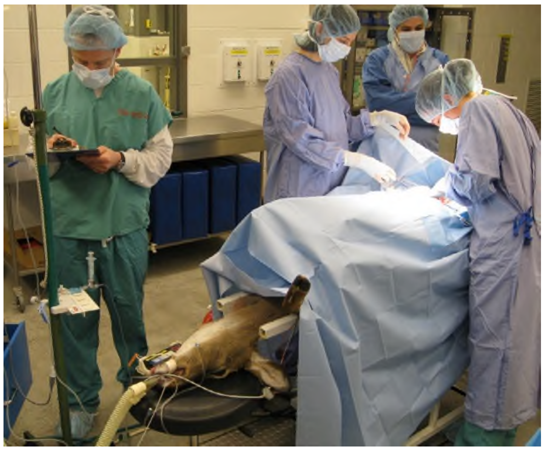

Figure 8. Sterilization surgery on a female white-tailed deer at Cornell University's Hospital for Animals. *Photo – J. Boulanger.*

From 2009–2012, we observed increased immigration of male deer into the sterilization zone, likely due to the prolonged cycling of estrus does on campus. Thereafter, in 2012 and 2013, we discontinued tubal ligations and performed ovariectomies on all females captured prior to becoming pregnant (Table 1). All trapping and surgery procedures conformed to the requirements of Cornell University's Institutional Animal Care and Use Committee (Protocol No. 2007-0102).

Following surgery and marking, we transported does back to the capture site, reversed sedation, and monitored individuals until recovery. Using radio telemetry and sightings, we evaluated deer movements and health during the first 48 hours after release. As required by the DEC LCP, we wrote the date at which the deer would be safe for human consumption on the back of the ear tag with indelible ink. Aggressive trapping efforts continued through 2010, until we had sterilized approximately 90% or more of the female deer in the core campus sterilization zone (based on camera monitoring, see below). In subsequent years, we targeted only the few deer (i.e., ~6 individuals) that immigrated onto campus annually.

As of summer 2014, we captured 167 deer; of these, 45 were male, 96 were females that received sterilization surgery, and 26 were control females (Table 1). Seventy-seven does received tubal ligations, and 19 received ovariectomy surgery, preventing births in 96% and 100% of these deer, respectively (Table 2). Of 29 radio-collared control deer captured and fitted with radio collars, three were recaptured and sterilized. Of the 26 remaining control deer, all (100%) displayed a swollen udder and/or had fawns present, indicating successful births. Based on examination of recaptured deer, the 4% of failed tubal ligation surgeries occurred because tissue regrew post-surgery, reconnecting the fallopian tubes, or other ovarian anomalies. These deer were subsequently re-sterilized.

Table 1. Number of surgery, control, and male deer captured during IDRM from 2007–2013.

Deer Captured by Category				
Year	**Tubal ligation**	**Ovari-ectomy**	**Control deer**	**Male deer**
2007/2008	20	11	0	17
2008/2009	27	0	10	21
2009/2010	19	0	7	7
Fall 2010	5	1	8	0
2011/2012	6	0	1	0
Fall 2012	0	4	0	0
Fall 2013	0	3	0	0
Totals	**77**	**19**	**26**	**45**

Table 2. Fawning comparison for sterilized and control deer.

Fawning	Tubal ligation	Ovari-ectomy	Control
Gave birth	3	0	26
Did not give birth	74	19	0
Totals	**77**	**19**	**26**

Earn-a-Buck Hunting

Prior to EAB, hunting on Cornell lands was a recreational, decades-long tradition, but permission was limited to a select few individuals at the discretion of various Cornell land managers. These few hunters had excellent hunting opportunities, but did little to reduce deer numbers. We consolidated Cornell hunting lands under a public, first-come, first-served, EAB hunting program designed to increase the harvest of female deer. Previous studies in Wisconsin and New Jersey demonstrated that EAB programs could increase harvest of antlerless deer, and since implementation of EAB at Cornell's Arnot Teaching and Research Forest (~4,000 acres) in 1999, managers observed an increase in maple (*Acer* spp.) and oak (*Quercus* spp.) regeneration (i.e., seedling and sapling survival) in some areas.

The EAB program was free, although prospective hunters had to apply for a Cornell hunting permit and submit to a Cornell Police (CUPD) background check. Approved hunters received a permit, vehicle dash tag for parking, and a pin-on identification tag that attached to an outer garment while hunting. We included the EAB website (now discontinued) on each hunting permit to provide hunters with information and rules. Approved hunters attended non-mandatory hunter orientation meetings where we stressed rules and good neighbor relations. We encouraged hunters to donate deer to a statewide venison donation coalition.

The EAB program established cooperative relationships with the DEC and local landowners. Each year until the establishment of the DMFA, we applied for and received DEC Deer Management Assistance Program Permits (DMAPs) for distribution to hunters to encourage additional harvest of antlerless deer. In 2012, we discontinued use of DMAPs due to the establishment of the DMFA.

To participate in the Cornell EAB program during the hunting season, approved hunters first had to sign in to specific hunting zones, and the number of hunters allowed in each zone was limited to prevent crowding. We required successful hunters to bring harvested deer to a nearby, 24-hour check-in station for biological data collection. We required hunters to fill out a harvest report form and record the number, sex and age of deer, if known, seen while afield. We required hunters to document the harvest of two female deer before qualifying to take a buck. After taking a buck, hunters started over, and again were required to harvest two female deer. Hunter harvest records were cumulative from season to season, allowing successful hunters to stockpile buck eligibility (e.g., 2- or 3-buck eligibility). By 2012, we determined that the success rate of our two female deer per buck EAB rule was not sufficient to achieve our stated reduction goals, and may have discouraged overall hunting effort. To encourage increased deer harvests, we relaxed EAB rules, requiring hunters to take one antlerless deer per buck.

The Cornell program proved to be very popular, with hundreds of hunter registrations prior to each season. However, only about half of those who registered actually signed in to hunt for an average of approximately 30 hours/year (Table 3).

As of 31 January 2014, Cornell EAB hunters harvested 606 white-tailed deer on lands outside the core campus sterilization zone, ranging from 69 during the pilot season in 2008, to 165 during 2012/2013, the first DMFA season (Fig. 9), but the reported sex ratio did not change appreciably over the course of our program (Table 3). We allowed harvest of radio-collared does beginning in 2009 to accelerate reduction of deer numbers on campus. Since the pilot EAB hunting program began in 2008, land available for hunting (including Cornell, state and private lands), on average, has increased (Table 3). Deer removed from the six zones closest to campus, which most directly decreased immigration into the core campus, ranged from 22–38% of the overall harvest. It took hunters 49–88 hours to harvest a deer, and hunter success rate was below 30% after the pilot year. With the establishment of the DMFA in 2012, we saw an appreciable increase in deer harvest. We did not directly estimate deer population numbers on EAB lands given the challenges associated with the size of the study area and terrain. Instead, we assessed population trends based on the average hours hunted per harvest and the number of deer observations and deer harvest per hunter day (Table 3). Changes in these estimates across years suggest fewer deer on the landscape, but not likely a reduction that approaches our goal of 50% in five years.

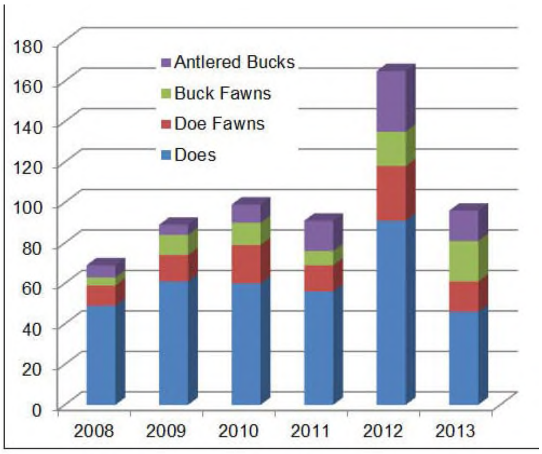

Figure 9. Number of antlered bucks, buck fawns, doe fawns, and does harvested by EAB hunters from 2008–2013.

We promoted self-policing and most of our tips on violations came from EAB hunters. With the help of DEC Conservation Officers and CUPD, we handled infractions every year, including 22 cases of trespassing by participants and nonparticipants, 11 stolen treestands, three cases of illegal baiting, one complaint regarding firearms discharge within 500’ of a home, and three incidences of hunters taking small bucks before they were buck eligible. EAB hunters reported six unmarked treestands and 13 unrecovered deer, including a large buck found with its antlers sawed off. We permanently removed five hunters from the EAB program due to violations.

Ecological Assessments

Determining contributions of deer to deterioration of local habitat conditions is challenging because of methodological difficulties, disagreement about best methods, and disputes from those opposed to lethal deer management who contest available methods. Even determining the appropriate deer density for an area is problematic because impacts are not solely a function of deer abundance, but are associated with productivity of habitats, and legacy effects (e.g., land use history, age of forest, and previous deer feeding pressure). Furthermore, most communities will not have the scientific or monetary resources to estimate local abundance, as we were able to do in this program. In addition, the number of deer that may be acceptable in one community may exceed socially- or ecologically-acceptable levels elsewhere.

Table 3. Comparison of EAB hunter effort and deer harvest results, 2008–2013.

	2008	2009	2010	2011	2012**	2013**
Acres available for hunting	1,438	1,577	1,784	1,929	3,865	3,865
Registrations	161	435	507	286	1,147	803
Active hunters	97	187	198	195	538	405
Average hours hunted	35	33	26	30	26	21
Average hours hunted per harvest	49	61	51	64	85	88
# deer observed per hunter day	0.7	1.3	1	0.9	0.4	0.3
Deer harvest per hunter day	0.07	0.04	0.07	0.05	0.04	0.04
Observed buck:doe ratio	1:2.1	1:2.5	1:3.2	1:2.3	1:2.4	1:1.5
Total deer harvested	69	89	99	91	165	96
Adult bucks harvested	6	5	9	15	30	15
Proportion of successful hunters*	0.38	0.25	0.27	0.28	0.20	0.19
*Success of harvesting at least one deer **Includes January DMFA season						

A better method is the assessment of feeding pressure, and researchers have proposed many different plants as indicator species. The most widespread and accepted method is a woody-browse index where investigators focus on removal of branch tips.

Notable problems with many of these browse indices is that woody browse is only one portion of a deer's diet, and the frequency and biomass loss is difficult to determine (i.e., branches could be browsed multiple times which would indicate a much different feeding pressure compared to a single incidence). Moreover, regrowth and removal of regrowth are difficult to evaluate. This method ignores feeding on herbaceous plants, and may not be useful for determining browse pressure in heavily impacted areas, such as typical suburban landscapes (Fig. 5).

How many deer an area can support without severe negative consequences for native vegetation requires reliable information about deer impacts on local vegetation, irrespective of the estimation of deer abundance. We have developed a simple approach using oak sentinel seedlings (Fig. 10) to replace deer abundance estimates, or complicated woody-browse surveys. This method allows individual landowners and communities to assess whether local deer populations are in line with conservation-based management targets, without the need to hire a botanist or wildlife professional.

Although we continue to experiment with additional species to assess their validity and ease of application, here we focus on red oak, a common species throughout Eastern and Midwestern North America, which we grew from locally collected acorns. In our study area, this species is intermediate in browse preference (i.e., not highly preferred, but also not the last to be browsed). Our acorns were stored over winter in refrigerated conditions and planted into Cone-tainers™ in late winter (Fig. 11). We grew germinating oaks in the greenhouse for several weeks until they were about a foot tall and had their first set of four to eight full leaves. Then we hardened them outside, before planting them at forested locations in the study area. We planted oaks in late spring, slightly later than oak seedlings would emerge from overwintering acorns in the field using a hand-held, 2-inch-diameter drill bit.

Figure 10. Red oak (*Quercus rubra*) seedlings ready for transplanting. *Photo – B. Blossey.*

Using this technique, we had extremely high survival rates, even in dry summers. We planted 40 individually marked oak seedlings at each forested site, and protected half of them with a metal or plastic mesh cage to prevent deer browsing (Fig. 12). This allowed us to assess whether the locations were suitable for oak growth, and all were. Consequently, we eliminated cages in later years.

To assess deer-browsing intensity, we regularly visited our planting locations to record browsing by deer and other species (e.g., rodents and insects) during the growing season, and again once in the following spring. The most typical sign of deer browsing was the removal of some or all leaves, or parts of leaves from a seedling (Fig. 12). Deer usually pulled at plants, creating a rough or fibrous appearance where leaves or stems were ripped off. A second sign of deer herbivory was the complete removal of a seedling, and this usually occurred soon after planting, before seedlings had developed deep root systems. Deer tugged on the leaves and pulled out the entire seedling, often found on the ground next to the planting hole.

Figure 11. Northern red oak seedling in Cone-tainer™ grown for 2–3 months and ready for transplanting. *Photo – B. Blossey.*

An individual oak seedling may need 10–20 years to grow out of reach of a deer under a forest canopy, and even longer to get into the canopy. In many instances, seedlings/saplings need to spend extended periods in the understory waiting for their chance to grow should the overstory be damaged (or harvested). Considering this early life history, more than an occasional browsing event on oak sentinels (damage to >3 of 20 seedlings) in any given year would indicate deer populations in the area are too high to achieve forest regeneration.

Yet we routinely saw browse on 10–15 of the 20 deer-accessible individuals in our study area, and most browsing occurred in early summer, indicating that seedlings were discovered rapidly (Fig. 13). Protected seedlings continued to grow, albeit slowly due to reduced light conditions in a forested area.

Figure 12. Red oak seedling growing within a wire cage (left) protected from deer herbivory, and a partially browsed seedling of the same age at the same site (right). *Photos – B. Blossey.*

We saw no difference in survival rates of oak sentinel seedlings between deer sterilization, control, and hunting zones. We also assessed deer browsing pressure in >40 forest locations throughout Tompkins County. While browsing pressure was not as high as in our study area, given current deer abundance, red oak recruitment will continue to fail throughout the county, putting the continued existence of diverse forests in long-term jeopardy.

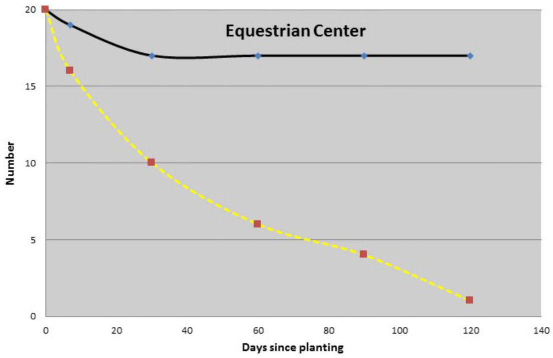

Figure 13. Survival of protected (solid line) and deer accessible (dashed line) oak seedlings planted at the Cornell Equestrian Center over a 3 month period (June–September).

