Work Session Meeting Agenda
2 Park Drive South, Great Falls, MT
Gibson Room, Civic Center
May 07, 2024
5:30 PM

The agenda packet material is available on the City's website: **https://greatfallsmt.net/meetings**. The Public may view and listen to the meeting on government access channel City-190, cable channel 190; or online at **https://greatfallsmt.net/livestream**.

Public participation is welcome in the following ways:

- Attend in person.
- Provide public comments in writing by 12:00 PM the day of the meeting: Mail to City Clerk, PO Box 5021, Great Falls, MT 59403, or via email to: **commission@greatfallsmt.net**. Include the agenda item or agenda item number in the subject line, and include the name of the commenter and either an address or whether the commenter is a city resident. Written communication received by that time will be shared with the City Commission and appropriate City staff for consideration during the agenda item, and, will be so noted in the official record of the meeting.

CALL TO ORDER

PUBLIC COMMENT

(Public comment on agenda items or any matter that is within the jurisdiction of the City Commission. Please keep your remarks to a maximum of five (5) minutes. Speak into the microphone, and state your name and either your address or whether you are a city resident for the record.)

WORK SESSION ITEMS

1. Discussion on Urban Deer Programs - Cory Loecker, Region 4 Wildlife Manager for Montana Fish, Wildlife & Parks.
2. Fire Department Presentation on Proposed Fees and Code Changes - Titles 5, 9 and 15- Chapter 9 - Mike McIntosh.

DISCUSSION POTENTIAL UPCOMING WORK SESSION TOPICS

ADJOURNMENT

City Commission Work Sessions are televised on cable channel 190 and streamed live at https://greatfallsmt.net. Work Session meetings are re-aired on cable channel 190 the following Thursday morning at 10 a.m. and the following Tuesday evening at 5:30 p.m.

Wi-Fi is available during the meetings for viewing of the online meeting documents.

UPCOMING MEETING SCHEDULE

City Commission Work Session, Tuesday May 21, 2024 5:30 p.m.

City Commission Meeting, Tuesday May 21, 2024 7:00 p.m.

Methods for Managing Deer in Populated Areas

A PRODUCT OF THE
HUMAN WILDLIFE CONFLICTS WORKING GROUP

SPONSORED BY THE
ASSOCIATION OF FISH AND WILDLIFE AGENCIES

Table of Contents

Introduction

What is the Association of Fish and Wildlife Agencies (AFWA)?

The Association of Fish & Wildlife Agencies represents North America's fish and wildlife agencies to advance sound, science-based management and conservation of fish and wildlife and their habitats in the public interest.

The Association represents its members on Capitol Hill and before the Administration to advance favorable fish and wildlife conservation policy and funding and works to ensure that all entities work collaboratively on the most important issues.

The Association also provides member agencies with coordination services on cross-cutting as well as species-based programs that range from birds, fish habitat and energy development to climate change, wildlife action plans, conservation education, leadership training and international relations.

Working together, the Association's member agencies are ensuring that North American fish and wildlife management has a clear and collective voice.

Purpose of document

The Human Wildlife Conflicts Working Group of the Association of Fish and Wildlife Agencies formed a task force to document methods used to manage deer conflicts within areas of high human densities. Throughout the document we will refer to these areas as "urban" areas. However, deer conflict situations arise in suburban, ex-urban, and other areas of high human densities and the content of this document applies to those areas as well. This document offers management options to communities and agency leadership for resolving common human conflicts with urban deer. It provides an overview of the common issues and identifies common management practices with their associated benefits and challenges. Because wildlife agencies often adopt management practices for dealing with urban deer conflicts for reasons that are not associated with the efficacy of the practice itself (e.g., social acceptance), this document is not designed to endorse specific practices over others. Instead, this document is designed to describe the various management practices in use, as well as the benefits and challenges associated with each practice and to provide defensible management options to North American agency leadership as they determine which practices will be employed in a particular state, province, region, or situation. In addition, this document can help articulate current information regarding urban deer conflict situations to administrators, leaders and legislators that oversee urban areas..

Acknowledgements

While many state and provincial agencies have managed deer for over a half a century, managing deer in populated areas poses many new challenges that don't exist with rural deer management. This document was compiled using many of the leading wildlife biologists in North America with expertise in managing deer-human conflict situations. Special thanks go to:
Geoff Westerfield (Ohio Division of Wildlife), Erin Shank (Missouri Department of Conservation), Carole Stanko (New Jersey Division of Fish & Wildlife), Justin Shannon (Utah Division of Wildlife Resources), Ben Layton (Tennessee Wildlife Resource Agency), Orrin Duvuvuei (New Mexico Department of Game and Fish), Emma Vost (Nova Scotia Department of Natural Resources), Michael Boudreau (Nova Scotia Department of Natural Resources), Nathan Snow (USDA/APHIS/Wildlife Services-National Wildlife Research Center), Richard Heilbrun (Texas Parks and Wildlife Department), Bryant White (Association of Fish and Wildlife Agencies), Brian Wakeling (Nevada Department of Wildlife Game), Thomas Decker (US Fish & Wildlife Service), and Mike O'Brien (Nova Scotia Department of Natural Resources). This document was requested, reviewed, and approved by the Association of Fish and Wildlife Agencies' (AFWA) Human-Wildlife Conflict Working Group and Wildlife Resource Policy Committee on behalf of the AFWA..

History of deer management

North America is inhabited by white-tailed, mule, and black-tailed deer. While all species have seen their populations fluctuate with changes in anthropogenic management, deer are a flagship success story.It is estimated that the white-tailed deer population in the U.S. was only about 300,000 in the 1930s. Today, that population has grown to an estimated 30 million; a 1,000 fold increase in less than 100 years. Deer are managed under the North American model of wildlife conservation and they provide many societal benefits. Deer are the most sought- after game animal on the North American continent and all North American deer species are enjoyed as a healthy and nutritious table fare. Prior to European settlement, white-tailed deer were common throughout most of North America providing meat and hides to the native Americans. However, during the late 1800s, unregulated hunting, including commercial market hunting, led to the extirpation of white-tailed deer throughout much of its range. During the early to mid-1900s, led by a widespread conservation movement across North America, many wildlife agencies initiated reintroduction efforts to reestablish white-tailed deer populations. Those reintroduction efforts lead to quickly growing white-tailed deer populationsThis growth continued throughout the 20th century, and white-tailed deer adapted to living in areas of higher human populations to take advantage of reduced predation and increased forage resources. This growth eventually led to increasing deer populations in many areas highly populated by humans.

While white-tailed deer have demonstrated the greatest numeric challenge in this urban situation, mule deer and black-tailed deer have adapted similarly and created identical challenges in portions of their range. State and provincial agencies have had to:

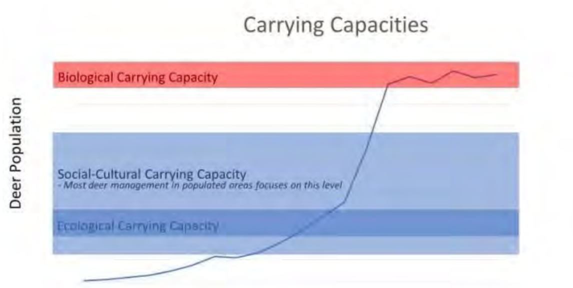
- Reassess how traditional deer management techniques can be used in these populated areas
- Develop new deer management strategies for these populated areas
- Encourage research into additional deer management tools for managing deer in populated areas
- Learn how best to work with government officials and city leaders together to address concerns regarding deer

The Concept of Carrying Capacity

When managing deer in populated areas, the question of how many deer should be in a given area is a crucial question. Three types of carrying capacities may be considered in this context: biological, ecological, and social-cultural.

- Biological Carrying Capacity (BCC) - The simplest concept is to consider the maximum number of deer that the habitat could support on a continuous, long-term basis. This level is referred to as the biological carrying capacity of the population. The biological carrying capacity however may not be the actual desired level. A deer population at biological carrying capacity will be able to sustain itself, but deer numbers at this level may influence plant and animal communities in this association. The biological carrying capacity in urban areas may be much higher than in a wild environment due to the increased availability of artificial sources of forage and water.
- Ecological Carrying Capacity (ECC) - The population level at which deer do not negatively influence native plants and animals and allow for the natural succession of the habitat is referred to as the ecological carrying capacity. Prior to the 1500s and major European settlement of North America, deer densities were likely 3.1-4.2/km2 throughout their range (McCabe and McCabe 1984, McCabe and McCabe 1997). Research in the eastern half of North America indicates ecological carrying capacity for white-tailed deer in the range of 3- 10 deer/km^2 (Healy 1997, Schmitz and Sinclair 1997). Beyond these densities, deer browse impacts the regeneration of certain plant life which in turn impacts other wildlife species which also depend on those habitats (DeCalesta, 1994, Tilghman 1989). Deer numbers at this level can still present challenges like deer-vehicle collisions or damage to artificial landscapes and gardens.
- Social-Cultural Carrying Capacity (SCC or CCC) - The deer population level at which the local human population can tolerate or accept the problems associated with a deer herd is commonly referred to as the social or cultural carrying capacity. In most cases when managing deer in populated areas, local human residents will determine the social carrying capacity for the deer herd and the desired deer population. Because of the variety of tolerances of multiple

stakeholders for deer within a particular area, the appropriate deer density will vary..