We continue our assessment of red oaks as a monitoring tool to assess deer impacts, and we will be expanding the list of species that communities or landowners may use in a forthcoming publication. What we can say, at this point, is that more preferred and browse-sensitive species, such as red and white trilliums (*Trillium erectum* and *Trillium grandiflorum*, respectively; Fig. 14), are severely browsed even in places where we see good survival of oak seedlings.

Figure 14. Abundant white trillium (*Trillium grandiflorum*) display in May (top) and feeding damage by deer (bottom). Each of the one hundred flags represents a flowering white trillium that was browsed by deer. *Photos – B. Blossey.*

Additional Impact Assessments

We also collected DVC data from CUPD on Cornell and adjacent lands to ascertain annual changes in these incidents, and to date, these accidents appear to be increasing (Fig. 15).

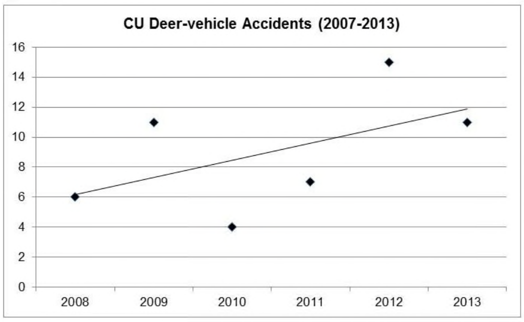

Figure 15. Number of deer-vehicle accidents reported to Cornell University Police from 2007–2013.

Similarly, information from the Tompkins County Health Department depicts a rapidly increasing number of human Lyme disease cases in the county, increasing 1,089% from nine in 2007, to 107 in 2011. However, increased awareness and improved reporting may have contributed to this increase. We continue our research to develop additional assessments that include other browse-sensitive indicator species, assessments of tick populations (Fig. 16), and social acceptance, given the controversies surrounding deer management.

Figure 16. Deer with an infestation of ticks on its ears. *Photo – P. Priolo.*

Deer Damage Permits

In 2012, we formed a second university Deer Management Committee (DMC) to review program goals and methods, and propose new management options. At that point, our annual population estimates indicated that despite our best efforts, we were unable to reduce deer numbers to acceptable levels during the first five years. We opted for use of DEC deer damage permits to supplement sterilization and EAB hunting, beginning in March 2013. In New York, use of deer damage permits is permitted primarily outside of regulated hunting seasons, but these permits may allow baiting, use of lights, and extended activity periods after dark (until 11 PM). We targeted areas previously inaccessible by EAB hunters on Cornell lands sandwiched between sterilization and EAB hunting zones.

A Deer Permit Coordination Group, a subset of the DMC, selected a small group of trained and proficient bowhunters with previous suburban deer hunting experience in the VOL program, who all passed a CUPD background check. We maintained a database of participants and used a website to manage logistics, treestand use, harvest reporting, and deer sightings. Participants conducted nuisance activities from elevated treestands with bait placed 20 yards away (Fig. 17), and reported the fate of every arrow shot. To maximize harvest, we began pre-baiting nuisance sites with corn several days before deer removal commenced. Recognizing that the efficacy of baiting is debated in the scientific literature, and that deer can avoid treestands and bait after hunter disturbance, we temporarily closed locations for 72 hours after two uses within 48 hours, to prevent overuse.

Figure 17. Baiting with corn to attract deer to a nuisance treestand site for deer removal with a NYDEC deer damage permit. *Photo – IDRM Program.*

Participants were not allowed to field dress deer on Cornell property in the DDP program, and removed deer using concealment (e.g., covered sleds) in sensitive locations with other recreational users. Efforts were made to be discrete and to not affect other recreational activities.

Participants conducted activities over a nine-day period beginning 16 March 2013, harvesting 11 deer. Given the success of the pilot activity, the number of available days, treestand sites, and harvest increased the following DDP season from 18 December 2013 to 10 January 2014, and again from 1 February to 31 March 2014. Treestand sites almost doubled from seven to 13, and participants removed 34 deer.

Concurrent with the February 2014 DDP activities, we modified our DEC research license to remove additional deer using collapsible Clover traps and euthanasia with a penetrating captive bolt. The U.S. Food and Drug Administration, the American Veterinary Medical Association, and Cornell's Institutional Animal Care and Use Committee approve this method. The captive-bolt technique provides for instantaneous euthanization of restrained deer, while allowing human consumption of the meat. Clover traps at DDP deer sites were sandwiched between the sterilization and EAB hunting zones, with a focus on sites unavailable for DDP archery activities due to state discharge restrictions (500' for archery).

We set traps at dusk and checked them for deer the following morning before sunrise. If deer were in a trap, we would collapse it to restrain the deer, allowing for safe and efficient euthanization. The time from determining a deer was in the trap to euthanasia was approximately 30 seconds. We conducted these activities from 5 March to 27 March, 2014, and collected scientific samples from eight deer using this method. The meat was donated for human consumption. We are in the process of using our oak sentinel approach to assess whether deer reductions through our DDP activities resulted in an appreciable reduction in deer browsing pressure.

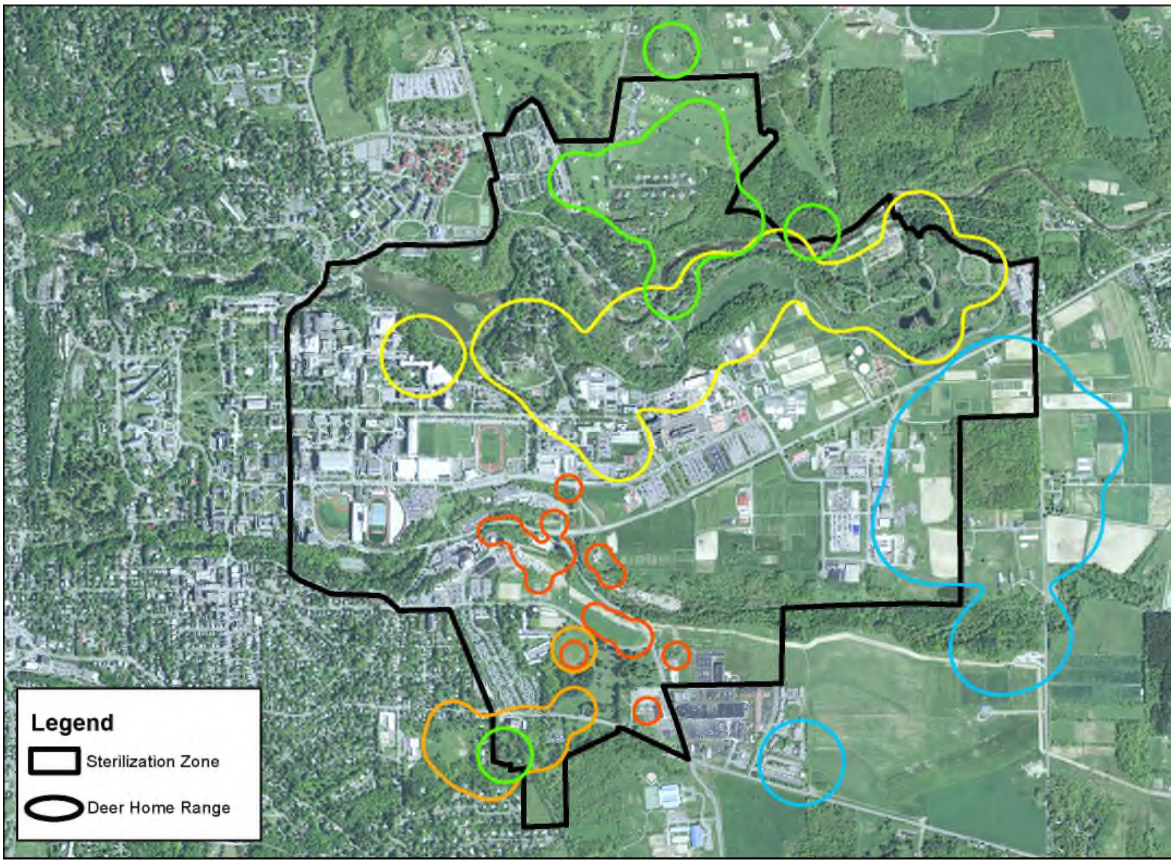

Figure 18. A sample of variation in shape and size of 95% adaptive kernel home range estimates for radio-collared adult female deer using the sterilization zone on Cornell campus.

Deer Home Range and Abundance Estimation

We began radio-tracking collared deer with telemetry equipment in September 2007 to track movements, birthing rates, and survivorship, and these efforts continue. We used triangulation, homing, or combinations of these methods to plot each deer's location. We logged and compiled the date, time, and field notes, and took dead deer to the CVM for necropsy to determine the cause of death. Using telemetry data, we used Geographic Information System (GIS) software and kernel density estimation to estimate home ranges - where deer spend 95% of their time - for each radio-collared deer (Fig. 18). Using locations from tagged, adult female deer in and near the core campus sterilization zone, we estimated the average home range size to be 142 acres. Suburban deer, such as those in our study, tend to have smaller home ranges than their rural counterparts, which benefits managers attempting to reduce negative impacts. Smaller home range size of female deer is related to dispersal distance (i.e., how quickly the next generation may immigrate into a deer mitigation zone).

Figure 19. Sterilization of female deer resulted in a noticeable drop of adult does and fawns, and an increase in the number of antlered bucks. *Photo – IDRM Program.*

To estimate deer abundance, we conducted an annual camera census (mark-recapture study) in the core campus sterilization zone each spring using 12 digital infrared-triggered cameras that took pictures at bait piles continuously for five days (Fig. 19). Cameras were placed in a grid system comprised of 100-acre blocks and calibrated to take a photograph every four minutes, if deer were present at bait piles. We tallied photographs and modeled deer abundance using NOREMARK population modeling software (now phased out). Communities interested in estimating populations may use MARK (http://warnercnr.colostate.edu/~gwhite/mark/mark.htm). Data collected from 2009 to 2013 suggest that the deer population in the sterilization zone on Cornell campus was stable or slightly increasing at almost 100 deer, or 57 deer/ mi^2, until we implemented additional DDP removal in 2014 (Fig. 20). Given these densities, we clearly did not meet our desired reduction of 75% (~14 deer/mi^2). But for the first time since inception of the program, we did see a significant drop in the overall deer population in the core campus area, almost directly corresponding to the number of deer taken by archery and Clover traps during the 2013/2014 DDP removal period.

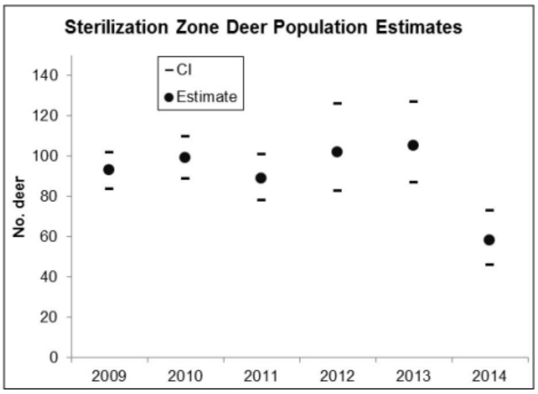

Figure 20. Estimates of deer abundance using infrared-triggered cameras in the IDRM sterilization zone (core campus) during 2009 to 2014 (CI indicates confidence interval of the estimate).

Despite a relatively stable deer population within the core campus sterilization zone from 2008 to 2013 (Fig. 20), we observed a decrease in does and fawns. To explore this further, we randomly sampled approximately 500 pictures from the camera survey to ascertain the relative visitation by bucks, does, and fawns in each year. We totaled the number of deer by sex and age visible in photographs, and determined a decrease in the number of does and fawns concurrent with an increase in the number of bucks. When comparing data from 2009 to 2012, for example, we noted a 38% and 79% decrease of does and fawns visible in photographs, respectively. By comparison, we noted a 90% increase in bucks visible in photographs between these years (Fig. 19 and 21).

Figure 21. Two mature bucks congregating in November at a bait station. This is unusual behavior at the peak of the rut (note swollen necks). *Photo – IDRM Program.*

Mortality

As of spring 2014, 84 out of 120 (70%) marked female deer had died due to DVCs (*n*=32), EAB hunter harvest (*n*=31), DDP activities using archery (*n*=5), Clover traps and captive bolt (*n*=4), capture-related mortality (*n*=4), and undeterminable or other mortality causes (*n*=8). A slightly higher proportion of sterilized female deer (*n*=27, or 29% of surgery deer) were killed by vehicles than control deer (*n*=6, or 23% of control deer), but this difference was not statistically significant.

While sterilization surgery is safe for most deer, some deer have conditions that increase their chances of mortality during capture or surgery. For example, surgeons euthanized one doe on the surgery table because of a hole found in the small intestine with no other evidence of injury. Another doe that died on the surgery table had lesions on the heart and parasites that put her at increased risk of anesthetic death. Another deer expired due to a congenital heart defect.

What continues to surprise us is the high rate of DVCs among sterilized deer in the core campus area, ranking slightly higher than hunter harvest as a mortality factor for the duration of the program. Considering that each DVC has an economic impact of approximately $2,600 or more, as reported in the literature, our radio-collared deer may have been responsible for >$80,000 worth of property damage on personal vehicles alone. However, when accounting for human injuries or fatalities, scene attendance or investigation, and carcass removal, costs per DVC may double, but emotional costs are unmeasurable. Interestingly, research suggests that about 50% or more of DVCs go unreported. Here we note the contradiction of sterilization as a humane alternative to hunting or culling, given that managers must rely on DVCs to reduce deer numbers.

Village of Lansing

Typical of many communities in the U.S., the VOL faced increasing DVCs and deer browse impacts considered unacceptable by residents. On behalf of the Board of Trustees, we implemented and coordinated a bowhunting program in 2007 using approved hunting plans, including voluntary landowners and bowhunters.

Most of the VOL landowners were happy to accommodate our efforts, knowing that we were exclusively using archery equipment to remove deer, and that the meat would be consumed. These were two very important considerations for residents. A spotless safety record, and increasing knowledge, allowed us to grow the program from a single property in 2007 to >30 properties in 2014.