Consequences of Overabundant Deer

The consequences of overabundant deer in urban and suburban settings range from mild to severe. The most significant concerns perceived by the public are human injuries, death, and property damage from deer-vehicle collisions (Connelly et al. 1987, Curtis and Lynch 2001). Collisions with deer are extremely frequent, estimated at >1 million each year in the United States (Conover et al. 1995). These collisions occur in all landscapes where deer and roads exist, but occur more regularly in urban and suburban areas where both deer and motorist are abundant (Nielsen et al. 2003).

Deer-vehicle collisions generate the highest amount of monetary damage from wildlife-vehicle collisions, averaging $6,717 per collision (Huijser et al. 2008). Since 1990, human fatalities from such collisions with wildlife, mostly deer, have increased 104% (Sullivan 2011). In addition, a large number of deer are killed in these collisions resulting in loss of recreational opportunities and their many intrinsic benefits (Huijser et al. 2008). An estimated 92% of deer involved in collisions die from the trauma (Allen and McCullough 1976). Human-deer conflict in **Princeton, New Jersey** arose after a no-firearms discharge law within the township was passed in the 1970s. From 1972 to 1982, there was a 436% increase in deer-vehicle collisions.

Another major concern expressed by the public is the risk of disease from deer (Connelly et al. 1987, Curtis and Lynch 2001). As with many species of wildlife residing in close proximity to human dwellings, deer are implicated as reservoirs and transmitters of zoonotic diseases. Specifically, urban white-tailed deer host a stage of the transmittable Lyme disease (Adams et al. 2006). Lyme disease is contracted by humans through an injection of the bacterium, *Borrelia burgdorferi*, during the bite of a deer tick (*Ixodes* spp.). These ticks require large mammals, such as deer, as a host for feeding and mating during the adult stage of the tick. The ticks lay eggs that hatch, after which the nymphs feed on small mammals or birds and become infected with the *B. burgdorferi*. The nymphs or adults then can move onto humans and bite, infecting the human. Incidents of Lyme disease have risen since the mid-1990s, with 2015 representing one of the highest years on record with 28,453 cases (www.cdc.gov/lyme/stats). The majority of cases occur along states in the northeast USA, but more cases are being reported throughout the Midwest region of the country in recent years. Other Lyme-like diseases such as Ehrlichiosis and Bourbon Virus are of increasing concern throughout portions of North America. Incidence of Ehrlichiosis has increased dramatically since the mid-1990s. Isolated but serious cases of Bourbon Virus and Heartland Virus in Missouri have raised concerns about deer densities and human exposure to tick-borne diseases.

Deer generate other consequences that are less obvious than collisions or disease, but nonetheless substantial. In particular, overabundant deer alter landscapes via intensive browsing and indirectly reduce the abundances of other wildlife (Waller and Alverson 1997). Hence, deer are considered a keystone herbivore. Deer in urban and suburban settings can become overabundant, reaching densities of 78 deer/km2 (Magnarelli et al. 1995). Overabundant deer browse heavily on forest understories until the vegetative community is mostly gone (Adams et al. 2006). This overbrowsing influences the distribution and abundance of species at multiple trophic levels that depend on those vegetative communities, and modifies the relative abundance of species that compete with deer (Waller and Alverson 1997). This type of intensive herbivory is not confined to forests. About 4% of urban and suburban households reported damage from deer herbivory to gardens, yards, and ornamental plants (Conover 2001). These types of damages average $73 per household.

Although rare, deer may be aggressive toward humans in areas of high human density where deer are abundant (Hubbard and Nielsen 2009). For example, 13 attacks on humans were reported at Southern Illinois University–Carbondale during 2005, including injuries to humans involving broken and dislocated bones, lacerations, scrapes, and bruises. These attacks were speculated to be female deer protecting fawns. Other attacks on humans have included male deer during the breeding season, likely in territorial defense as rutting behavior (Conover 2001).

City Challenges with Urban Deer

In many parts of the United States and Canada, deer populations have increased in urban environments. Elected city officials are often asked and expected to solve urban deer-related issues, but there are a variety of challenges that must be overcome to address issues and reduce conflicts. The first challenge is to identify the problem and set clear objectives to achieve success. This can be difficult because social tolerance of deer in municipalities varies, with some residents viewing deer as a benefit to the community and others viewing deer as a detriment. This lack of consensus among residents has increasingly become a source of controversy for elected officials, as their polarized constituents propose fundamentally different solutions to address urban deer-related challenges. Residents in favor of having deer in town promote the philosophy that local citizens need to learn to live and co-exist with wildlife. Those opposed to urban deer often call for strategies to decrease deer densities in an effort to reduce deer-vehicle collisions, address zoonotic diseases risks to humans, alleviate material damage to lawns and gardens, and address public safety concerns.

One challenge that city officials are faced with is the lack of management authority over wildlife species. That authority generally rests with the state or provincial wildlife management agency. Elected officials must work with state or provincial agencies to determine and achieve defined objectives. If cities believe that urban deer is entirely a wildlife agency problem and not a city problem, little progress will be made in reducing conflicts. Coordination and collaboration is critical.

Wildlife management agencies primarily limit deer population size by using regulated public hunting to harvest bucks and does. Cities usually have ordinances and other laws that prohibit the discharge of firearms in city limits due to the impracticality of its use in areas of high human density. The inability to use hunters to regulate deer populations eliminates the primary tool used by wildlife agencies to reduce herd size. Humans in urban areas often have greater mutualistic views of wildlife, and may not be accepting of utilitarian views of hunting or firearms in general. Yet, in some areas the public is becoming increasingly accepting of hunting as a management tool to obtain locally grown, organic protein, such as locavores. Exacerbating the problems, many cities do not prohibit feeding of deer. Protection from harvest and added forage resources can create a refuge for deer and increase deer densities in urban environments.

Jurisdictions with the most pronounced deer problems are generally those with high deer abundance and restricted hunting regulations. These regulations may apply to an entire state or province (such as restrictions in New York state due to fears of low deer numbers in the mid-1900s) or they may be related to weapons restrictions at the municipal level (no weapon discharge within town limits or within a certain distance of houses). Many suburban communities integrate green spaces, such as large gardens or recreational areas within close proximity of houses and weapons cannot be discharged under normal conditions. Changes to regulations (e.g., allowances for harvest) may take years to enact, and communities may be reluctant to approve even those hunting methods with limited range and noise, such as archery hunts. Consequently, communities may struggle to determine appropriate solutions while the deer population, and human conflicts with deer, continues to increase.

In 6 different New England communities during the late 1980s, human-deer conflicts began to emerge as a threat to human safety with increased vehicle collisions and an increase in detected cases of Lyme disease, along with increased nuisance complaints due to deer browsing in local gardens. These jurisdictions recognized the need for deer population control, but varying levels of public support limited their abilities to implement uniform strategies in a timely manner. The creation of local deer management committees and the comprehensive consultation process implemented by the larger communities limited action when consensus could not be reached. In the 2 largest communities, solutions to the urban deer overpopulation were delayed by over ten years as pressure from animal rights groups and local residents limited implementation of deer management committee recommendations.

In **Cayuga Heights, New York**, 40 meetings were held over 3 years, finally resulting in an experimentation stage before a management solution could be agreed upon 2 years later. In another instance, intervention from the local Humane Society in **Amherst, New York** resulted in suspension of a bait-and-shoot program implemented 2 years earlier. Several consultants were hired by the town to determine the best course of action. Three years passed with the deer population continuing to cause nuisance to the local community before an agreement was made to implement 1 year immuno-contraceptive study followed by bait-and-shoot.