We interviewed and vetted new bowhunting participants before allowing them into the program, and not everyone was accepted. Annual hunter meetings informed participants of regulation changes, and each hunter received a Code of Conduct document that we developed to standardize guidelines and techniques. In addition to excellent bowhunting skills, sensitivities and temperaments among our hunters were crucially important for our continued success. On occasion, our hunters encountered local opposition and illegal activity (e.g., unsanctioned, trespassing hunters), and had to handle themselves accordingly. In addition to these activities, we coordinated 20–30 bowhunters per year using a secure website which allowed hunters to optimize communication, treestand use, and harvest reporting. It took substantial volunteer time to coordinate these activities.

In our experience, having a few dedicated hunters willing to take multiple deer was far more valuable than having large numbers of hunters. Each year, a few hunters were responsible for the majority of the deer harvested. These few individuals were generally the most vested in the program and spent more time hunting. Two of our participants owned and utilized blood-tracking dogs, which helped limit loss of wounded deer that ventured off properties (Fig. 22).

Figure 22. The availability of blood-tracking dogs among some of our participants helped in locating shot deer that were difficult to track. *Photo – B. Blossey.*

We conducted hunting in the VOL from fixed treestand locations based on close cooperation and communication with landowners and neighbors. Where discharge distances fell within 500', we obtained written permission from adjacent landowners. Each year we noted overuse of treestands with high deer traffic, or sightings of large bucks. Quick success created high shooting pressure in certain locations, and we experimented with temporary closings. However, surviving deer also became savvier, passing treestand locations just outside shooting range.

Initially, the VOL used DEC-issued DMAPs, but hunter harvests were constrained by lack of property access, lack of ability to harvest more than two deer per hunter per year using DMAPs, and changes in deer behavior due to hunting pressure. The establishment of the DMFA allowed a longer season and more liberal antlerless deer harvests, but discharge distances set by New York State (previously 500') limited use of certain areas. With changes in discharge distances to 150' approved for the 2014 season, we expect an expansion of access and more ease in determining and shifting treestand locations.

After safely harvesting several hundred deer from VOL lands, our observations and anecdotal reports from VOL residents and officials suggested a substantially reduced deer population, fewer DVCs (Figs. 23 and 24), and a return of some native plants not seen in previous years. However, complete data from VOL is lacking, which precludes statistical testing. Moreover, our aforementioned ecological assessments using red oak sentinels indicated that deer reductions have not sufficiently reduced negative impacts after seven years of coordinated bowhunting. Consequently, we are contemplating changes, including use of bait and DDPs to achieve management goals.

Figure 23. White-tailed doe after a fatal collision with a vehicle. *Photo – B. Blossey.*

Overall, our experiences, along with those of the participating landowners and hunters, have been positive. Landowners who initially participated in the deer management program continue to participate, and we have never lost access to a property due to our activities. We experienced no problems with safety, and no infractions of rules by approved participants. Despite our success in managing a safe and organized deer management plan in VOL, we recognize that goals have not been fully achieved. Further deer reductions will be necessary.

Lessons Learned

We describe an increasingly aggressive deer management program in a suburban landscape for the benefit of other communities challenged with white-tailed deer impacts. Despite our use of surgical sterilization, EAB hunting, and DMFA liberalization of antlerless deer harvest during the first five years of this study, it became clear that we only stabilized the deer population, and did not reduce numbers to a level that alleviated negative impacts. By winter of 2013, we stabilized the campus deer herd to approximately 100 animals (57 deer/ mi^2), a density much higher than project goals (75% reduction =~14 deer/mi^2). Despite these numbers, we did see a decrease in campus does and fawns appearing in photographs during the five-year study period, a decrease offset by an increase of bucks.

Bucks from outside the core campus sterilization zone may have been attracted to the does that received tubal ligation surgery. These females continued estrus cycling each month through February or March, as they did not become pregnant during the normal breeding season. Moreover, EAB program rules required the harvest of two female deer before becoming buck eligible, resulting in few bucks harvested and higher survival rates. For these reasons, we replaced tubal ligation with ovariectomy surgery, and relaxed the EAB rule to one antlerless deer per buck, to increase buck harvests. These changes occurred during the last two years of this study. In 2014, however, we discontinued use of surgical sterilization and EAB rules.

Results from theoretical studies and the Cornell experience do not bode well for the feasibility of surgical sterilization as the sole tool for reducing high-density, open deer populations. We recognize that local housing densities and lack of open space present real challenges for managing deer in suburban and urban areas, and social pressures against lethal control may direct communities toward sterilization or other fertility control programs. Due to the high cost, this will only be feasible in affluent communities, or with help of donors. Nonetheless, communities considering, or being forced into a deer sterilization program by opponents of deer removal, should be prepared to only achieve small reductions in deer numbers. In this scenario, a high proportion of females would need to be treated, and deer mortality from DVCs should offset births and immigration. However, they may not see long-term success, even over 10 years or more, unless immigration can be controlled, or deer mortality rates can be increased. Even under those circumstances, whether ecologically-articulated goals, such as oak recruitment, can be achieved remains questionable. We see little hope for long-term viability of this strategy. Those communities that started with sterilization only, have subsequently either embraced lethal deer management, or allowed deer populations to persist at undesirable levels.

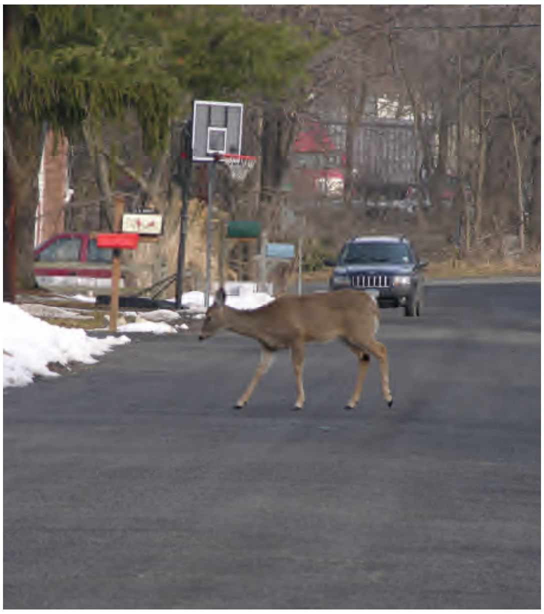

Figure 24. White-tailed deer crossing the road in front of an oncoming vehicle. *Photo – P. Curtis.*

Recommendations for Agencies

- Create suburban deer management zones to reduce deer numbers and associated impacts (similar to DEC's DMFA).
- Expand deer hunting seasons (September to January or beyond) to increase hunting times and avoid changes in deer behavior in response to elevated hunting pressure.
- Expand the ability to use dedicated permits to reduce deer populations and make sure that qualification for use of such tags include conservation goals.
- Consider changing the name of nuisance deer tags (Deer Damage Permits, DDP, in New York State) to Deer Conservation Permits (DCP) to reflect management goals.
- Allow unlimited take of deer for hunters using DCPs.
- Ensure that DCP policies are flexible to allow take of antlered and antlerless deer as needed to meet management objectives.
- Articulate (and assess) management goals using conservation concerns, not only hunter satisfaction and deer numbers. This will receive more support in communities – but maybe less support from hunters.
- Incorporate ecological goal-setting in hunter education programs by initially updating hunter education instructors, and then revamping hunter curricula.
- Consider regulatory structures and management policies that could integrate regulated commercial hunting as a tool to achieve ecological carrying capacity at reduced deer densities.
- Explore incentive programs or financial match grants to stimulate community deer management programs.
- Assess program success using ecological indicators paired with social science work.

Though we strongly advise against implementing sterilization or other fertility control programs without also integrating lethal control, where pursued, we recommend that >90%, and preferably 95% of female deer be targeted for sterilization surgery due to high survival and reproductive rates in suburban landscapes. If a community cannot afford these high costs (e.g., approximately $1,000/deer or more), then sterilization should not be implemented. Sterilization effectiveness may increase for smaller-scale, gated communities that can prevent deer immigration. Other communities are trying immunocontraceptive vaccines. However, these vaccines have proven less effective than sterilization, and our own experience suggests that culling is the most cost-effective management option.

Liberal antlerless deer take through the DMFA allowed for additional deer harvest on EAB lands. The DMFA permits harvest of two antlerless deer per day during open seasons, but survey research indicates that hunters might not wish to harvest more than 2–3 deer per season. In a survey of EAB hunters at Cornell's Arnot Forest, for example, hunters were willing to harvest an average of only 2.5 antlerless deer per season. Should this hold true on Campus EAB lands, more registered hunters would be necessary to offset these limitations. Interestingly, many hunters registered with EAB but never participated, suggesting that these hunters may view these lands as a "backup" place to hunt, or that hunters simply did not have time to participate.

As seen in other EAB studies, we demonstrated that a majority of deer harvested on CU lands across years were adult does, followed by fawns. However, data collected at the deer check station suggest that we have not achieved a 50% reduction in deer numbers. More importantly, increases in antlerless harvest have not yet resulted in demonstrative reductions in rates of oak browsing in the EAB study area. Daily hunting pressure may affect deer behavior by pushing deer into adjacent "no hunting" lands, or creating nocturnal deer. Retaining hunter interest while reducing deer populations remains a paradox, because as deer become sparse or savvy, hunting participation may wane. The question remains as to whether we can retain sufficient hunter interest while decreasing the number of deer in the future.

Permits issued by DEC allowed for a significant increase in deer taken near campus via archery equipment and captive bolt, and these additional methods should help decrease deer numbers and impacts in the core campus sterilization zone (Fig. 25). However, use of a captive bolt was controversial, and its use on Campus lands precipitated national petition efforts by groups opposed to killing of deer. Communities that choose to use lethal control may be subjected to intense controversy and need to be prepared. It takes strong local leadership to weather potential intense negative media campaigns.

We cannot stress enough the issue of safety during this integrated approach to deer management. Our efforts demonstrated that lethal control through hunting and sharpshooting can be safely and effectively conducted in areas with dense human populations and high public use. We also demonstrated that deer can be safely and humanely captured and euthanized with a penetrating captive bolt in areas where firearms or bows could not be discharged. With the discontinuation of deer sterilization on core campus, we will continue using lethal methods into the future.

Figure 25. DDP deer harvests. *Photo – B. Blossey.*

We remain optimistic that continued reduction in deer numbers will lessen negative impacts as this study continues, particularly given recent changes to the IDRM Program.

To review, IDRM changes included:

1) discontinuation of surgical sterilization;
2) discontinuation of EAB rules (hunters may self-select deer harvested based on state laws);
3) the DMFA program which allows harvesting two antlerless deer per day during open hunting seasons; and
4) use of DDPs to allow deer taken outside of regular hunting seasons (Fig. 26).

Figure 26. A sterilized doe (recognizable by the ear tag) feeding in bright daylight on remaining corn at a nuisance bait site. *Photo – IDRM Program.*

Cayuga Heights, a dense suburban village between Cornell University and VOL, has implemented deer sterilization via an independent contractor, but is also contemplating lethal control. These efforts may help reduce deer immigration into neighboring areas. We also remain hopeful that we can educate hunters about benefits of balancing recreation with clearly-articulated goals for ecological restoration and conservation. The expanded use of DDPs and use of Clover traps with penetrating captive bolt in 2014 (sixth year of study) helped reduce the campus deer herd by 45% in just one year. Continuing efforts to reduce deer numbers and impacts are aided by the fact that we are working with a sterilized population with low recruitment.

Overabundant suburban deer populations continue to challenge natural resource agencies and local communities. Although Cornell University as a single landowner is able to combine lethal and nonlethal deer management techniques with wildlife agency and cross-campus support, communities will need broad-based support and the political will to implement lethal deer control. Moreover, communities will need credible and professional wildlife agency staff able to balance both the biological and social dimensions of mitigating negative deer impacts.

Recommendations for Communities and Landowners

- Assess conditions using deer impact and ecological indicators, not deer numbers.
- Articulate desirable deer management goals, not in terms of deer numbers alone, but in concert with ecological and other indicators. Make sure that these assessments continue so management approaches implemented can be validated for their effectiveness and changed if unsuccessful.
- The most successful approach is using sharpshooters over bait (with rifles, bows, or crossbows).
- Avoid, where possible, nonlethal methods as they have not shown promise in areas where deer can move freely on the landscape. Where sharpshooting over bait is not a possibility, we recommend a multi-pronged approach given that archery and fertility control by themselves have not reduced deer populations to tolerable levels. The inclusion of lethal methods can result in a protracted fight with those opposed to killing of deer. Having articulated, measurable deer impacts, and goals to reduce them, will go a long way in winning public support, but may not avoid legal challenges. Local leaders should be patient and have endurance. Professional management advice will be essential.
- Develop local expertise (or contract this out) on deer management. Not every hunter will have the background and information needed to effectively coordinate or implement approaches that differ markedly from traditional hunting.
- Organize hunter/participant education and training. Learn techniques and approaches to enable safe and more successful deer removal. This is particularly important for what we consider the best approaches: bait and shoot at night with volunteer rifle (where permitted), bow or crossbow hunters, or use of contract professionals. Despite the excellent safety records for such programs, people opposed to such approaches will launch scare campaigns. Be prepared.
- Fewer, trained hunters/participants are better than open access. Properly managed access and stand use will increase success rates.
- Continue to assess conditions and report to residents. Support for the program will be essential, because once started, deer management must be maintained.
- Fence high-value plantings (ornamental or native) because deer population reduction may take many years, leaving these plants vulnerable during the interim. We need to protect seed sources and genotypes.
- Begin managing deer populations before impacts become excessive. If deer are in your community now, there will likely be many more in a few years. Save expense and prevent negative impacts by managing proactively rather than reactively.
- Suburban deer management requires community involvement and municipal support. State agencies cannot force management action on private or municipal public lands. If community deer impacts are excessive, inaction by local policy-makers is socially and ecologically irresponsible.

Recommendations for Communities and Landowners *continued*

- Involve legal counsel in the planning process to ensure appropriate compliance with State Environmental Quality Review laws and minimize potential legal challenges by opponents of deer management.
- Identify constraints to effective deer management within municipal codes and ordinances and modify as needed.
- Work with state agencies to identify constraints within state statutes that limit effective deer management within communities, and advocate for amendments granting greater flexibility and regulatory authority to state agencies.
- Consider capture and euthanasia as an effective and humane technique for deer population management in developed areas where other forms of lethal control may be inappropriate. In contrast to fertility control, capture and euthanasia yields immediate reduction of the deer population and associated impacts.