In many situations, solutions to deer conflict issues require the joint coordination of multiple jurisdictions. In **Cook County, Illinois**, for example, the legal custodian of wildlife is the Illinois Department of Conservation; the legal custodian of the habitat, however, is the Cook County Forest Preserve District. A successful urban deer management program requires the cooperation of all levels of government, with funding, staffing, and communication distributed in such a way as to promote shared responsibility.

Consultation and deliberation is important to democratic representation within public trust process. Yet delays in decision-making can greatly affect local communities as deer populations increase along with human conflicts if their growth is not limited in some fashion.

Wildlife Agency Challenges with Urban Deer

State and provincial wildlife agencies also have challenges to solving urban deer issues. Similar to most cities, many wildlife agencies have limited funds that are primarily generated through license sales, and they may not have a dedicated budget to address urban deer issues. Limitations exist on using federal funds raised through excise taxes (i.e., Wildlife Restoration Funds) to address nuisance wildlife. Agencies have not been able to hire and support staff in urban settings at the same rate at which urban deer problems have developed.

Another set of challenges for state and provincial wildlife agencies is prioritizing which communities to help and how many resources to devote to the problems. Some wildlife agencies have well defined plans or policies outlining the processes they will take to help communities manage urban deer conflicts. These plans may set criteria, provide direction and consistency, and define management options when working with elected city officials. In the absence of urban deer plans or policies, objectively prioritizing which cities to help and allocating resources may be difficult.

Community leaders often call upon wildlife agencies to remove urban deer, but each technique present specific limitations. Lethal removal by sharp shooters with firearms can be challenging in many instances, and having the proper training and equipment is necessary before culling deer in urban environments. Trap and cull measures may be perceived as safer, but substantial expense, equipment, and expertise is required. Efforts should target removal of resident deer, as deer that migrate through urban areas may contribute little to the challenge. In addition, removing deer may solve challenges only temporarily if the attractants are not removed because additional deer may move into the urban area.

In many cases, lethal removal is socially unacceptable and wildlife agencies are asked to translocate urban deer. Aside from mortality from capture related stress (capture myopathy), moving urban deer can be expensive, logistically challenging, and may spread wildlife diseases to healthy deer herds where the animals may be released. Cost-benefit analyses should be conducted prior to translocation efforts, and disease histories and risks should be factored into the decision making processes (WAFWA 2014). Wildlife agencies should do all they can to prevent the spread of disease, particularly chronic wasting disease. Translocating deer involves a great amount of risk and could have negative biological impacts on deer populations if disease is spread from one population to another.

Fertility control is another socially popular alternative to culling and translocation. These efforts are expensive, highly invasive, logistically challenging to implement, and not entirely effective (WAFWA 2015).

Defining Success in Urban Deer Management

Identifying the challenges of cities and wildlife agencies is an important first step in addressing urban deer issues. Cities and wildlife agencies need to work together to identify the challenges of urban deer and jointly craft solutions that are acceptable to all.

Urban deer management has three main components: 1) determining where we are, 2) identifying where we want to be, and 3) bridging the gap between the two places.

Determining “where we are” often involves an understanding of the densities and growth rates of deer are in a given area, the number of deer/vehicle collisions, the amount of property damage that is occurring, and the social tolerance of citizens towards deer.

Identifying "where we want to be" involves determining what success looks like for a given municipality. Wildlife agencies should work with cities to define goals and objectives in some form of management or action plan. Examples of defining success can involve working towards reaching a socially acceptable deer density, reducing deer/vehicle collisions and property damage (e.g. deer eating flowers or plants in gardens), and surveying the public to obtain their opinions.

When defining success, wildlife agencies should work directly with elected officials when possible because they represent the voice of the citizens. Having elected officials help determine a socially acceptable number of deer for a given city will help wildlife officials know how to best address urban deer issues, and it will provide direction when neighboring landowners disagree about how many deer should be in a given area.

Determining how to "bridge the gap between the two places" involves selecting a strategy to reduce urban deer and reach management goals and objectives. Each strategy has benefits and drawbacks, and they should be carefully considered before being implemented.

If communities and wildlife agencies are going to make progress towards solving urban deer challenges, they must communicate well and work together in a true partnership. Determining what success looks like and implementing agreed upon strategies to achieve goals are important components to addressing urban deer issues.

Biology of Deer in Populated Areas

Wildlife populations residing in human populated areas face stresses that differ from their counterparts in rural settings (Ditchkoff et al. 2006). Due to these stresses, wildlife living in populated areas may modify their behavior or life-history strategies to successfully avoid or cope with the different stresses. For deer, behavioral modifications may include shifts in habitat use, diets, feeding behavior, movement patterns, and home range sizes while life-histories may differ in reproductive rates, survival, and disease transmission rates.

Behavioral Adaptations

Although deer appear to avoid human disturbance when possible, they easily habituate to human development and readily use residential areas that contain sufficient cover (Swihart et al. 1995, Kilpatrick and Spohr 2000). Compared to their wildland counterparts, deer in human populated areas make use of vastly different habitat types such as golf courses, lawns, and ornamental shrub rows. With the human development, anthropogenic food sources (e.g., wildlife feeders, gardens, ornamental plants) are introduced on the landscape and deer modify their behavior and movements to exploit these artificial food sources. For example, suburban deer in Connecticut browsed more heavily near houses, which was attributed to the anthropogenic food sources found near the human dwellings (Swihard et al. 1995).

In general, size of deer home ranges decrease as development and human dwellings increase (Kilpatrick and Spohr 2000, Grund et al. 2002, Storm et al. 2007, Hygnstrom et al. 2011). This could be a result of habitat composition and configuration across the rural-urban gradient and an increase in movement barriers (e.g., highways, railroads, housing developments, and fences) as human development increases (Grund and Woolf 2002, Storm et al. 2007, Wakeling et al. 2015). Wildlife living among developed areas may be forced into smaller home ranges due to limited access to smaller patches of suitable habitat (Ditchkoff et al. 2006). Alternatively, deer living in developed areas may be able to exploit higher concentrations of food and other resources which allow them to decrease their home range sizes while meeting their annual needs (Tufto et al. 1996, Kie et al. 2002, Saïd and Servanty 2005).

Similar to deer in rural settings, movement of deer in developed areas varies by season. During the non-growing season (fall, winter), deer move more than they do during the growing seasons (spring, summer) (Storm et al. 2007, Walter et al. 2010). As food becomes scarcer during the non-growing season, deer increase their movements. Difference in movement may be greater for deer in developed areas as they travel further distances to find suitable resources during the non-growing season. Additionally, deer in populated areas tend to shift their movements toward dwellings in the winter (Vogel 1989, Cornicelli et al. 1996, Kilpatrick and Spohr 2000, Grund et al. 2002. Storm et al. 2007); this can be partially explained by the supplemental food sources and the radiant heat and wind breaks provided by homes (Swihart et al. 1995, Grund et al. 2002).

Biological Adaptations

Densities of deer in areas with higher human densities are typically greater than densities in undeveloped landscapes and areas can become overpopulated due to a lack of natural predators, reduced hunting pressure, increased recruitment, and favorable habitat conditions. Due to the anthropogenic food sources, resources may be less limiting for deer in populated areas and individuals may be in good health despite high population densities (Etter et al. 2002, DeNicola et al. 2008). Further, urban landscaping often provides a constant source of food for the deer and deer within urban areas, especially when at medium-low deer densities, tend to be in optimal health.

As nutrition improves, wildlife reproductive rates increase and result in higher offspring survival, and ultimately greater densities (Robbins 1993). Because of the favorable conditions, deer may experience higher reproduction in urban settings than in rural populations (Etter et al. 2002). This could be attributed to the artificially abundant food sources which allow females to reproduce without the density dependent effects experienced in nonurban landscapes. However, barriers to movement and other stresses may affect deer breeding success and offspring survival (Wakeling et al. 2015). Ditchkoff et al. (2006) documented a high rate of fawn abandonment near populated areas, possibly as a result of human disturbance.

Because of differences in hunting pressure, road densities, and predator ecology, deer experience different rates of mortality in rural, exurban, and suburban areas. Deer survival in populated areas is typically higher than rates in rural landscapes due to lack of hunting and natural predators (Bateman and Fleming 2012, Etter et al. 2002). This difference in survival rate is greater for male than female deer because male deer are generally hunted by humans to a larger extent.

Deer in human populated areas are often buffered from natural limiting factors that their counterparts experience in rural and wilderness landscapes. In developed areas, deer often face less pressure from predators and have ample food. However, deer near human populated areas face a different suite of stresses, predators, and obstacles. Anthropogenic factors such as deer-vehicle collisions, entanglement in lawn structures, drowning in pools, and attacks by domestic dogs may account for alternate mortality for deer in populated areas (Harveson et al. 2007).