Figure 27. Deer feeding close to occupied buildings such as this house may preclude use of firearms or cartridge-fired dart rifles. *Photo – P. Curtis.*

Recommendations for Policy-makers

- Although deer populations have always been managed for sustainability, recognize that game management laws were developed in a time of deer scarcity. Game law changes since the early years of management have made progress, but they have not adequately evolved to address current deer management challenges in all areas. Push for continued adaptation and progression of laws and regulations.
- Work with management agencies to remove statutory prohibitions that limit management tools and effectiveness in rural and suburban environments (e.g., discharge setbacks [Fig. 27], prohibitions of specific tools except in research contexts, constraints on hunting season length, bag limits, and implements).
- Authorize managing agencies to establish regulations for the limited and controlled use of bait to increase hunter efficacy where needed.
- Authorize managing agencies to establish a regulatory structure specifically for community-based deer management that incorporates nontraditional techniques for recreational hunting (e.g., longer hunting hours, use of lights, sound suppression on firearms, and incentives).
- Streamline the permitting processes for sharpshooting, deer culling, deer capture and euthanasia, and fertility control.
- Expand the toolbox for agency or professional sharpshooters (e.g., use of sound suppression on firearms, discharge from vehicles).

A Deer Manager's Toolbox – Lethal Control

Translocation

Research conducted on the capture and translocation of deer suggests that animals are stressed during the process, and experience high mortality after release, which is why we choose to place this method in with other lethal controls. Translocation is cost prohibitive, may increase the spread of disease, and few places would accept these animals. Many wildlife management agencies prohibit this technique.

Predator Reintroduction

Deer predators such as wolves and mountain lions were extirpated over much of their range, and recent work has shown that coyote predation does not control overabundant deer populations, with the exception of very special circumstances. At this time, wildlife management agencies are unlikely to advocate for release of mountain lions or wolves in our region due to biological constraints in suburban landscapes, and stakeholder concerns over resource use and safety. It is also questionable whether large predators would have the ability to control abundant deer populations given the ratio of predator to prey. In Wisconsin's remaining wolf range, for example, there are likely more than 1,000 deer for every wolf, a clear indication that wolves by themselves, while certainly feeding on deer, will not be able to control or reduce deer numbers sufficiently.

Regulated Hunting

This is often the first method proposed as a solution for deer problems, and is advocated by both state wildlife management agencies and hunters. Successful deer reduction via hunting depends on a community's established objectives. For example, hunting, where permitted, may be useful in reducing some level of DVCs, or when implemented before deer populations become too large. This method, along with sterilization, comprised the core of Cornell's initial deer management approach. Our experiences with regulated hunting at Cornell, along with many other communities in the U.S., suggest difficulty in reducing deer abundance to a level that achieves ecological goals. The lack of success in reducing deer populations further may result from a collection of problems including lack of access, hunting regulation impediments, and hunter behavior and preferences. Many areas may remain closed to hunters due to landowner preferences, and deer will quickly find these refugia. Hunting regulations (short seasons, lack of ability to shoot multiple bucks or does, discharge distances) may prevent dedicated individuals from filling more than the usual one or two tags that most hunters use per season. High hunting pressure in certain areas will result in changed deer behavior (animals may become increasingly nocturnal or change travel routines), decreasing hunter success. Furthermore, most hunters do not see themselves as deer managers, and consider hunting their recreation. Even successful individuals rarely shoot more than two or three deer per year, and others may need to be educated about techniques when pursuing suburban deer. Our harvest success rate in the EAB program of <30%, and the many hours hunters spent in the field to harvest a deer, suggest that improvements in the regulated hunting approach are necessary to achieve goals for deer impact reduction.

Capture and Euthanize

Methods used to capture and euthanize deer include drop nets, Clover traps, or darting to capture deer, followed by penetrating captive bolt, exsanguination, firearms, or chemical euthanization. In most instances, these methods will require contracting with professionals from USDA/APHIS/Wildlife Services, law enforcement, or private contractors. Although we have successfully used Clover traps and penetrating captive bolt, a technique approved by the U.S. Food and Drug Administration, the American Veterinary Medical Association and by Cornell's Institutional Animal Care and Use Committee, to euthanize deer in dense suburban areas, staff time and expense were concerns for its continued use. In addition, this method resulted in vehement opposition from a minority of local residents.

A Deer Manager's Toolbox – Lethal Control *continued*

The capture-and-euthanize approach has been halted by court order in some communities where attempted. Use of dart rifles and immobilization drugs to capture deer is quick and effective, but using this method in conjunction with euthanasia renders deer meat unfit for human consumption, one of the key conditions that many communities stipulate for deer control. Being able to donate deer meat for consumption is why we chose to use Clover traps and penetrating captive bolt.

Bait and Shoot

This is the only method we are aware of that has demonstrated quick reductions in suburban deer populations. While bait and shoot has clearly reduced deer numbers and DVCs in numerous suburban communities, we are not able to assess whether deer reductions have also resulted in reductions in ecological impacts. We are pursuing this work on Cornell lands, but we cannot provide much evidence at this time. Bait and shoot methods may be divided into either volunteer contributions, such as in our DDP efforts at Cornell, or contractual services by professionals. In both instances, participants bait deer into locations where discharge of bows, crossbows, or firearms is safe; and deer are shot at close range. This method is most effective on naïve deer herds unfamiliar with hunting. Although hunted deer tend to be much more cautious, bait-and-shoot methods can still lead to population reductions. Using contractual services is expensive, but time spent afield is greatly reduced, and costs are generally much less than fertility control. Bait-and-shoot techniques are clearly the most likely to reduce deer populations to the lowest levels possible, given all of today's options.

Regulated Commercial Hunting

Under current laws and regulations, this method is not legal in most states. This proposed method may include contracting deer management out to approved individuals or companies, or expanding the ability of recreational hunters to sell meat or other deer parts. Contractors or individuals would be able to sell venison at market prices to cover their time and costs. Numerous and notable wildlife professionals in the U.S. support and continue to debate this method. North American wildlife management agencies have not moved forward with the idea of bringing back commercial hunting, and the sale of wild-caught venison is prohibited in most states. Moreover, hunters who consider it a threat to their recreational pursuits vehemently oppose commercial hunting. Ironically, venison sold in U.S. stores is either farm-raised or imported from New Zealand, where white-tailed deer were introduced and have become an invasive pest species, and where deer are commercially hunted.

A Deer Manager's Toolbox – Nonlethal Control

Change Ornamental Planting Regimes

The recommendations to use non-palatable plantings often contain non-native, sometimes invasive species, and thus not ecologically-acceptable options. Furthermore, widely planting just a few reliably deer-resistant plants will greatly reduce local biodiversity with unacceptable consequences for native insects and birds that require native species as food and shelter.

Repellents (Chemical and Physical)

Repellents in various forms (chemical or nonchemical, such as scare devices in gardens or along roadways) may have short-term effects, if at all, but they are not a permanent solution, despite widespread claims.

A Deer Manger's Toolbox – Nonlethal Control *continued*

Fences

Although some deer can clear an 8-foot-high fence, depending on terrain, this minimum height can be effective for keeping deer out of high-value areas permanently, but it excludes other wildlife, has high initial costs, and pushes deer into adjacent unfenced areas. Fences will remain an essential option to guard roads, high-value ornamental plantings, or threatened populations of native species. However, they have no effect on overall deer abundance in a community.

Fertility Control

At present, sterilization can only be performed on deer in New York State as part of approved scientific studies and requires a DEC License to Collect and Possess (LCP) research animals. In other states, you should contact your state wildlife agency to determine applicable laws and regulations. Such regulations change frequently, and you need to keep up to date. Until further data are gathered and analyzed, this technique continues to be experimental, and is not an approved method routinely available to managers. See below for a more in-depth treatment of fertility control.

Deer Fertility Control

Attempting to manage a suburban deer herd using fertility control alone will not likely be successful in areas with high deer densities. Deer are long-lived (>12 years), and without mortality, sterilized female deer will continue ecological and social impacts unabated, except for the gradual attrition of deer killed by vehicles. Modeling has shown that removing a female deer has two to three times the impact on population growth than sterilizing a female deer. Managing a deer herd via vehicle collisions is both inhumane and costly for community residents.

Surgical Sterilization

Modeling studies have suggested that a high percentage (80% or more) of female deer must be treated to have measurable effects (either population stabilization or decline) over a period of five to 10 years. Male deer are not sterilized because a single buck can mate with dozens of female deer, and capturing all male deer in an open population is extremely difficult. In many suburban deer herds where hunting is limited, deer survival is high, with DVCs as the primary mortality factor. Garden and ornamental plants subsidize deer herds, resulting in high quality food sources and deer in good condition, even at very high densities. Consequently, reproductive rates are also high, with most adult females producing twin fawns, and occasionally triplets. Under these conditions, treating at least 90% of the females should be the minimum goal, and sterilization rates of 95% or more are desirable. If less than 50% of the female deer in an area are treated, there is little chance to have any measurable population-level effects.

Surgical sterilization of female deer is very expensive and limited by scale. In a research project conducted in Cayuga Heights, New York, deer were captured, anesthetized, and transported by skilled personnel. The animals were then sterilized (removal of the animals' ovaries) by licensed veterinarians in temporary surgical facilities. The entire procedure cost about $1,000 per animal, on average. However, this cost per deer is not constant because the easy-to-capture deer are treated first with little effort ($700–800 per deer). Yet much greater effort is needed to catch the last remaining individuals to reach target sterilization levels. This greatly increases treatment costs per deer. Once 85% or more of the females have been sterilized, it may cost >$3,000 per animal to treat the last 10 to 15% of remaining females. All treated deer should also be marked with ear tags to distinguish treated animals from unsterilized ones.

Application of fertility control in free-ranging deer is scale limited. Catching and treating female deer is technically and economically feasible on relatively small areas, from 2–5 mi^2. Given typical suburban deer densities of 100 deer/mi^2 or more in the northeastern U.S., in areas greater than five square miles, the practicality diminishes because of the cost and time involved in detecting, and then capturing and surgically treating, hundreds of deer. In addition, even if the initial sterilization goal of 90–95% can be achieved, there will be ongoing annual maintenance costs to treat immigrating untreated females.

To catch and treat a high percentage of deer will require not only sustained effort and planning, but also cooperation from landowners and local police agencies. With sufficient trap sites, possibly 50–60% of the female deer in an area can be caught by stationary traps (e.g., Clover traps or drop nets; Fig. 28). Once this level is achieved, mobile darting from a vehicle at night will be needed to catch wary female deer that are reluctant to approach baited sites. Because it is illegal to have loaded firearms (dart rifles) in a vehicle in some states, police collaboration (officers are exempt from this rule) may be needed for mobile darting and animal recovery on private lands. This technique may also require permission from private landowners to discharge or access property for deer recovery.

Without this flexibility, it will be difficult to achieve the high treatment rates necessary for the anticipated long-term population reductions. Even under ideal scenarios in open populations (where immigration is a possibility), our experience shows that the anticipated population declines were not achieved on the Cornell campus. Even when 90% or more of the females were sterilized over five years, immigration of both males and females from the surrounding areas offset mortality, and the herd size remained stable.

Figure 28. Groups of deer are best captured together via drop nets when possible. *Photo – IDRM Program.*

Immunocontraceptive Vaccines

A number of different approaches and techniques exist that can be considered contraceptive agents. These include steroidal contraceptive drugs, and vaccines such as GnRH (GonaCon™) or Porcine Zona Pellucida (PZP). Many of the same limitations noted for surgical sterilization (e.g., cost, scale, permitting, and access to deer) also apply to any application of immunocontraceptive vaccines. In addition, current vaccines and adjuvants (material in a vaccine designed to enhance the immune response) require that treated female deer be given booster shots every year or two. Ideally, all treated animals should be individually marked (e.g., ear tags) to avoid focusing efforts on deer already treated. In field experiments to date, it has been difficult to keep free-ranging deer on a booster schedule. After deer have been trapped and tagged, experienced deer become bait shy, and may be difficult to approach within dart range (15–25 yards), even in a suburban setting.

Steroidal contraceptive drugs do exist, but they are not practical for free-ranging deer. Steroidal drugs persist in deer carcasses, so that they can impact other species (e.g., humans or scavengers) after meat consumption. It is very unlikely that any steroidal drug would be registered by the U.S.

Environmental Protection Agency (EPA) for application in free-ranging deer.

The USDA/APHIS/Wildlife Services-National Wildlife Research Center (NWRC) has developed an immunocontraceptive vaccine (GonaCon™) that is EPA-registered for use on female deer in the U.S. However, GonaCon™ is not currently registered in New York State, given no cooperator or local entity has requested its use and agreed to pay the costs for a lengthy registration process. GonaCon™ must be state-registered as a Restricted Use Pesticide, which can only be administered by USDA/APHIS/Wildlife Services staff, state wildlife personnel, or persons working under their authority. Many state wildlife agencies consider the GonaCon™ vaccine experimental, and as for surgical sterilization, a research license (LCP) is required to capture, tag, and treat free-ranging deer. Initially, this may cost about $400 to $500 per deer, but as for surgical sterilization, the costs increase as a higher percentage of the herd is vaccinated. That is because unvaccinated deer become increasingly difficult to locate and capture. The current EPA label states the vaccine must be hand-injected, requiring deer capture and immobilization. The efficacy of the vaccine diminishes after a year or two, and the same animals would need to be recaptured and hand-injected with booster shots, at high cost.

Porcine Zona Pellucida (PZP) is the most commonly used immunocontraceptive vaccine for deer and other wildlife. As would be the case for GonaCon™, a research permit is required to treat female deer in New York. There have been many research trials with PZP vaccines in deer in New York (e.g., Seneca Army Depot, Irondequoit, Fire Island National Seashore, Hastings-on-Hudson), and elsewhere (e.g., National Institute of Standards and Technology, Maryland, and Fripp Island, South Carolina). The Humane Society of the United States is currently studying a longer-lasting adjuvant that could provide multiple-year effects with fewer booster doses. Preparation of a reliable, single-dose immunocontraceptive vaccine has been difficult, and at this time, none are currently available.

Research data from Seneca Army Depot in Romulus, New York, indicated that about 13 to 14% of female deer treated with either a GnRH or PZP immunocontraceptive vaccine became pregnant and delivered fawns (usually a single fawn). The reasons for these failures are not well understood, but could be due to variability in the immune system response of individual females. As for other vaccines, not all animals respond to the same dose of drug in the same way, and resulting antibody titers can be quite variable. This may partially account for the higher than anticipated pregnancy rates (31.2%) for PZP-treated deer in the Fripp Island, South Carolina, study discussed below. The formulations of the GnRH and PZP immunocontraceptive vaccines used at Seneca Army Depot were prepared by the NWRC. Annual booster doses were recommended for each female deer. We observed that if deer were not given booster shots in the fall, about 28 to 29% of those deer treated with either GnRH or PZP vaccines would produce a single fawn during the following summer. Not treating deer with GnRH contraceptive vaccines for two consecutive fall seasons resulted in 57% pregnancy rates for those female deer. In addition, we noted depletion of bone marrow fat in about 10% of female deer treated with a PZP vaccine. The cause for this anomaly is unknown. Bone marrow fat is usually the last body fat metabolized during a severe winter. Wildlife managers use levels of bone marrow fat to determine if winter-killed deer died of malnutrition. Consequently, there is potential for mortality of PZP-treated deer during a severe winter in northern states.