Deer-vehicle collisions are the principle cause of mortality in areas where deer and humans coexist (Etter et al. 2002, Wakeling et al. 2015). As road density increase, deer vehicle collisions make up a larger portion of deer mortalities (Forman and Alexander 1998). Although does are killed by vehicles in proportion to their availability on the landscape, bucks are killed at a higher rate than their availability because of the increased buck movements associated with breeding seasons (Olson et al. 2014, Wakeling et al. 2015).

Although natural predator densities may be lower in human dominated areas than in rural habitats, human pets may prey on wildlife at rates similar to natural predators (Ditchkoff et al. 2006). Additionally, Ditchkoff et al. (2006) found that coyote predation on white-tailed deer neonates in urban areas exceeds rates found in rural areas. In deer populations that artificially or naturally exceed carrying capacity, abundant deer can reduce hiding cover for neonates and increase their predation risk, which may lower fawn survival (Piccolo et al. 2010). For fawns in one overpopulated area, the primary cause of mortality from birth to 14 days was emaciation, whereas coyote predation was the primary cause in older fawns (Sams et al. 1996). Low fawn survival may explain why some high density populations in developed areas do not experience growth despite high adult survival and fecundity (Etter et al. 2002).

Disease and Environmental Differences

Land use and land cover alterations have changed the amount and configuration of habitat available to wildlife. In the West, much human development occurred on deer winter range where deer congregate seasonally; development restricts the available habitat in these seasonal areas with high deer densities and further concentrates deer into smaller areas. Local factors such as gardens, desired ornamental shrubs, and artificial feeding around residences can also concentrate deer at relatively few locations on the landscape and result in smaller home ranges for local populations. Large numbers of animals in close proximity for extended periods of time increases the likelihood of exposure to any diseases that individual deer may carry.

The landscape changes in developed areas may accelerate contact rates with infectious agents and influence the dynamics of disease transmission (Ditchkoff et al. 2006, Joly et al. 2006, Miller et al. 2007). As a result, deer disease prevalence in human populated areas can be greater than that found in rural landscapes and can become a major source of mortality (Ricca et al. 2002, Ditchkoff et al. 2006).

Because deer survival is typically higher in populated areas where hunting pressure is low and predator populations are reduced, infected deer may live longer, allowing more time to shed infectious agent. Additionally, infected carcasses may last longer on the landscape allowing the disease more time for transmission.

Prevalence of chronic wasting disease (CWD) was almost twice as high in developed areas than in undeveloped landscapes (Farnsworth et al. 2005). Because development tends to reduce hunting pressure and increase survival, adult deer, particularly adult males, tend to live longer in human developed areas. Because of this, males were 2–2.5 times more likely to test positive for CWD in human populated versus rural landscapes while the difference in CWD prevalence was relatively insignificant for females.

High deer densities and concentration areas, such as that resulting from human development and supplemental feeding, are factors that most likely resulted in the establishment of self-sustaining bovine tuberculosis (TB) in a free-ranging deer population in Michigan (Schmitts et al. 1997). The unnatural concentrations and close contact that results from human development and artificial baiting provides ideal conditions for the transmission of bovine TB through inhalation of infectious aerosols and ingestion of contaminated feed (Whipple and Palmer 2000).

Role of Wildlife Agencies in Managing Deer

The basic tenet of North American wildlife law is the Public Trust Doctrine which affirms that, while natural resources, such as wildlife, belong to the public, government is the entity entrusted to manage wildlife for the conservation and sustainability of that renewable resource and for the benefit of current and future generations. State fish and wildlife boards and commissions set laws and regulations to manage deer as trustees according to this doctrine, and employ the experts that collect the data and provide recommendations pertinent to each state's deer population as trust managers. State fish and wildlife agencies are the best resource for providing biological data, local effects of deer on the environment, laws pertaining to wildlife, advice on how to determine if there is a deer overabundance issue, and the options to address issues. State agencies also monitor the health and disease status of the deer herd,and issue any permits necessary for various management activities such as contraception and sterilization, capture and tagging, translocation, culling, and hunting. However, the public is entitled to hold the trustee responsible for its efforts in managing wildlife and may redress against management actions.

Many states have specialized programs or regulations for managing overabundant deer where hunting is not practical or desirable. There is often a wealth of information on the state agency's website on options for addressing deer from a homeowner and a community perspective. The state wildlife agency may have staff available to a municipality to provide educational presentations, review information and data pertaining to the issue, and to answer questions on management options.

Although state agencies are the experts in deer management and the best source of information, the community and the community leaders generally determine the social carrying capacity of the wildlife. If problems are detected, the community should work with the wildlife agency to develop an objective and methods to achieve that objective.

Deliberative discussions are needed to assess local community values, economic effects, available science, and resident feedback. These conversations are often emotional, and reaching consensus may be difficult and time-consuming. State wildlife agencies can guide communities in methodologies to gather resident opinion through non-biased surveys and in the estimation of deer populations. No single deer density estimate will be acceptable in all situations, and indices of conflict may be more suitable to measure and manage in some instances. Some indices include: levels of deer-vehicle collisions, property damage, environmental degradation, incidence of Lyme disease, and tolerance levels of residents.

Generally, communities require a substantial amount of time to reach the point of consensus and plan development. Implementation actions to address overabundant deer could be a year or two away, which allows deer populations, which can double every other year, to continue to grow in the interim. The amount of human resources will depend on the selected management activity; some programs can rely primarily on volunteers while others require municipal employees. Each community should assist in selecting the best option for their community. Deer management will require annual maintenance. Deer will continue to reproduce and immigrate from surrounding areas. Any deer management program should be evaluated annually for progress toward objective, revisions to improve efficiency, and

The Northeast Section of The Wildlife Society, in their position statement entitled Managing Chronically Overabundant Deer, suggests the following steps to formulating a deer management plan in developed areas:

1. Identify positive and negative deer impacts
2. Define objectives to measure progress towards alleviating or eliminating negative impacts and continuing or enhancing positive impacts
3. Collect data on problematic deer impacts
4. Review management options
5. Invoke decision-making process – legal, social, logistical, and economic
6. Develop and implement a communication plan
7. Ensure state wildlife agency and local government agencies have the ability to authorize regulated harvest where special local hunts may be needed and enhance management authority where possible
8. Identify permitting requirements
9. Implement management actions
10. Monitor changes in deer impact levels
11. Review and modify management actions

current biological and social conditions.

Population trend is the directional movement in relative abundance or other key parameters through time (sensu Skalski et al. 2005),and is discussed with great detail as applies to deer monitoring in Keegan et al. (2011). Trend indices are measures that are presumed to correlate with population abundance (or other parameters); thus, trend indices may indicate whether a population has increased, declined, or remained stable over time, if certain assumptions are met. Trend indices are also sometimes used to infer magnitude of annual changes, and, if collected over multiple years, trend indices can also be analyzed to provide a quantitative estimate of magnitude of population change by linear or nonlinear modeling. Trend indices can be either direct (involve direct counts of deer) or indirect (involve counts of indirect evidence of deer presence, such as scat or tracks).

Despite widespread use of trend indices in wildlife management, there is much uncertainty regarding usefulness of these indices (Anderson 2001, Williams et al. 2001, Lancia et al. 2005), including debate as to whether they should be used at all (Anderson 2001, Williams et al. 2001). Also, statistical power of trend indices to detect an actual change in population abundance is often very low. Consequently, changes in population size often have to be quite large (e.g., halving or doubling of the population) to be detected by trend indices. Similarly, statistical theory underlying trend indices has received very little study (Skalski et al. 2005). Despite these questions, trend indices are frequently used, primarily because of cost-efficient application over large geographic areas and challenges involved in developing valid estimates of abundance.

Trend indices are most frequently used to index changes in population abundance, although they may also be used to index trends in age structure, adult sex ratios, or productivity or recruitment ratios. Whereas a great variety of trend indices exist, the underlying assumption is that there exists a homogenous (across time, habitats) and proportional relationship between a change in the trend index and a change in abundance or other population parameter. Thus, before using any trend index managers need to consider 3 key questions:

1. Does a change in abundance result in a change in the index?
2. What is the relationship between deer abundance and the index? Frequently, the relationship is assumed to be linear, but often is not.
3. Are the data for the index collected consistently over time and is the sampling representative of the population? Both of these must be true for a trend index to have any real relationship to abundance.