Population reductions in deer herds treated with immunocontraceptive vaccines depend on the proportion of deer treated, along with mortality, immigration, and emigration rates. While the proportion of deer treated can be controlled under ideal circumstances, and hunting or culling can influence mortality rates, usually there is no control over emigration or immigration unless the herd is fenced, or on an island. While numerous studies concerning the efficacy of PZP in deer have been conducted, population reductions have been reported at only three sites: Fire Island National

Seashore, the National Institute of Standards and Technology (NIST), and Fripp Island. Reductions in deer numbers have been variable, however, because of the lack of control over mortality and immigration rates at these sites, and because of treatment intensity and ability to administer boosters effectively. With the mostly-fenced herd at NIST, deer population reductions started after two years, declined at a modest 6–8% for 5 years, then numbers stabilized. Further reductions were apparently offset by immigration. At Fripp Island, deer populations declined by 35% during 2006 to 2010 (from 357 deer to 231). Most does observed (91–94%) were ear tagged and had been treated with PZP immunocontraceptive vaccines. Despite this high level of treatment, overall annual pregnancy rates for treated females averaged 31.2% over the five-year study. Pregnancy rates were variable, in part, because different formulations of PZP were used at different times. Although deer populations were reduced at NIST and Fripp and Fire Islands, the densities remained at >100 deer/mi^2, continuing their devastating ecological impacts.

A contragestation (abortion) agent (prostaglandin F2α) has proven to be safe and highly effective in deer. Any risk to secondary consumers is minimal because prostaglandin F2α is rapidly metabolized by treated females. The use of this material in free-ranging deer would still be experimental and require a research permit, and there are several limitations. The drug has to be administered by injection or darting each year early in pregnancy. As for contraceptive vaccines, all treated female deer would have to be tagged. Negative public perceptions of abortion agents may also limit acceptance of the technique.

Currently, darting and hand-injection are the only potential methods for delivering immunocontraceptive vaccines. In some areas, dart rifles that use blanks containing gunpowder are considered firearms, and are restricted to legal discharge setbacks close to occupied buildings (Fig. 27). CO_2-powered dart rifles, however, may be exempt from these restrictions.

Research underway to collar deer at automated, unmanned feeding stations with acaricide-treated collars for tick control may allow delivery of immunocontraceptive vaccines in the future (if successful). However, devices to collar deer are experimental, and none are currently registered in New York, or anywhere in the U.S. Furthermore, such automated stations have not been invented for delivering immunocontraceptive vaccines, and would be problematic to operate in the field. The device would have to be designed to safely and accurately inject deer of widely differing body sizes, and exclude deer that have already been treated. They would also have to be resistant to human tampering and vandalism. The accidental injection of a human with the vaccine, in the course of any tampering, would raise a significant liability issue.

The NWRC has a goal of developing an orally-effective immunocontraceptive vaccine for deer. To date, this has not been feasible, as it is difficult to get drugs through a ruminant digestive system, and have the drugs absorbed in suitable doses. A delivery system (e.g., feeders available only to deer) would also have to be designed to avoid the unintentional contraception of other non-target wildlife species.

Because each female only needs to be captured and treated once, and efficacy of treatment is substantially higher with surgical sterilization, it is clear that surgical sterilization is currently a better option than immunocontraception. Also with surgical sterilization, efficacy rates are usually between 96% and 100%, which is far higher than immunocontraceptive vaccines (currently about 85 to 90% efficacy rates). However, neither technique has proven effective at achieving desired deer population reductions in island or fenced deer populations, let alone in wild, free-ranging deer populations.

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One of the most pressing problems for habitat conservation and forest regeneration are white-tailed deer (*Odocoileus virginianus*). Deer-related impacts to woodlands and suburban communities are not new, and have been occurring for decades. What has changed is the magnitude of the losses, and greater public awareness of negative impacts. Although deer are still a valued recreational resource, many stakeholders view deer as “pests” because of the pervasive economic, health, and safety impacts in the eastern United States.

Challenges

- Deer management must be based on clearly articulated outcomes, sound science and informed policy decisions.
- Forest ecosystem sustainability, and the health and safety of community residents, all depend on a successful outcome.
- Agencies, community leaders and managers need to be held accountable to provide appropriate information to residents and decision makers about the status of the health of their communities and deer related impacts. It is their civic duty to reduce deer related impacts despite sometimes vocal public opposition to lethal management. Continuing failed approaches (including sterilization) to appease a minority wastes public resources and endangers species, habitats and human health.
- It will take strong agency leadership, and local community support, to develop and sustain deer management programs. Changes in procedures and approaches will need to be based on measurable evidence, not just deer numbers alone, but also on deer related impacts.

The Cornell University campus is no different from many other communities throughout the east, with a mix of fragmented forests, farm lands, and suburban development. We developed the Integrated Deer Research and Management Program to study the effectiveness of management approaches for deer in developed landscapes. It is our hope that other communities will learn from our experiences, as it does not serve public interests to waste time and money on programs that are likely to fail. Our goal is to conserve both deer and forest habitats for future generations, and reduce negative impacts associated with overabundant deer populations. Despite our best efforts over seven years, we have yet to achieve measurable reductions in deer-related impacts. Our study illustrates the enormity of the deer management challenge facing communities throughout North America. Hoever, we believe we have found new approaches that may be successful in the next few years.

Cornell University
Department of Natural Resources
Cornell University Cooperative Extension

NORTHEAST WDM COOPERATIVE

Appendix E

DEER MANAGEMENT IN URBAN AND SUBURBAN NEW YORK

A Report to the New York State Senate and Assembly

December 31, 2018

www.dec.ny.gov

Basil Seggos, Commissioner

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Deer Management in Urban and Suburban Areas of New York State

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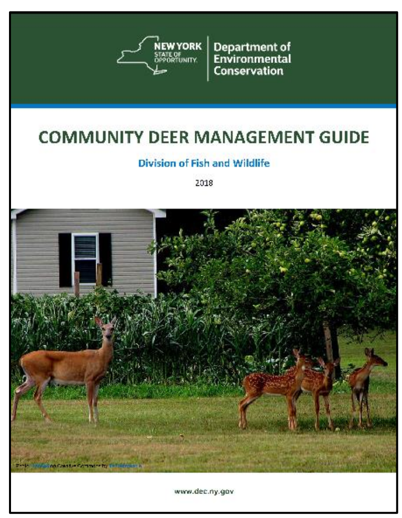
Introduction

White-tailed deer (*Odocoileus virginianus*) play vital roles in the natural and cultural environment of New York and are highly valued for their beauty and grace as well as the utilitarian benefits they provide. However, the abundance of deer in large parts of the state is causing increasing problems, particularly in suburban and urban areas. Common types of human-deer conflict include deer-vehicle collisions on roads, deer damage to landscaping plants and an increase in diseases carried by ticks that feed on deer. High densities of deer also threaten the long-term viability of forest ecosystems.

Because deer are large, highly mobile animals, there is little that individual property owners in developed areas can do to reduce the deer-related problems they face. Enclosing a property in a fence that deer can't jump over can prevent landscaping damage, but it does nothing to reduce the risk of deer-vehicle collisions. Furthermore, such fences around yards have the effect of pushing the deer onto other properties, thus improving the situation for some residents at the cost of making it worse for others. Reducing deer problems for community residents as a whole typically requires approaching deer management at a community level. That means making decisions as a community rather than as individuals and taking actions at a large enough geographic scale that they will affect deer throughout the community.



DEC has created a Community Deer Management Handbook to help people understand the deer problems they're experiencing and guide communities through the process of assessing the need for deer management, evaluating possible approaches and planning a course of action. Community-based deer management is taking place across the country, and another good source of guidance along with information on the experiences of many other communities is the Community Deer Advisor website (deeradvisor.org) developed by Cornell University with DEC input.

History of Deer Overabundance in New York

After rampant deforestation and unregulated hunting wiped out over 95% of the country's deer in the 19th century (McCabe and McCabe, 1984), management in the first half of the 20th century was aimed at increasing deer numbers. New York was highly successful in this effort, as were many other states. Deer numbers increased throughout the 1900s. By mid-century, wildlife managers across the country recognized that deer populations in many areas, including parts of New York, were outstripping their food supply (Leopold et al., 1947; Severinghaus and Brown, 1956). Deer overabundance has been a worsening problem ever since.

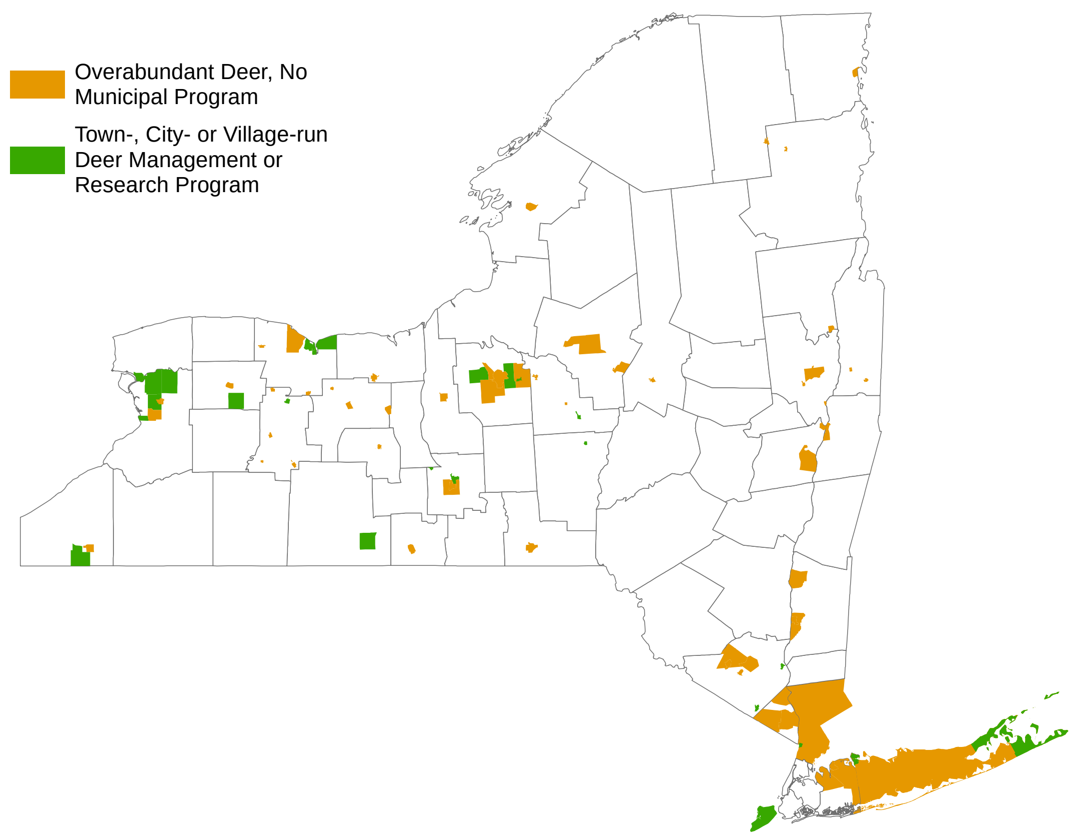
In the 1940s, agricultural damage by deer was reported as a problem throughout the Southern Tier of the state (Severinghaus and Brown, 1956) and in Albany County (NYSDEC, 1944). In 1959, a law was passed allowing a January shotgun season in Westchester County. The text of that legislation described a "critical overabundance of deer" that was causing "severe damage" to agriculture as well as damage to home landscaping (1959 N.Y. Laws, Ch. 738). At the same time, the state wildlife biologists were noting that deer populations in the Catskills and central Adirondacks were larger than the natural food supply could then support and were causing chronic habitat degradation, which, in the case of the Adirondacks, they believed had already been occurring for over 50 years at that point (Severinghaus and Brown, 1956). However, DEC's efforts to loosen hunting restrictions in order to reduce these populations were stymied by lack of public support (Severinghaus and Brown, 1956; NYSDEC, 1980).

Agricultural damage was more successful than ecological degradation at stimulating change, and throughout the following few decades, as hunting was allowed in more areas and firearms seasons were added in areas that previously only had archery seasons, the memos that accompanied introduced bills gave supporting arguments such as that deer had "become a problem" (NYSDEC, 1968) and that deer were causing "damage to crops, orchards and ornamental shrubs and trees" (NYSDEC, 1973), which escalated to "substantial damage" (NYSDEC, 1976) and "very significant damage" (NYSDEC, 1983a) as the years passed. "Deer-vehicle collisions" (NYSDEC, 1977) were also mentioned during this period as a specific problem in need of alleviation.

A position statement that was drafted by DEC biologists in 1983 declared that all areas of the state that support deer populations should be open to firearms hunting, arguing that restrictions on such hunting codified in statute or local ordinances result in "unacceptable levels of deer damage" and populations that "exceed the carrying capacity of the land." It also noted "serious deer problems" in "'some suburban and urban areas" (NYSDEC, 1983b). However, this recommendation to open the remaining closed areas was not successful, and little progress has been made on this front in the ensuing years. In fact, more areas have effectively become closed to deer hunting as many local governments have passed ordinances forbidding weapons discharge or hunting. People encounter deer on a daily basis now in places where a few decades ago they were never seen, and the highest deer densities in the state can be found in urban and suburban areas.

Current Overabundance Hotspots

Urban and suburban deer overabundance is most common in the parts of the state that are most developed and have the most restrictions on hunting, including Long Island, New York City and Westchester, Onondaga, Monroe and Erie Counties. The map below shows communities that have active deer population reduction programs and municipalities where DEC staff are aware of deer overabundance issues but there is currently no community-based management or research program.



Causes of Overabundance

Deer Biology

White-tailed deer are considered generalists, which means they can thrive in a variety of habitats and eat a variety of foods. They are found in forested and brushy areas from the Northwest Territories in Canada all the way to South America. Primarily browsers and grazers, they eat both woody and herbaceous vegetation. They normally find the most to eat in edges, or transition zones between forest and more open habitat types, where there is an abundance of both kinds of food available. They are also a behaviorally adaptable species that easily adjusts to living in close proximity to people. The current pattern of human land use is ideal for creating and sustaining high-density deer populations because open areas such as residential developments and agricultural fields are interspersed with forested areas, providing plentiful edge habitat as well as a variety of nutritious crops and ornamental plantings that supplement the natural food available to deer. Suburbs have been referred to as "deer factories" because they provide such good conditions for deer populations to grow.