The primary problem with most trend indices is the relationship between the index and abundance has not been determined. Despite this, trend indices are often treated as if they accurately and precisely reflect population abundance even though such a relationship has not been demonstrated. Because of this uncertainty, trend indices are most correctly applied only to determine a relative (as opposed to absolute) change in abundance. A second important problem among trend indices is difficulty in meeting assumptions. Failure to meet explicit assumptions or apply methods to account for unmet assumptions may result in failure of an index to adequately reflect change in populations.

For most trend indices, the relationship between index and deer abundance is not only unknown, but also likely not consistent. Rather, it varies over time and among areas due to changes in environmental factors (season, habitat, weather, deer behavior), human influences (hunter behavior, differing observers), and sampling protocols (sampling effort, plots vs. belt transects). A variety of techniques are used to deal with this variation, which cause violation of the assumption of a homogenous and proportional relationship between abundance and the index. First, sampling strategies are frequently systematic or stratified random as opposed to purely random. These former sampling strategies attempt to account for vegetation type or other environmental attributes varying among survey areas or times. By blocking surveys according to these differences, the overall index should better represent the entire population.

Systematic or stratified random surveys are also often easier to implement than completely randomized designs, especially when surveys are associated with roads or trails which are not randomly located across the landscape. A potential negative effect of systematic sampling is you may not capture all of the environmental variation across the landscape due to your sampling not being random. However, this problem can be overcome by ensuring stratification (blocking) includes all relevant variables in the stratification (e.g., all habitats likely to be used by mule deer). A second way to deal with environmental variables that may affect the relationship between abundance and index includes standardization of survey methodology, which is most often used to account for weather and observer effects. Third, important environmental factors can be included and accounted for in models to relate abundance to the index under "constant" conditions.

Many trend indices (such as pellet-group counts, harvest-per-unit-effort, track surveys,) have been extrapolated to provide estimates of population abundance, creating considerable overlap between trend indices and abundance estimators. Methods most commonly used as abundance estimators require additional assumptions for extrapolation from index to abundance that is beyond this discussion of trend indices and will be covered in the Abundance and Density section.

Minimum aerial counts and classification. — A minimum count represents the absolute minimum number of deer known to be present in a given area (while recognizing an unknown proportion of the population was not seen or counted). Counts and classifications are frequently accomplished through helicopter or fixed-wing surveys; however, several other techniques (e.g., ground counts, spotlight counts) can also yield minimum counts. Counts are often standardized to effort, such as numbers seen per hour of flight time or miles of survey route.

Advantages

- Sample sizes obtained from aircraft, and thus minimum estimates, are usually much greater than from ground-based methods.
- Helicopter counts presumably provide more accurate counts and sex and age classification than do ground-based counts because of independence of roads, ability to observe deer in inaccessible areas, longer observation times, closer proximity to deer, and ability to herd deer to provide optimal viewing opportunities (however, observing undisturbed deer from the ground with enhanced optics also allows accurate classification). This may not be true if substantial vegetation cover significantly obscures deer or allows only "fleeting" glimpses of deer.
- A segment of the public strongly favors census and minimum counts over samplebased population estimation. Sample-based estimates are frequently called into question and dismissed by the public if they do not mirror perceptions.
- Provides an absolute minimum population estimate which is understood and accepted by the public (sampling techniques, statistical inference, and probability are poorly understood by many constituents).

Note: the last 2 bullets represent challenges to agencies in educating constituents about the value of sampled-based methods.

Disadvantages

- There are very few cases where mule deer census is possible. Radiomarking studies have shown even very intensive efforts covering 100% of an area fail to account for all individuals due to concealment or observer factors (Bartmann et al. 1986).
- Costs are high compared to most other indices.
- Cost for a census would be prohibitive except for small, mostly confined areas.
- Although presumed to be more accurate than ground-based methods, validation is lacking, particularly for fixed-wing aircraft.
- Significantly more hazardous for biologists than ground-based methods.
- Minimum counts are frequently smaller than annual harvests, causing the public to question survey data and permit allocations.
- Motion sickness or marginally skilled pilots can result in poor viewing opportunities and highly biased data (e.g., large proportions of groups flee to cover before classification).
- Relationship to true population size often unknown or uncertain.

Assumptions

- Census – all members of the population in a given area are detected and accurately counted.
- Minimum count – members of the population counted in a given area are representative of the actual population.
- If minimum counts collected across time, a consistent proportion of the population is counted.
- If population components are separated, sex and age classes are correctly identified.
- Detectability is similar across sex and age classes, or counts are conducted during biological periods where free intermixing occurs between target sex and age classes (Samuel et al. 1987, Bender 2006).

Techniques

Both population censuses and minimum counts are usually conducted from either helicopter or fixed-wing aircraft, with flight protocols (such as airspeed, altitude above ground level, and spacing of transect lines) and observer behavior (including number of observers, direction of observation, and width of transect lines observed) held constant among surveys. Because population census is seldom feasible for free-ranging deer, remote sensing techniques are being evaluated to increase efficiency and improve detection rates (Lancia et al. 2005). Experimental techniques that have been tried include use of aerial photographs to obtain counts of concentrated individuals or thermal imaging. Forward looking infrared (FLIR) sensing has been used for a variety of ungulates with limited success outside of smaller or enclosed areas (Dunn et al. 2002, Drake et al. 2005). Additionally, remotely operated vehicles (ROVs) are being explored as a means to decrease risks to biologists (K. Williams, U.S. Geological Survey, personal communication). However, remote methods seem to have limited applicability, particularly with respect to classification.

Minimum aerial counts are the most commonly used trend index for mule deer. Minimum counts are frequently converted to estimates of population abundance in 1 of 3 ways:

1. Correcting counts for different likelihoods of observing deer based on habitats.
2. Altering size of sampling units based on habitat (Bartmann et al. 1986, Freddy et al. 2004).
3. Assuming all deer along the aerial transect were seen and estimating the width of the transect using distance sampling methods to correct for varying detection probabilities based on habitat, transect width, or other variables.

Uncorrected aerial surveys flown with consistent flight protocols to ensure consistent and near total coverage of sampled areas are converted to deer observed/unit area or deer observed/hour to obtain a population index. Aerial counts for population trend, as contrasted with counts used solely for sex and age composition, usually have much more specific survey protocols, similar to those required for abundance estimators such as sightability models. Despite this, as with sightability models and similar methods, estimates will always be negatively biased because topography and other visual barriers will prevent complete observation of survey units.

Spotlight surveys and ground counts.—Spotlight surveys and ground counts are similar, with spotlight surveys representing a special case of ground surveys. Spotlight surveys are conducted at night when deer may be less reluctant to use open habitats or areas adjacent to roads (Harwell et al. 1979, Uno et al. 2006). Both spotlight surveys and ground counts are used to collect minimum count and herd composition data. Typically, routes are standardized, replicated, and usually conducted from motor vehicles (especially for spotlight surveys); ground counts may be conducted on foot or from horseback as well. Surveys can be based on continuous observation along a route or restricted to observation points. Distance sampling methods, including stratification by habitats, are occasionally used to extrapolate minimum counts to abundance estimates.

Advantages

- Easy to conduct, inexpensive compared to aerial surveys, and can cover large geographic areas.
- Produce F:D ratios similar to those from aerial surveys (Bender et al. 2003).

Disadvantages

- Roads do not occur randomly across the landscape and their location likely biases proximity of deer (e.g., may be along a riparian area).
- Buck age structure and sex ratio data likely biased because of poorer sighting conditions and behavior of bucks as compared to helicopter surveys.
- Detection probabilities vary with habitat conditions, weather, observers, disturbance.
- Amount of traffic along trails or roads can affect proximity of deer.
- Sample sizes usually low compared to aerial surveys.
- Low light capability of optics influences results.
- May generate disturbance to adjacent human residents and frequent reports of illegal hunting.

Assumptions

- Sample is representative of the population.
- Index reflects changes in population size rather than changes in deer distribution or detectability.
- Roadsides or trailsides representative of area in general or non-changing over time, or surveys stratified by habitat.

- Deer are equally observable every time the survey is conducted (e.g., vegetation screening between seasons or years is not variable).
- Methods consistent among years and groups counted without error.
- Sex and age classes correctly identified and have similar detectability.
- Observers are equally skilled.
- Extrapolation to population size or density requires further assumptions outlined under distance sampling and sightability models in the Abundance and Density section.

Techniques

Methods used include horseback counts, hiking counts, and counts from motorized vehicles. Ground counts can involve riding, driving, or hiking along a route or between observation points. Surveyors move along a standard route, traveling from one location to another that provides a good vantage point for searching for deer. If using specific observation points, after spending a specified amount of time at an observation point, the observer moves farther along the survey route until the next observation point is reached. Survey data can be interpreted as minimum numbers counted, numbers observed/mile, or used as inputs into distance sampling models to estimate abundance.

Spotlight surveys are usually conducted in habitats that are representative of the unit or area being surveyed. They are conducted shortly after dark, when deer are active and may be less reluctant to use areas close to roads. A driver navigates a vehicle along a permanently established route, while an observer (or 2) shines a spotlight along the side of the route and records all deer seen and classifies deer by sex and age class. Typically, number of deer seen/mile of route serves as an index to deer abundance and sex and age composition provides trend information on population demographics. Data are occasionally used as inputs in distance sampling models. However, managers should recognize deer distribution is likely not independent of roads and a rigorous sampling approach is necessary.

For both ground and spotlight surveys, routes are usually repeated several times each year to account for variability in survey conditions and reduce the chance of an unusually high or low count being used to index population trend. Occasionally, the highest total among replicated surveys is used to index the population as it reflects the minimum number of individuals known to be present.

Harvest per unit effort (HPUE).— Harvest per unit effort scales total harvest by some estimate of hunter effort, most commonly number of hunters or number of hunter-days (i.e., the total number of days hunters actually spent hunting). As the estimate of effort becomes more refined (hunter-days instead of hunters), the trend estimate is considered more sensitive to changes in abundance.

Advantages

- Relatively easy and inexpensive to collect effort data through harvest surveys.
- Presumably more accurate than harvest uncorrected for effort.
- Strong empirical background in fisheries management.

Disadvantages

- Subject to response distortion biases present in social surveys.
- Vulnerable to changes in hunter behavior.
- Influenced by changes in deer vulnerability (e.g., weather conditions, road closures, hunter access, antler restrictions, allocation among weapon types, rutting behavior of bucks).
- High hunter densities may cause interference in harvest rate and bias HPUE estimates.
- Low hunter densities, limited-entry harvest strategies, and mature-buck management strategies can result in significant hunter selectivity and thus decouple any relationship between HPUE and deer density.

Assumptions

- Harvest and effort data are accurate and unbiased.
- Population closed during hunting season except for harvest removals.
- Probability of harvest constant during the season (can be corrected for differential vulnerability among areas).
- Harvest is proportional to population size.
- Effort measure is constant (i.e., hunters equally skilled).

Techniques

Harvest and effort data are most commonly collected from hunter surveys or check stations. The HPUE index, such as 0.05 deer harvested/hunter-day, is often used as a stand-alone trend index to compare changes within a management unit and is considered to be more reflective of actual changes in population abundance than harvest alone because of the accounting for hunter effort (Roseberry and Woolf 1991). However, HPUE does not account for variation in harvest rates due to effects of weather or other factors that could impact harvest. Hence, running averages across multiple years are often used to reduce effects of annual variation in these factors. Comparisons among management units differing significantly in habitat is a problem, because HPUE reflects both abundance and vulnerability of deer, and vulnerability can change significantly with the amount of security cover. Roseberry and Woolf (1991) found some HPUE models to be very useful for monitoring white-tailed deer population trends based on harvest data.

Total harvest.— The simplest trend index is an estimate of total harvest. This index assumes encounters between hunters and deer, and thus harvest, increase as deer abundance increases and decline as abundance declines.

Advantages

- Data easily and frequently collected, primarily from surveys of hunter effort and harvest.

Disadvantages

- Annual variation in harvest estimates can be extremely high and thus provides limited inference for population trend.
- Vulnerability to harvest changes with changes in hunter behavior (e.g., regulation changes, equipment changes).
- Vulnerability to harvest changes with environmental conditions (e.g., weather conditions, changes in access, habitat changes).
- Harvest rate varies with hunter and deer density.
- Many potential sources of bias (response distortion) in hunter questionnaires, which are frequently not accounted for.
- Often estimated without variance, thus providing no basis for statistical inference.
- Often of poor or unknown accuracy.
- Generally more effective with very intensive buck harvest strategies such as open entry seasons.

Assumptions

- Harvest data are accurate.
- Harvest is proportional to population size.
- There is no response or non-response bias if collected through hunter questionnaires.
- Harvest rate (proportion of population harvested) is constant among areas or time periods being compared.
- Population is closed during hunting season except for known harvest removals (e.g., no in-season migratory movements).

Techniques

Harvest data are most often collected via hunter surveys or, less commonly, hunter check stations. If season length and other harvest regulations are the same among seasons, then total harvest alone is often used as a trend index within management units. Because of the substantial influence of habitat on deer vulnerability, total harvest should not be used as an index among dissimilar management units. As limitations on harvest increase relative to deer abundance (e.g., reducing hunter numbers through limited entry), value of harvest as an index declines. Thus, because female harvest is often more limited, harvest indices are generally based on buck harvest. If season lengths vary, harvest may be modified to harvest/day or daily harvest modeled as a function of season length or numbers previously harvested, with the latter used to estimate population abundance (Davis and Winstead 1980, Lancia et al. 2005). Age-at-harvest data are used in many population reconstruction models (Williams et al. 2001, Gove et al. 2002, Skalski et al. 2005).

Track surveys.— Track surveys involve counting numbers of individual tracks or track sets that cross a road or trail, usually with direction of movement limited to one- way to reduce double counting (McCaffery 1976). Surveys are usually conducted following clearing of roads or trails of old track sets by dragging or following snowfall that covers previous tracks. Data are used most commonly as a relative index or minimum count, but can be used to calculate densities (Overton 1969).

Advantages

- Simple to conduct, relatively inexpensive, and cover a large geographic area.
- May be used for preliminary sampling to implement a more robust method.

Disadvantages

- Limited rigorous validation.
- Difficulty in distinguishing among individuals or species if several ungulate species are present.

- Dependent on activity levels and movement patterns.
- Very dependent upon proper weather or substrate conditions for accurate counts.
- Multiple counts of the same individuals very likely.
- Mild weather conditions that minimize use of winter ranges in some years may result in unreliable data.
- Number of individuals may be indiscernible when deer travel in groups. Assumptions
- Methods consistent among years and groups counted without error.
- Index reflects changes in population size rather than changes in deer distribution or activity levels.
- Extrapolation to population density requires further assumptions (Overton 1969).

Techniques

Tracks are most commonly counted along dirt or sand roads, which are dragged before counting, or during deer migrations, usually when leaving winter ranges. In the former, roads are dragged to obliterate any tracks that are present; then routes are revisited after some time period (often 1 week, assuming no disturbance to survey substrate, e.g., rain that washes away tracks) and number of track sets counted. The index is usually presented as number of track sets/mile if collected over the same amount of time annually, but can be converted into density by making several assumptions about deer movement patterns (Overton 1969). For winter range counts, survey routes are established so they run essentially perpendicular to travel routes between winter and spring ranges. These survey routes are then counted periodically after the start of migration to spring ranges (WGFD 1982). Only deer tracks moving away from winter ranges are counted, with counts run after fresh snowfall or after dragging routes to clear existing tracks. The index in this case is usually presented as the minimum number of individuals counted or number of tracks/mile if routes are run for the same time period each year (usually the entire migration period).

Pellet counts.— Pellet group surveys involve counting the number of fecal pellet groups encountered in plots or belt transects. Mean number of groups can be used as a trend index or is occasionally converted to estimates of population size by integrating defecation rates and number of days indexed (Marques et al. 2001). Pellet group counts for population trend are most frequently conducted on winter ranges. Because habitats are not uniform and pellet group distribution depends on relative habitat use, pellet group transects are most often stratified among vegetation types (Neff 1968, Härkönen and Heikkilä 1999). For greatest accuracy, permanent transects that are cleared of old pellet groups after each survey should be used to eliminate confusion in aging pellet groups.

Advantages

- Easy to conduct, little equipment needed, can cover a large geographic area.
- Have been correlated with other trend indices including aerial counts and hunter observations (Härkönen and Heikkilä 1999).
- Can provide data on relative use of habitats (Leopold et al. 1984).

Disadvantages

- Power to detect trends frequently low, particularly for low density populations.
- Size and shape of plots (e.g., belt transects vs. circular plots) and sampling effort strongly affect results (Härkönen and Heikkilä 1999).
- Bias associated with inclusion or exclusion of groups lying along plot boundaries.
- Difficult to distinguish species in the field if several species of ungulate are present.
- More appropriate for areas of seasonal concentration such as winter ranges.
- Degradation of pellets varies in different environmental conditions and with populations of scavengers such as dung beetles.
- For abundance estimation, there is little validation of most commonly used daily defecation rates which undoubtedly vary with season, diet.
- Labor intensive to conduct over large area.
- Potential for observer bias in aging pellet groups if transects not cleared after each counting.