Deer are a prey species that evolved under high levels of predation mortality. As a result, they have a high reproductive rate; females (does) can produce young at one year of age, and they average two offspring (fawns) per year. Both males (bucks) and females breed with multiple mates each year, so each buck can impregnate several does. Reducing the number of bucks in a population therefore tends not to diminish reproductive rates. Under ideal conditions, deer populations can double in size every two to three years. When there is plenty of food available, an average of 30-40% of the deer in a population have to die every year to keep the population from growing (Matschke et al., 1984).

In fully functional ecosystems, populations would be controlled by a combination of interacting factors, including food supply, predation, disease and weather. This doesn't mean that population density would be stable; it's normal for animal populations to fluctuate due to variable environmental conditions. High population densities would not be sustained across broad geographic areas, because mature forests don't provide enough suitable deer food to support such populations. However, fully functional forest ecosystems don't exist in New York. Even deer in large wild areas such as the Adirondacks are not living in an intact ecosystem, because wolves and mountain lions, historically their principal predators, have been eliminated. Bears, bobcats and coyotes do prey on deer, particularly fawns, but hunting by humans is currently the primary predatory force acting to control population levels in rural and remote areas. In more developed areas, local laws and landowner opinions have severely constrained hunting, and predators are scarce, so the majority of deer deaths are caused by collisions with vehicles. This relatively low mortality combined with abundant food has allowed suburban and urban deer populations to reach extraordinarily high levels. Even if the full suite of natural predators were to return to New York, significant reductions of deer populations in developed areas would not be expected, because wolves and mountain lions would avoid or not be tolerated in such areas.

Public Attitudes

Deer population levels are traditionally managed at the landscape scale with regulated recreational hunting. Since 1990, DEC has used citizen input to help set population target levels. For most of that time, targets were based on recommendations that were developed for each Wildlife Management Unit (WMU) by a small group of residents of that WMU who were chosen to represent a range of stakeholders affected by deer (e.g. farmers, hunters, landowners, motorists). However, broad public awareness of the issues surrounding high-density deer populations has remained low until quite recently, and those recommendations often didn't adequately reflect the negative impacts of deer. Furthermore, there were numerous weaknesses of this citizen input format that became apparent over time, including the difficulty of representing the spectrum of public interests and values with a small group. In 2018 DEC began using a survey-based process to gather the information on citizens' preferences that, in combination with data on forest condition, will be used to guide future deer population management decisions. The survey results will provide input from a broad sample of citizens, better reflecting public priorities.

However, attempts to lower severely overabundant populations with changes in hunting regulations have had limited success. Increasing the mortality rate of does is the key to controlling deer populations, so DEC increases the number of Deer Management Permits (DMPs), also known as antlerless-deer tags or doe tags, made available to hunters in areas where populations are above target levels. In some parts of the state there has been virtually unlimited availability of DMPs in recent years, but even so, the desired harvest levels are not being achieved. Many hunters are opposed to population reduction and are therefore unwilling to shoot does. Those who do shoot does may quickly obtain enough meat for their family and friends, and continuing to hunt and process deer just to donate the meat to food banks requires considerable commitment and altruism. Declining numbers of hunters and limitations on access to huntable land are additional obstacles. Many landowners are unwilling to allow hunting because of concerns about privacy, safety, liability or bad behavior by hunters, or because they are philosophically opposed to killing animals.

Population control through hunting is particularly challenging in urban and suburban areas. Due to local discharge ordinances and restrictions by landowners there is typically little land accessible to recreational hunters in these areas, so localized strategies developed and applied at the community level are usually necessary for effective deer management. These may include controlled hunts and culling with a DEC-issued Deer Damage Permit (DDP). Consensus on deer management is often difficult to achieve, however, and it can become a contentious and controversial issue in a community. Community members may have widely varying perspectives on deer and be passionate about their opinions and priorities. Development of a deer management program in some communities has taken several years and involved legal challenges from residents who disagree with the majority. Other communities have abandoned their planning attempts due to the conflict generated.

Local Laws

Because the State has authority over wildlife, local municipalities can't legally specifically restrict hunting or trapping except on land that they own or manage (Kalbaugh, 2015). However, many municipalities have passed ordinances restricting weapons discharge in the name of public safety. These ordinances often prevent hunting of overabundant deer populations on land where hunting could be conducted safely and in full compliance with state laws. Landowners who are experiencing negative impacts of overabundant deer and would like to address their problem by allowing hunting on their property are unable to do so. Communities working to address deer impacts often find themselves hindered by their own ordinances, which they then must rescind, revise, or grant variances to. In some cases, initial community movements toward deer population control spark highly vocal opposition from those opposed to lethal control (including hunting), and the latter group is able to influence public officials to pass a restrictive ordinance. Several more years typically pass before the increasing severity of deer impacts moves the political pendulum back toward enabling lethal methods.

Monroe County, which surrounds the city of Rochester, illustrates multiple facets of the interplay between hunting restrictions and suburban deer overabundance. In the early part of the 20th century, it had no deer population and no hunting. The first hunting season (one week, bucks only) was created in portions of the county in 1945, but the city of Rochester and some neighboring areas remained closed (1945 N.Y. Laws, Ch. 613). In 1976, with the goal of reducing damage to crops and landscaping (NYSDEC, 1976), an archery-only either-sex deer season was established in portions of the formerly closed area, including the town of Irondequoit (Decker et al., 2004). However, two years later, the Irondequoit town council passed an ordinance prohibiting discharge of a bow and arrow (Decker et al., 2004) and the state Legislature eliminated the archery season in portions of the nearby town of Greece (1978 N.Y. Laws, Ch. 768). As damage problems continued in Irondequoit, the discharge ordinance was revised in 1983 to allow archery-only DDP use (Decker et al., 2004). After a lengthy and contentious community decision-making process, the first municipal deer management program in New York began in 1993, when the town of Irondequoit initiated a culling operation (Porter & Underwood, 2001). Both county and town discharge ordinances were modified to allow firearms use for this cull, which continued for nine years (Decker et al., 2004). Controversy over the use of lethal techniques persisted, so a four-year study of immuno-contraception was conducted concurrently, beginning in 1997 (Porter & Underwood, 2001). A controlled hunt was added to the program before the study ended, and this hunt has continued on as the sole population management method (Decker et al., 2004).

Irondequoit clearly has the authority to restrict firearms discharge for public safety reasons, as it is one of the 20 towns explicitly granted that authority by the Legislature (NY Town Law, § 130(27)). Only one village (Green Island, in Albany County) has been granted similar authority (NY Village Law § 20-2003). Beyond these specific instances, local governments have general authority (and responsibility) to protect public safety, but the extent to which that covers blanket restrictions on weapons discharge is questionable (Kalbaugh, 2015). Some municipalities even pass ordinances specifically limiting or prohibiting hunting, in contravention of state law and legal precedent (Kalbaugh, 2015). The proliferation of questionable restrictions causes confusion for the public, unnecessarily limits opportunities for hunters, complicates the role of DEC biologists, and hinders the management of overabundant deer populations. State action to clarify the legal status of municipal ordinances affecting hunting could enable communities to implement effective management methods more quickly and consistently, possibly preventing their deer problems from reaching such levels of severity.

State Laws

There are several sections of current New York state law that also hinder effective deer population management, particularly in the more heavily developed parts of the state. These laws can prevent DEC from responding fully to local needs and assisting communities in effectively addressing their problems with deer overabundance. Provisions of state law that pose an obstacle in this manner fall primarily into two categories: those that restrict DEC's ability to establish seasons, bag limits and methods of take for hunting and those that limit the methods that can be used to take deer under DDPs.

Some parts of the state, such as Nassau County, New York City and the area around Buffalo, are closed by law to deer hunting. Other areas, such as Westchester and Suffolk Counties and the areas around Albany and Rochester, are primarily or entirely restricted by law to hunting with vertical bows. Parts of the state that are closed to deer hunting or have severe limitations on legal methods of take are, not coincidentally, many of the areas with the worst deer overabundance problems. Deer populations need to be reduced throughout these areas, and regulated hunting is a needed tool to accomplish that reduction. The increasing deer populations and impacts in Westchester County and other bow-only areas demonstrate that bowhunting alone, especially with just vertical bows, is not effective enough to accomplish broad-scale population reduction. Allowing crossbows to be used in all situations where vertical bows may be used, as most Northeastern states have done, would make it easier for hunters to provide relief to the communities suffering the most from deer overabundance. Allowing DEC to set firearms seasons in all counties would facilitate population reduction at a broader scale, putting less of the burden on individual communities.

For a variety of reasons, vertical bows and crossbows are used more commonly than firearms for hunting in urban and suburban areas. They are quieter, so less likely to disturb residents, and the shorter effective range leads to close shot distances, reducing possible safety concerns. The discharge setbacks in New York state law reflect these differences; bows may be discharged closer to buildings than firearms may. In some states, such as Connecticut, there is no discharge setback for any archery equipment. This can greatly facilitate deer control in developed environments by either hunting or culling.

As described in the "*Conflict Reduction Activities*" section below, DEC is working to develop an extended urban archery season for antlerless deer that municipalities could choose to participate in. This would provide a longer hunting opportunity and allow hunters to take many more does in participating areas. It could be made even more useful to communities if DEC had the ability to allow hunters to use certain strategies to increase their effectiveness. For example, baiting and using lights to hunt at dawn and dusk, when deer are most active, can greatly facilitate deer removal efforts, but by state law, are prohibited during hunting. Connecticut and Pennsylvania both allow hunters to use bait in urban deer management zones. Measures to increase hunter motivation to shoot more deer beyond what they and their families need can also be very helpful. A financial benefit would be one such motivation, but state law currently prohibits DEC from establishing conditions under which hunters could be compensated for taking deer or wild venison could be sold. In Vermont, deer meat can be sold during the hunting season and for 20 days afterward.

A potential barrier to the implementation of the extended urban season is the lack of a cost-effective method for distributing the tags necessary to facilitate it. State law allows only a one-time charge of $10 per hunter for DMPs each year. License-issuing agents (thousands of businesses and local municipalities around the state) keep a small percentage of this fee to compensate them for the time involved in selling the tags. To allow hunters who are interested to keep removing deer in areas of overabundance, DEC's goal is to set up a system in which hunters who fill DMPs in designated zones can get replacement tags as many times as necessary throughout the season. However, the agency has no authority to charge an additional fee, and without additional compensation, license-issuing agents may be unwilling to participate in such a program.

Shooting deer in a non-hunting context requires a DDP and is referred to as culling. State law gives DEC the authority to allow some actions under a DDP that are prohibited for hunting, such as use of bait, shooting deer at night with the aid of lights, shooting deer in parts of the state that are closed to deer hunting, and use of crossbows in areas where crossbow hunting isn't allowed. This flexibility tends to make culling more effective than hunting at reducing deer populations in urban and suburban settings. However, there are other restricted activities that lack provisions in law authorizing DEC to allow them under a DDP. These include use of bait within 300' of a road, shooting deer from a vehicle, shooting within discharge setback distances, and use of rifles on Long Island and in Westchester County. Rifles are more accurate at a greater distance than shotguns are, and the easiest way to get close to a deer is in a vehicle. Not having such options available makes deer control much more difficult and costly for local municipalities.

Also of relevance to culling programs is the issue of who can be paid for acting as a shooter on a DDP. In some municipal culls, the people shooting are federal wildlife control agents or other nuisance wildlife professionals. In other cases, communities prefer to use local hunters who volunteer their time and services to carry out the actions authorized by the permit. This requires considerable commitment to the cause of population reduction, because it often involves spending long hours sitting in a tree stand on cold winter nights, and if the shooters aren't licensed Nuisance Wildlife Control Operators, state law prohibits them from being compensated for their efforts. If this were changed, local sportsmen rather than commercial companies or government agencies could receive some of the taxpayer dollars being spent on these programs, which should decrease some residents' opposition to them.

Impacts of Overabundance

Impacts on Human Activities

The deer-related problems that directly affect human activities are the ones that receive the most public attention. In recent decades, frequently mentioned concerns have included deer-vehicle collisions (DVCs) on roads, deer eating crops in agricultural areas and landscaping plants in residential areas, and the potential role of deer in the increase of tick-borne illnesses such as Lyme disease.

Based on insurance claims, State Farm estimates that there are over 70,000 DVCs annually in New York (data provided by State Farm Insurance®) and that nationally the average property-damage cost per collision is approximately $4,000. Losses are not limited to property; although the federal highway fatality database (National Highway Traffic Safety Administration Fatality Analysis Reporting System) doesn't separate the data by species, 437 people were killed in the U.S. in 2015 in crashes caused by vehicles striking or attempting to avoid an animal, many of which were doubtless deer. Taking into account additional factors, the average total cost of a DVC has been estimated to be more than $6600 (Huijser et al., 2009). DVCs thus can be estimated to cost the citizens of New York over $462 million per year.

In 2002, New York farmers estimated their deer-related crop damages at $59 million, and about one quarter of farmers indicated that deer damage was a significant factor affecting the profits of their farms (Brown et al., 2004). Deer damage to gardens and landscaping creates considerable unhappiness, extra work and expense for homeowners. The efforts of some residents to protect their property with fencing can lead to conflict between neighbors and throughout communities. Lowered property value due to the inability to maintain landscaping is also a concern in some areas.

Many parts of New York are considered high-risk areas for human infection with Lyme disease (Diuk-Wasser et al., 2012), based on the density of infected black-legged ticks (*Ixodes scapularis*). Reducing deer populations to very low levels can reduce tick densities (Kugeler et al., 2016) and probably Lyme disease rates (Kilpatrick et al., 2014), because deer are the primary food source for adult female black-legged ticks. However, less drastic deer population reductions may not lower the chances of human Lyme infection (Jordan et al., 2007; Kugeler et al., 2016). Small mammals such as rodents and shrews, not deer, are the main tick hosts that pass on the Lyme-causing bacteria (*Borrelia burgdorferi*). Several other tick-borne diseases are less common but increasing in frequency. Deer are the principal hosts for the lone star tick (*Amblyomma americanum*), which can cause an allergy to the consumption of mammalian meat (Commins et al., 2011) as well as transmit ehrlichiosis and other diseases to humans (Childs and Paddock, 2003).