Assumptions

- Methods consistent among years and groups counted without error.
- Index reflects changes in population size rather than changes in deer distribution, activity levels, or behavior.
- Extrapolation to population abundance requires further assumptions including 1) constant defecation rates, 2) exact knowledge of time of use in days, and 3) population density uniform throughout range.

Techniques
This method involves clearing permanent plots or belt transects of accumulated pellet groups and returning after a specified time period to count the number of new pellet groups. Number of pellet groups/unit area or transect serves as the index to abundance. Pellet group surveys are often used on winter ranges at the end of winter. Pellet group counts are commonly converted to densities by dividing by number of times a deer defecates/day and number of days plots were exposed. For example, if you assume a deer defecates 10 times/day and after 10 days you find 700 pellet groups/acre, it is assumed 7 deer were present (7 deer × 10 days × 10 pellet groups/day/deer) (Neff 1968, Härkönen and Heikkilä 1999). Although used as a trend index or abundance estimator, pellet group counts are usually more valuable in determining relative habitat use patterns (Neff 1968, Leopold et al. 1984, Härkönen and Heikkilä 1999).

Pellet group data are inherently non-normal in distribution, so more complex analysis techniques are useful in teasing out inferences. The negative binomial distribution (Bowden et al. 1969, White and Eberhardt 1980) is particularly useful for examining pellet group data.

Hunter observation surveys.— Hunter observation indices involve having hunters record the number, and occasionally sex and age classes, of deer seen during hunts. Because hunter numbers and effort can be extremely large and are confined to a relatively narrow time frame, numbers of animals seen and herd composition samples collected by hunters can be large and have been correlated with other independent estimates of population size, trend, and composition (Ericsson and Wallin 1999).

Advantages
- Tremendous number of person-days of effort with little cost to agencies.
- Extremely large sample sizes in some cases.
- Have been correlated with other trend indices and with aerial survey data (for other species).
- Provides hunting public with a sense of "ownership" of population data.
- Provides a method requiring little agency time to corroborate other trend indices.

Disadvantages
- Sensitive to response distortion biases of hunters.
- Untrained observers may not count or classify deer accurately.
- Independence of observations unknown (but can be accounted for if double counts are assumed when constructing confidence intervals around ratio estimates).
- Detection of target species varies among habitats and thus changes in distribution may be confused with changes in population size unless stratified by habitat.
- Relationships between abundance and observation index vary among areas.
- Precision of estimates low or undefined.

Assumptions
- Numbers of deer observed and recorded without bias.
- Sex and age classification correctly identified and reported.
- Number of hunter-days is consistent or observations are standardized per hunter day.
- Hunters equally skilled in detecting deer (for abundance trend only).

Techniques
Hunters are provided data forms and asked to record numbers and sex and age classes of deer seen during their hunts and number of days (or similar measure of effort) hunted. Data are usually converted to a standard measure of effort such as deer seen/hunter-day for the trend index (Ericsson and Wallin 1999). Data for deer seen/hunter-day are usually compared within an area between years to estimate annual rate of change in population size. Because ability to detect (observe) deer varies among habitats, this index (as well as all other direct indices) should not be used to compare management units differing in habitats. Although infrequently used for mule deer, estimates of annual population change and calf:cow ratios obtained from this method have been shown to be similar to aerial survey counts for moose (*Alces alces*, Ericsson and Wallin 1999). These data are much less expensive to collect, suggesting this method may provide a useable index for mule deer management with further development of the technique.

Abundance and Density

Estimates of abundance or density (i.e., abundance per unit area) over broad geographical areas are often desired to empirically manage mule deer populations. Because mule deer are widespread and often inconspicuous, total counts have proven to be impractical, even when localized and in fairly open habitats. As a result, statistically-based sampling methods offer the only realistic way to estimate mule deer numbers on the scale of most management units. Cover and terrain often make deer inconspicuous; therefore, methods used to estimate abundance must account for incomplete detectability of deer in the sampling areas. Based on studies with radiomarked deer and counts of known numbers of deer in large enclosures, detectability is often considerably less than 100% even when the census effort is very intensive (McCullough 1979, Bartmann et al. 1986, Beringer et al. 1998). To help address problems related to widespread distribution and incomplete detectability, abundance and density estimates are usually made during winter when mule deer are more concentrated and more visible against snow cover. Estimates of mule deer abundance and density are further complicated because numbers are dynamic and populations are seldom geographically discrete. Deer are born, die, immigrate, emigrate, and frequently move back and forth across management unit or sampling frame boundaries. Methods for estimating abundance and density must take into account whether the population of interest is assumed to be geographically and demographically closed or open during the sampling period. Population modeling offers an alternative to sample-based population estimation by using demographic parameters such as harvest mortality, sex and age ratios, and survival estimates to predict population numbers. Unfortunately, the public can sometimes be highly skeptical of credible model-based population estimates that do not conform to their perceptions because actual deer are not being counted (Freddy et al. 2004).

Sample-based Methods

Distance sampling.— Distance sampling can be used to estimate number of deer within a fixed distance away from a line or from a point based on distribution of decreasing detection probabilities as distance increases (i.e., deer farther away are harder to see) (Buckland et al. 2001, 2004; Thomas et al. 2010). Distribution of detection probabilities can be estimated based on the assumptions that 1) all deer on the line of travel will be detected or accurately estimated, 2) detection will decrease as distance from the line increases, and 3) deer distribution is independent of sampling design. Population size can be extrapolated from numbers of deer in a sample of line transects or plots that can be stratified by deer density or habitat. Distance sampling for ungulates is usually done along transects from a fixed-wing airplane or helicopter and has been used primarily for species such as pronghorn (*Antilocapra americana*) that occur in relatively flat, open habitats (Johnson et al. 1991, Guenzel 1997, Whittaker et al. 2003, Lukacs 2009). A similar method has been evaluated for mule deer in pinyon (*Pinus* spp.)-juniper (*Juniperus* spp.) habitat in a large enclosure with relatively small bias (White et al. 1989). Use of distance sampling for roadside surveys or spotlight surveys is not recommended because the assumption that deer distribution is independent of transect location is unlikely to be valid when roads are used as transects. Violating the assumption of independent distribution can result in highly biased estimates.

Advantages

- Robust method with relatively few constraining assumptions compared to other methods.
- Provides a probabilistic estimate that accounts for detectability and does not require marked deer if all deer on the line of travel are assumed to be 100% detectable.
- Can be relatively inexpensive if used in fairly open and flat areas where use of fixed-wing aircraft is practical.
- Relatively easy to design and conduct using geographic information system (GIS) software and global positioning system (GPS) units.
- Can be applied to ground mortality transects as well as aerial population surveys.

Disadvantages

- Only realistic in open areas with little terrain relief where deer close to the line of travel are almost 100% detectable. For mule deer, this method would probably be limited to habitats such as upland plains, open agricultural areas, or perhaps some sagebrush (*Artemisia tridentata*)-steppe winter ranges. Even in these habitats, a helicopter would often be required as the sighting platform to achieve acceptable detectability.
- Confidence intervals can be wide (e.g., 95% CI > ±25%) when there is high variability in deer densities between transects within a stratum.
- Dependent on assigning individual deer or clusters of deer to the correct distance interval or accurately determining distance from the line of travel. This can sometimes be problematic, especially with high deer densities.

- Observer fatigue can become an issue during prolonged surveys.
- Can be relatively expensive if a helicopter is used.

Assumptions

- All deer on the line of travel are detected or accurately estimated.
- Distances are accurately measured or deer are recorded in the correct distance band.
- Detection probability decreases as distance from the line of travel increases.
- Deer distribution is not related to transect distribution.
- All deer within a detected group are accurately counted (if group or cluster is the sampling unit). If the individual is the sampling unit, this assumption no longer applies.
- Deer are detected in their original position before any movement related to the survey effort. Deer are not recounted during the survey.

Techniques

Aerial distance sampling for ungulates usually involves:

1. Establishing a set of lines of known length across the area of interest that delineate centerlines of a set of fixed-width transects.
2. Flying along each line while maintaining height above ground level (AGL) as constant as possible (with fixed-wing aircraft the flight path may be offset from the line to compensate for the blind spot directly below the aircraft).
3. Accurately assigning individual deer or clusters of deer to fixed-width bands that delineate specific distance intervals away from and perpendicular to the line of travel.