Impacts on Forest Ecosystems

There is a growing awareness of the ecological impacts of deer overabundance. Deer are altering forests across the state, perhaps permanently. Just as livestock can overgraze a range and reduce it to a barren wasteland, deer can over-browse a forest. Because mature canopy trees aren't affected, deer impacts on a forest may not be immediately evident, but they are profound and long-lasting. Browsing by deer at high densities reduces diversity in the forest understory (Horsley et al., 2003; Nuttle et al., 2014) and enables invasive species to out-compete natives (Knight et al., 2009). It also prevents seedlings of many species from growing into the next generation of trees (Tilghman, 1989), ultimately leading to fewer mature trees in a more open plant community with a different and less diverse species composition (White, 2012): in other words, the gradual disappearance of forests.

In areas with long histories of high deer impacts (as can occur in urban/suburban areas where hunting has been constrained or prohibited), reducing deer population density or removing all deer may not be sufficient for plant diversity to recover (Webster et al., 2005; Royo et al., 2010; Nuttle et al., 2014), even as much as 20 years later. Some species are so thoroughly eliminated by deer that they may have to be planted if they are to be restored to such areas. Impacts on endemic species can be devastating. For example, evidence suggests that current deer population densities in eastern North America will result in the extinction in the wild of ginseng, a valuable medicinal herb, within the next century (McGraw and Furedi, 2005).

The ecological changes brought about by deer also cascade through forest plant communities into wildlife communities, reducing the abundance and diversity of songbird species that use the intermediate levels of a forest (deCalesta, 1994). Furthermore, high-density deer populations interfere with habitat management efforts. Because browsing by deer counteracts the regenerative effects of natural forest disturbances such as fire (Nuttle et al., 2013), attempts to promote forest health through restoration of such disturbances and to increase populations of wildlife species that depend on young forest stands may fail unless deer populations are reduced. Regenerative processes are impaired in many parts of New York, particularly for tree species that are economically valuable, like sugar maple (Shirer and Zimmerman, 2010). Even in the Adirondacks, where deer densities are lower than in much of the rest of the state, both direct and indirect impacts of deer browsing must be counteracted for a diverse forest to regrow (Behrend et al., 1970; Sage et al., 2003). Ecosystem impacts may be magnified in urban and suburban parks and natural areas, which provide important habitat for migrating birds and other wildlife but are often subjected to the highest deer densities.

High-density populations can also harm the deer themselves by increasing competition for food and transmission of diseases and parasites. Deer in lower-density populations tend to be in better physical condition (Keyser et al., 2005), all else being equal, because there is more food available to them. Because they don't come in contact with as many other deer, they are less likely to be infected with parasites or diseases (Storm et al., 2013). If chronic wasting disease, or CWD, were to reach New York again, its ability to spread within the state could be facilitated by high-density populations.

Setting Deer Population Goals

In 2018, DEC began implementing a new process for setting deer population management directions throughout New York. Staff collaborated with the Center for Conservation Social Sciences at Cornell University to develop a public survey and send it to a sample of homeowners in approximately one-third of the state. The rest of the state will be surveyed in 2019 and 2020. The survey asks respondents questions about their interests and concerns related to deer, how they would like to see the deer population in their area change over the next several years, and how important deer management issues are to them. These responses will be analyzed to determine whether the residents of each part of the state want their local deer population to increase, decrease, or stay at its current level. The results will guide DEC's overall population management decisions, unless the population level desired by area residents would be ecologically unsustainable.

Data on forest regeneration (the process of tree seedlings growing into the canopy to replace trees that have died) will be used to evaluate the condition of forests throughout the state and the effect that deer are having on those forests. DEC is collaborating with researchers at SUNY College of Environmental Science and Forestry (ESF) and Cornell University to assess forest regeneration and deer impacts. A model has been developed based on Forest Inventory Analysis data (collected annually throughout the state by the U.S. Forest Service) and incorporating deer harvest data as an index of deer density. The model will show where deer are a significant factor contributing to poor forest regeneration, indicating that deer populations need to be reduced in those areas.

DEC's deer population management decisions are made at the landscape scale, and the state has been divided up into 23 WMU Aggregates (WMUAs) for this purpose. Since each WMUA is a large area with a diversity of land uses, management applied at the WMUA scale via hunting regulations is not likely to lead to ideal population levels for every locality, particularly urban and suburban communities where little hunting occurs. Communities suffering from deer overabundance need to identify locally appropriate goals, based on deer-related impacts. Direct estimation of deer population density in such areas is difficult, expensive and unreliable, but ecological impact can be used as a density index. DEC has collaborated with Cornell and SUNY ESF to develop an ecological impact monitoring method suitable for non-scientists to use. It's called Assessing Vegetation Impacts from Deer (AVID), and the website (aviddeer.com) contains all of the information necessary to start monitoring. In addition, a smartphone app that will soon be available will allow all of those resources to be carried into the field. Training sessions are offered periodically around the state for people who would like some hands-on instruction. AVID users are encouraged to enter their data into a central database, and in the future those data should also be useful to DEC for evaluating how well overall deer population goals are being met.

Conflict Reduction Activities

DEC's efforts to reduce deer-human conflict start with the population goal-setting process. The public survey is designed to reach a broad cross-section of residents and elicit opinions on appropriate deer population levels that are based on both positive and negative experiences with deer. A population level that is supported by public opinion will therefore be one that reduces negative impacts on people to a point where they are outweighed by benefits of deer. In addition, incorporating impacts on forest regeneration into the decision-making process may frequently lead to populations below the level at which that balance is reached, which will reduce deer-human conflicts even more.

However, for the reasons described in the "*Causes of Overabundance*" section above, DEC's efforts to reduce high-density deer populations are often not very successful, and even when overall deer density in an area is not excessive, localized high densities may occur and create conflict. In these situations, staff provide a wide variety of information and advice to help individuals and communities find ways to address the deer-related problems they are experiencing. DEC biologists respond to telephone calls, e-mails and letters, perform site visits to assess damage and recommend solutions, give public presentations, participate in local committees tasked with developing recommendations for specific communities, maintain informational webpages with links to additional resources, and produce written materials such as a flyer for landowners on forest impacts of deer and a handbook to guide communities through the deer management decision-making and planning process.

DEC also offers a few types of free permits to facilitate localized deer impact reduction using techniques that would be illegal without DEC authorization. Deer Management Assistance Program (DMAP) permits provide antlerless-deer tags to landowners or municipalities so that people hunting on their land can shoot more does than they would otherwise be allowed to. There were 1,929 DMAP permits active in 2017, of which 11 were issued to municipalities. Deer Damage Permits (DDPs) are issued in situations where hunting, even with DMAP, doesn't reduce deer densities enough to alleviate negative impacts. DDPs typically allow taking of deer outside of hunting seasons and may allow techniques that aren't available to hunters, such as baiting and shooting at night. DEC biologists issued 1,636 DDPs in 2017, including 18 in urban/suburban situations. Most DMAP permits and DDPs are used to address deer damage on agricultural properties. Nonetheless, both permit programs also provide opportunity for community-based deer management efforts.

To specifically address very localized tick populations, which are often elevated in urban and suburban areas with high deer densities, DEC issues licenses to municipalities and state parks authorizing use of 4-Poster™ pesticide delivery devices. 4-Posters™ are deer bait stations that apply pesticide to the heads and necks of deer as they eat the bait, killing ticks that are on them. Because of the many negative effects of deer feeding, including the potential to increase deer numbers and exacerbate impacts of deer overabundance, DEC requires that there be a population reduction program active in the area where the 4-Posters™ will be deployed.

Although fertility control methods alone are not effective for reducing open deer populations (see discussion in the "*Management Approaches*" section below), they may still play a valuable role in a multi-faceted, strategic urban/suburban deer management program. If asked, DEC may allow surgical sterilization of does to be conducted under a DDP in a small, densely developed area where lethal removal doesn't seem feasible, as long as lethal population reduction methods are being employed in the surrounding area. DEC also facilitates the continued development of fertility control techniques by authorizing novel scientific research. Numerous field research projects on both sterilization and immuno-contraception of deer have been and are being conducted in New York communities, beginning with Irondequoit in the 1990s (Porter and Underwood, 2001) and continuing through projects currently ongoing in Hastings-on-Hudson and Staten Island.

Additional programs to facilitate deer management in urban/suburban areas are under development. DEC biologists are designing the regulatory framework for a statewide extended urban antlerless deer hunting season in which municipalities could choose to participate. Similar programs in other states have been quite successful. Staff are also exploring DEC's capacity to offer small grants to communities for deer management planning. However, grants to pay directly for deer population reduction would probably be even more helpful to the communities. Such grants could potentially be sourced from the state general fund or Environmental Protection Fund.

Management Approaches

Increasing Public Awareness and Involvement

DEC works to increase public awareness by providing information on deer biology and management on the agency's website and through press releases, e-mail distribution lists, social media and public meetings. Within the past few months, the Division of Fish and Wildlife has created a new permanent position focusing on outreach and promotion and acquired a temporary Excelsior Fellow who will be working on outreach and marketing. This additional staff capacity should increase DEC's ability to engage the general public in deer management decisions.

Currently, most state wildlife management activities are funded by shooters and hunters through federal excise taxes on sporting arms and ammunition and through sales of hunting licenses. Diversifying the funding base so that a broader cross-section of the public provides financial support for wildlife programs is a long-needed reform (Jacobson et al., 2010) that would reduce the sense of disenfranchisement felt by many non-hunters and foster greater connectivity of diverse beneficiaries. Some states, such as Texas and Virginia, have chosen to dedicate a portion of the state sales tax on outdoor gear to their wildlife management agency budget. This can broaden the support base to at least include all those individuals who pursue nature-related recreation. Other states such as Missouri and Arkansas, recognizing that all citizens of the state are beneficiaries of wildlife management, dedicate a portion of all state sales tax to their wildlife management agency budget (Cerulli, 2013). As hunter numbers continue to decline across the country, approaches such as these will become increasingly necessary from an economic perspective. Social considerations provide additional reasons to adopt them as soon as is feasible.

On a local level, there is often a high degree of resident involvement in community discussions of and decision-making about urban/suburban deer management issues. Considerable conflict may arise during these processes, due in part to differing values and priorities among residents. However, a portion of the discord can be traced to misconceptions about deer population biology and the role of deer in forest ecosystems, as well as about the safety and humaneness of hunting. Educational outreach that appropriately addresses issues of importance to residents can increase their awareness and thereby affect their views on management approaches (Lauber and Knuth, 2000), potentially reducing conflict within the community and facilitating more timely adoption of effective management methods.

Reducing Vulnerability to Impacts of Deer

Deer-vehicle collisions – Given the economic losses, injuries and deaths associated with DVCs, there has been surprisingly little research on effective methods to reduce them. Some approaches, such as lower speed limits and standard deer crossing signs, are commonly used or recommended despite little evidence of effectiveness (Mastro et al., 2008). However, speed limit does appear to influence the risk of nighttime animal-vehicle collisions, and the effect is strongest for fatal crashes (Sullivan, 2011). In addition, a recent study found a decline in DVCs in the first year after installation of deer crossing signs (Found and Boyce, 2011), suggesting that at least when the signs are novel, they succeed in changing motorist behavior enough to be effective. Similarly, there is evidence from studies involving other wildlife species that temporary (i.e. only installed at high-risk times of year) signs and warning systems (such as lighted signs) that are activated by an animal's presence may be effective at reducing collisions (Mastro et al., 2008). One of the best-studied DVC-prevention methods is the installation of reflectors along roadsides, and the vast majority of these studies indicate that reflectors are ineffective (Mastro et al., 2008).

The most effective approach seems to be the construction of suitably designed wildlife underpasses or overpasses, with deer-proof fencing between the crossing structures (Mastro et al., 2008; McCollister and Van Manen, 2010). However, this is also an expensive method that is only likely to be justified on sections of road where collisions are very frequent or there are additional reasons to construct wildlife crossing structures. A cost-benefit analysis indicated that deer population reduction through hunting or culling is the most cost-effective approach that will reduce DVCs by at least 50% (Huijser et al., 2009). The return of major deer predators such as mountain lions could reduce deer populations, DVCs and the associated societal costs, but the effect would probably be seen mostly in rural areas, not urban and suburban communities (Gilbert et al., 2017).

Tick-borne disease – Tick-borne diseases, particularly Lyme disease, have been the focus of considerable research attention in the past few decades. However, most field studies evaluate methods for reducing tick densities or numbers of infected ticks, because demonstrating a reduction in human disease rates is much harder to do. It is therefore unclear what interventions can actually reduce disease risk (Garnett et al., 2011; Eisen and Dolan, 2016).

Tick ecology is complex, and ticks often depend on multiple host species at various stages of their life cycle, so there is a wide variety of approaches for controlling tick numbers. Tick populations can be reduced by keeping vegetation mowed short and removing leaf litter (White and Gaff, 2018), removing invasive plant species (Williams and Ward, 2010), treating the vegetation or ground with chemical pesticides (Eisen and Dolan, 2016; White and Gaff, 2018), treating the vegetation or ground with a fungus that infects ticks (Eisen and Dolan, 2016), treating small rodents with pesticide (Dolan et al., 2004; Schulze et al., 2017), reducing deer populations (Kugeler et al., 2015), treating deer with pesticide

(Pound et al., 2009; Curtis et al., 2011; Wong et al., 2017), and excluding deer with a fence (Eisen and Dolan, 2016; White and Gaff, 2018). Some of these methods act quickly but are effective for relatively short periods of time, whereas others are long-term approaches. Using a combination of methods may be more effective and ecologically sustainable than relying on a single approach (Mount et al., 1999; Schulze et al., 2007; Williams et al., 2018). However, climate is one of the principal determinants of tick distribution and abundance, so the problem of tick-borne disease can be expected to grow as climate change continues (Stone et al., 2017). Various types of vaccine are under development (Zraick, 2018), and their availability could make a tremendous difference in the effort to reduce disease rates.

One of the deer-related tick reduction methods, treating deer with pesticide by means of 4-Posters™, has been employed by several communities and state parks on Long Island. An appropriately designed 4-Poster™ program can lower tick populations in the area immediately around the devices (Pound et al., 2009; Curtis et al., 2011; Wong et al., 2017), but communities that have used 4-Posters™ have often not been satisfied with the results. For example, although the town of Shelter Island in New York has been using 4-Posters™ for 10 years, residents feel that there is still a serious tick problem there (B. Payne, Shelter Island Animal Control Officer, pers. comm.). Effectiveness can be reduced if alternate food sources such as acorns reduce deer use of the devices (Pound et al., 2009), and it's possible that the long-term availability of abundant food in the 4-Posters™ acts to maintain or even increase high deer densities (Wong et al., 2017), which would tend to make tick population reduction more difficult. In addition, keeping the devices supplied with corn and pesticide is very expensive, and they act as feeders not only for deer but also other wildlife species such as geese, squirrels, raccoons, crows, turkeys and bears.

Plant damage – Deer browsing can create problems in many different contexts, from ecological degradation to crop losses to ornamental plant damage. Information on various ways to reduce plant damage by deer is available from Cornell Cooperative Extension (Curtis and Sullivan, 2001) and many other sources.

The only sure way to keep deer from eating plants is to enclose the plants in a sturdy fence that deer can't jump over, which usually means at least eight feet high (VerCauteren et al., 2010). Shorter fences can be effective (although not 100%) if they are slanted or otherwise create a barrier with depth (VerCauteren et al., 2006; Stull et al., 2011), or if they are electrified (VerCauteren et al., 2006). Individual plants can be protected with small cage-like enclosures (Curtis and Sullivan, 2001).

There are many chemical deer repellents on the market, and some of them are fairly effective at protecting plants, especially if they are reapplied frequently (Ward and Williams, 2010). However, they will be less effective if there are few alternative sources of food for the deer (Curtis and Sullivan, 2001). Many types of frightening devices are also available, but those that have been tested have been found to be only briefly effective at best, because deer quickly habituate to them (Gilsdorf et al., 2002; Gilsdorf et al., 2004; VerCauteren et al., 2005; VerCauteren et al., 2006; Hildreth et al., 2013).

People often claim that landscaping damage from deer can easily be avoided through "deer-resistant" planting – choosing plants that deer don't like to eat, – and an internet search will quickly turn up many lists recommending plants to use. However, those lists should be treated with skepticism. A given species can often be found in a "preferred by deer" category on one list and an "avoided by deer" category on another. Deer are not all alike; their habits and preferences can vary regionally and on an individual basis. When food is scarce they will eat plants that they normally avoid (Curtis and Sullivan, 2001). Furthermore, some plants that appear on "deer-resistant" lists are non-native plants that become invasive and cause ecological and economic harm, so they should never be planted.

Hazing, which is active physical harassment of the deer, is a labor-intensive way to prevent deer damage to plants. In New York, hazing requires a permit from DEC. The permit may allow shooting deer with non-lethal projectiles such as rubber buckshot or beanbag rounds. Alternatively, hazing can take the form of chasing by a dog that is prevented from leaving the area it is protecting (for example, by an underground electronic fence). The effectiveness of hazing is dependent on the presence and vigilance of the hazer.

Intentionally providing food for deer is sometimes suggested as a way to reduce browsing on plants people wish to protect. However, this approach is just as likely to have the opposite effect. Deer tend to congregate at sites where food is provided, and they continue to eat their natural foods and preferred plants, so in many cases plant damage near feeding locations actually increases (Milner et al., 2014). Furthermore, supplemental feeding increases deer survival and reproduction, leading to population growth (Milner et al., 2014), which increases all negative impacts of deer. Preventing people from feeding deer is therefore an important component of strategies to combat deer impacts.

One of the most significant shortcomings of approaches such as fencing, hazing or the use of repellents is that they can only benefit individuals, not the community as a whole. Any action that decreases one resident's likelihood of damage will increase the pressure on everyone else's plants. The only way to reduce plant damage throughout a community, and the only method that can bring forest ecosystems back into ecological balance, is reduction of the deer population.

Reducing Deer Populations

For deer populations to be reduced, deer deaths must outnumber births. The white-tailed deer is a prey species that evolved under high predation levels, so its natural state includes a high mortality rate. For a healthy deer population to remain stable, on average 30-40% of the animals must die each year (Matschke et al., 1984); otherwise the high reproductive rate will result in population growth. In undeveloped areas of New York, most of this mortality occurs through predation of fawns, hunting of adults, and malnutrition during severe winters. In residential areas most deer deaths result from collisions with vehicles, and those don't usually occur at a high enough rate to offset reproduction (Etter et al., 2002). Hunting and/or culling programs are therefore necessary to increase mortality.

Hunting – Allowing recreational hunters access to as much land as possible in a community is the simplest approach to deer population reduction. Many landowners, including municipalities, currently prohibit hunting on their land, and since hunting is the principal mechanism for deer population control, this practice allows populations to grow to unsustainable levels. In communities that are trying to reduce deer-related impacts, opening more private and public properties up to hunting and encouraging hunters to shoot as many does as they legally can will provide additional recreational opportunities for local hunters while benefiting the entire community. To increase the success of such an effort, communities may wish to conduct outreach to increase local non-hunters' understanding of hunting and the excellent safety record of New York hunters and raise hunters' awareness of the negative impacts of overabundant deer and the importance of reducing populations.

Both firearms and archery equipment (including crossbows) can be used safely and successfully in residential areas (Kilpatrick et al., 2002; Williams et al., 2013). Under New York state law, archery equipment is allowed to be used closer to houses and other buildings than firearms are, so bowhunting lets hunters utilize areas as small as a suburban backyard, giving better access to all the spaces used by deer. However, despite their great similarity in functional shooting distance, current law still requires a greater setback distance for crossbows than vertical bows. Firearms offer accuracy at longer distances, so they may increase effectiveness in larger parks and other greenspaces, where deer may be farther from the hunter and noise disturbance of residents is less of an issue. Removing municipal restrictions on which hunting implements can be used in an area will increase the likelihood of successful population reduction.

If community residents are uncomfortable with the idea of simply opening up land to hunting under state regulations, a "controlled hunt" may be a way to address their concerns while still accomplishing population reduction through recreational hunting. A controlled hunt is just a way to formalize the authority that all landowners have to restrict how hunting occurs on their land. Individual property owners can choose whether they want their property to be included in a municipal controlled hunt. A set of rules is established that applies to all participating properties and places limits or requirements on hunting on those properties that are stricter than state law requirements (e.g. limiting hunting activity to specific times of day, days of the week, particular locations or designated hunters). Many communities have successfully used controlled hunts to reduce deer numbers and impacts (Kilpatrick and Walter, 1999; Kilpatrick et al., 2002; Williams et al., 2013). Here in New York, the village of Cornwall-on-Hudson in Orange County and the town of Irondequoit in Monroe County both have long-running controlled hunt programs. DEC wildlife biologists can assist with the planning of controlled hunts.

Municipalities in New York can enroll in DMAP to increase the ability of hunters to reduce local deer population densities. Through DMAP, DEC provides an allotment of antlerless-deer tags to be used during deer hunting seasons on designated lands. The municipality distributes these tags to hunters for use on the specified properties. This enables those hunters to shoot more does than they would ordinarily be allowed to.

Culling – In many urban and suburban situations, hunting may not be able to lower deer populations enough to bring impacts down to a sustainable level (Williams et al., 2013). In these cases, the best option may be culling, which is the term for killing deer outside of a hunting framework. In New York, a DEC-issued DDP is necessary for a culling program to occur, and such permits typically allow the use of methods that are not available to hunters, which is why culling is usually more effective for rapid population reduction than hunting.

For example, nearly all municipal culling programs involve the use of bait to attract deer to locations where they can be shot safely and efficiently, and most of the shooting occurs at night, when deer are out searching for food and spotlights can be used to temporarily induce them to "freeze," providing a good opportunity for a shot. Culling usually occurs at a different time of year than hunting, for example in mid-winter, when deer have less natural food available and can be more easily attracted to bait. Culling is most effective when it can be conducted from vehicles on roads, because deer often let vehicles approach closely without taking alarm, but DEC doesn't have the legal authority to allow this technique to be used.

Culling can be conducted by either volunteers (usually local hunters) or professionals. Any DEC-licensed Nuisance Wildlife Control Operator (NWCO) can be paid to kill deer. There are companies that specialize in urban/suburban deer culling, and the Wildlife Services branch of the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture can also be hired for this purpose. Culling by volunteers is most likely to be done with archery equipment, because of the ability to be quiet and unobtrusive and utilize small habitat patches throughout the community. Professionals usually cull using rifles. They may have considerable experience selecting safe shooting zones in developed areas and typically also have specialized infrared equipment that enables them to detect people and other animals from a distance at night.

DEC works with municipalities to facilitate the development of culling programs that fit each community's individual circumstances. Currently there are communities culling with volunteers in Madison, Suffolk and Tompkins Counties. In a couple of towns in Erie and Suffolk Counties, local hunters have become NWCOs so that they can be compensated for their efforts. USDA APHIS Wildlife Services conducts culls for some communities in Onondaga and Suffolk Counties, while several municipalities in Erie, Orange and Niagara Counties utilize their police officers to cull deer. The village of Cayuga Heights in Tompkins County hires White Buffalo, Inc., a deer management organization, to conduct their cull.

If there are only a few places in a community where deer can be safely shot, or if community members are unwilling to support methods that involve shooting, alternative approaches to population reduction will be necessary. Professionals can be hired to capture deer with traps, nets or anesthetic darts and then kill them with either a captive-bolt gun or injection of potassium chloride (Leary et al., 2013). However, there are several negative consequences of these methods. Trapping causes stress and possible injury for the deer, use of a captive bolt on a wild, unsedated animal is challenging for the operator, and use of chemicals renders the carcasses unsafe for consumption, so the meat is wasted.

Fertility control – People who are disturbed by the idea of killing animals often wish to control deer populations by reducing the birth rate rather than increasing the death rate. Yet, even with effective fertility control, this wouldn't be a good way to reduce impacts of deer because it would just keep populations from growing; it wouldn't lower them. Deer can live to be 20 years old, so population reduction would happen slowly, if at all. Without hunting or culling, most deaths would be from vehicle collisions, which isn't a prudent or humane method of removing deer. (On low-speed roads, DVCs commonly result in considerable suffering followed by slow death or permanent crippling.) Meanwhile, the negative social and ecological impacts of deer would continue at levels which were found to be unacceptable by the community when they decided to initiate deer management efforts.

Currently, however, the lengthy delay in potential impact reduction is a secondary consideration, because effective fertility control on a population-wide scale has not been achieved except in small isolated populations in enclosures or on islands (Rutberg et al, 2013b). The problem is that deer have such a high reproductive rate that a few fertile individuals can produce enough young to replace the small number of deer that die each year in urban and suburban settings. Wary individuals who are able to avoid capture and treatment, along with immigrants moving in from neighboring areas, provide more than enough reproductive capability to overwhelm fertility control efforts in the majority of cases (Merrill et al., 2006). Even on an island of less than 9 mi^2, a fertility control program that continued for 16 years was hampered by an inability to capture a high enough percentage of the deer, and meaningful population reductions only occurred in certain areas that provided the best access to the animals (Underwood, 2005; National Park Service, 2015).

Surgical sterilization is the most reliable way to render a deer infertile, and for does it can be accomplished by either ovariectomy or tubal ligation. The latter technique doesn't prevent ovulation, so sterilized does will still go into estrus and mate. Because they won't get pregnant, however, they will go through several estrous cycles each year, creating an extended rutting season. This could have a number of negative consequences, including more DVCs, increased stress and lower overwinter survival, and an increase in the local population due to bucks being attracted from neighboring areas (Boulanger and Curtis, 2016). An ovariectomy program is not likely to have these consequences.

Immuno-contraception is the other fertility control method that is often suggested by those seeking alternatives to lethal population reduction. ZonaStat-D is a contraceptive agent for deer that has recently been approved at the federal level by the Environmental Protection Agency. It contains porcine zona pellucida (PZP), which prevents fertilization, not ovulation, so it has the same potential for negative consequences as tubal ligation. GonaCon™, a contraceptive agent developed by the U.S. Department of Agriculture, prevents does from going into estrus, but in field trials it seems to have a slightly lower success rate than PZP (Gionfriddo et al., 2009; 2011; Rutberg et al., 2013a). Unlike surgical sterilization, immuno-contraception is neither effective on all treated animals nor a permanent treatment; does must be re-treated on a regular basis to maintain infertility. This becomes increasingly difficult as experience makes them more wary.

Although fertility control alone is not a viable method for reducing open populations, it may be useful in conjunction with other methods of population control (Raiho et al., 2015). A fertility control program might lead to population stability or reduction in a limited area if immigration from surrounding areas could be minimized. Substantially lowering the populations in those surrounding areas through hunting or culling would be a way to do that. The combination of a core sterilization area surrounded by a lethal control zone reduced the deer population in Cayuga Heights, New York by almost 40% in two years (P. Curtis, Cornell University, pers. comm.). Fertility control might also potentially be used to keep a population stable after it has been lowered to an appropriate level through hunting or culling.

Even in these limited circumstances, though, the logistical and financial burdens entailed in current fertility control methods would present a significant obstacle to implementation of meaningful programs in most communities. All fertility control methods are extremely labor-intensive and expensive, because deer must be captured for treatment and marking and virtually all does must be treated to prevent population growth. Capture, anesthesia and surgery also create stress and may result in injury or death of captured deer. If a community decides that these costs are acceptable to them and they wish to pursue fertility control in a small highly developed area where shooting deer doesn't seem feasible, they may receive a DEC permit to use surgical sterilization as part of a deer management program. However, because of the ineffectiveness of fertility control for reducing populations or impacts, lethal population reduction methods must also be used concurrently in nearby areas.

Relocation of deer, reintroduction of large carnivores – People who don’t want deer to be hunted or culled in their community sometimes suggest capturing the deer and moving them somewhere else or reintroducing large carnivores such as wolves or mountain lions so that they can lower deer numbers. These are not useful methods of reducing deer populations in developed areas. Reintroduction of large carnivores is not ecologically or socially feasible in areas with high human density and no large blocks of natural habitat. Capturing and relocating deer results in significant levels of stress, injury and mortality (O’Bryan and McCullough, 1985; Jones and Witham, 1990; Beringer et al., 2002), and also presents a risk of spreading disease. In most locations, if deer were removed, they would quickly be replaced by immigrants from the surrounding area.

Conclusion

Deer overabundance in urban and suburban areas is challenging community residents, local municipal officials and state agencies across the country. In some respects, New York is at the forefront of management approaches to this problem, but state laws prevent the use of several of the most effective techniques. Removing those legal obstacles would make it easier and more affordable for communities to address their deer-related problems. Because deer in developed areas are occupying and using many small private parcels with different landowners, widespread resident support and participation are usually necessary for effective deer management. In some communities, lack of understanding of deer biology and discomfort with population reduction methods hinder and delay the development of management programs. Expense can also be a significant obstacle.

Many communities are finding ways to address their problems with overabundant deer, but it's important to recognize at the outset that it's a complicated process requiring a long-term commitment. All deer impact management methods have to be continued and/or repeated year after year. Due to the nature of biological systems, reducing deer populations is necessary for long-term impact reduction on a community-wide scale. Successful programs include hunting, culling, or both. Continued research on fertility control methods may produce additional useful options in the future. Actions that are taken to reduce deer populations must be maintained, or the problems will quickly return.

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