Transects are usually parallel and systematically spaced across the area of interest with a random starting point. Stratification based on deer density or habitat can be used to help reduce variance. As an alternative to 2 and 3 above, actual distances of deer or clusters perpendicular to the line can be determined using a laser range finder and the sighting angle. However, for species such as mule deer that often occur in numerous, small groups, use of distance intervals rather than actual distances is a much more practical method (Guenzel 1997). Fortunately, little bias usually results from assigning deer to distance intervals as opposed to measuring actual distances (Thomas et al. 2010). Distance intervals can be delineated using strut markers (fixed-wing aircraft) or window markers (helicopters) that have been calibrated for a specific AGL (e.g., usually between 75-300 ft [25-100 m] depending on aircraft type, cover, and terrain) to demarcate distance intervals perpendicular to the line of travel using a specific eye position (Guenzel 1997). The AGL can be accurately measured using a digital radar altimeter or a laser rangefinder mounted on the belly of the aircraft. For each observation, AGL should be automatically saved to a computer to allow distance measurements to be corrected, if necessary, for actual AGL. Effective transect width (i.e., truncation limits) and width of distance intervals depend on predicted detectability (i.e., narrower widths are used as detectability decreases). Four or five distance intervals are typically used to estimate an adequate detection function.

Program DISTANCE was specifically designed to estimate population size from distance sampling data (Thomas et al. 2010). This software:

1. Models detection probabilities as a function of distance from the line of travel when 100% detectability is assumed on the line of travel.
2. Allows covariates (e.g., cluster size, habitat, weather conditions) to be considered in the distance model.
3. Allows mark-recapture data to be incorporated when detection is 200% larger when transects and detection probabilities were used compared to quadrat sampling with a generic sightability correction, leaving doubt as to which method was more biased.

When detection on the line of travel is not certain, simultaneous double counts using 2 independent observers or a sample of radiomarked deer can be used to correct for incomplete detectability (e.g., Kissling et al. 2006). Cluster size bias can occur using distance sampling because, as distance from the line increases, deer in large groups (i.e., clusters) are more easily detected than individual deer or small clusters. Program DISTANCE can correct for cluster bias using regression methods based on the number of deer counted in each cluster relative to their distance from the line.

Strip-transect sampling.— In areas where cover and terrain make distance sampling infeasible, fixed-width (strip) transect sampling can still be used to obtain a minimum count that can be adjusted using generic or survey-specific detection rates based on detectability of marked deer. Population size can then be extrapolated from the sample of strip transects corrected for detection rates. Helicopter line transects have been evaluated for mule deer and white-tailed deer with satisfactory results (White et al. 1989, Beringer et al. 1998). However, Freddy (1991) compared quadrat sampling to transect sampling for mule deer in sagebrush habitat and reported estimates >200% larger when transects and detection probabilities were used compared to quadrat sampling with a generic sightability correction, leaving doubt as to which method was more biased.

Advantages

- Allows transect sampling to be used in some situations where distance sampling is not feasible because of low detectability or terrain.
- Transect sampling designs are relatively easy to lay out with GIS and are easy to fly with GPS units.
- Provides a probabilistic estimate of the number of detectable deer that can be adjusted using detection probabilities.
- Usually does not require handling and marking of deer.

Disadvantages

- Detection probabilities often must be determined using a sample of radiomarked deer which can substantially add to costs. Depending on diversity of habitats being sampled, different detection probabilities may be required for different strata, transects, and even within individual transects.
- Relatively expensive because an aircraft is required and considerable flying may be needed depending on size of the sampling frame, deer distribution, cover, and desired precision. In areas with substantial cover and terrain, transect widths must be reduced.

Assumptions

- Transect width can accurately be determined and deer can be correctly identified as being in or out of the transect.
- Deer do not move out of a transect before detection and they are not recounted in subsequent transects.
- Detection rate estimates are unbiased and accurately represent actual detection rates. Marked deer have the same probability of being sighted as unmarked deer.

Techniques

Transect counts for mule deer are usually flown using a helicopter. Transect width can be delineated by tape on the windows that has been calibrated for a specific AGL height. Unlike distance sampling, there is no need to demarcate distance intervals. Similar to distance sampling, sample transects usually run parallel, are evenly spaced across the area to be surveyed, and have a random starting point. Stratification based on deer density or habitat can be used to help reduce variance. Habitat should be fairly homogenous within each stratum to minimize the number of unique detection probabilities required.

Plot sampling using quadrats.— Quadrat sampling is similar to transect sampling except population size is extrapolated from a sample of randomly selected polygons that are often square and, prior to GPS technology, usually laid out using cadastral coordinates (e.g., section lines). Small (i.e., usually ≤2.6 km^2), intensively surveyed quadrats are used as sampling units in an attempt to improve detectability. Quadrats are usually stratified based on habitat or prior deer density information. Sampling designs can include random, random spatially balanced, and hybrid census and sampling combinations. Quadrat sampling methods for mule deer were described by Kufeld et al. (1980) and Bartmann et al. (1986).

Advantages

- Provides a probabilistic estimate of number of detectable deer.
- Fairly straightforward design that can be laid out with GIS (prior knowledge of deer distribution is very helpful) and flown using GPS.
- Does not require handling and marking of deer.

Disadvantages

- Relatively expensive because a helicopter is usually required and considerable flying may be needed depending on size of the sampling frame, deer distribution, and desired precision.
- Confidence intervals can be wide (e.g., 95% CI > ±25%) irrespective of sample size, especially when deer occur in an unpredictable or clumped distribution.
- Does not include an inherent detectability correction, so actual population size is unknown. Generic sightability factors can be used to adjust the population estimate, but they can be of questionable value because a number of variables can influence

sightability (e.g., group size, cover, terrain, snow cover, time of day).

- When deer densities are high, it can be difficult to keep track of deer that have already been counted.
- Deer may move out of a quadrat in response to the aircraft before they are counted.

Assumptions

- Each quadrat within a stratum that may contain deer has a known (often equal) probability of being selected for sampling.
- Deer are detected at a fairly high rate (e.g., >60%), are not double counted, are not erroneously accounted for by being forced into or out of a quadrat, and are accurately identified as being in or out of a quadrat when close to the perimeter.
- Generic sightability factors accurately represent actual detection probabilities.

Techniques

Quadrat methods often use sampling polygons with small areas (0.25-1 mi2 [0.65-2.6 km2]) to increase detection rates. Smaller quadrats are used in areas with considerable cover such as pinyon-juniper woodlands, whereas larger quadrats can be used in more open areas such as sagebrush-steppe. Using similar-sized quadrats tends to decrease among-quadrat variation, but is not required. In the past, sampling designs were usually based on cadastral section lines, but GIS and GPS units have greatly increased design flexibility. Use of GPS units has also made quadrat sampling much more practical because quadrats can be accurately flown without landmarks. Stratification can be useful for increasing precision and for optimally allocating sampling effort based on expected deer density. When there is sufficient prior knowledge of deer distribution, stratification can most effectively be achieved on a quadrat by quadrat basis rather than by geographical area.

Quadrat methods for estimating mule deer numbers can require considerable helicopter time (e.g., 20-40 hours is typical for management units in western CO, Kufeld et al. 1980). Extensive amounts of flying can cause observer fatigue and result in prolonged surveys because of weather and conflicting work assignments. Use of multiple helicopters and crews is recommended to finish counts in a timely manner under preferred conditions when snow cover is present. Quadrats should be flown by first following the perimeter to identify deer close to the boundary as being in or out. The interior of the quadrat should then be flown with sufficient intensity to count all detectable deer. Even though the quadrat method attempts to maximize detectability compared to sampling using transects or larger area units, unknown detectability remains an obvious issue. Survey-specific detection probabilities could be determined by including a sample of radiomarked deer or using sightability covariates, but the small size of the quadrats and high cost of the quadrat method make this impractical in many cases. In lieu of specific detection probabilities, generic sightability factors developed using radiocollared deer in similar habitats have been used to adjust quadrat population estimates. In Colorado, a sightability factor of 0.67 is typically used for quadrats in pinyon-juniper winter range and 0.75 is used for sagebrush-steppe (Bartmann et al. 1986; Colorado Division of Wildlife [CDOW], unpublished data). For generic sightability factors to be applicable, quadrats should be flown with as many variables as possible similar to those that occurred when sightability factors were developed (e.g., high percentage of snow cover, same number of observers, quadrats with the same area). However, even when effort is made to keep survey protocols as consistent as possible, the validity of using generic sightability factors can be questionable because of the number of variables that can affect detectability (e.g., group size, deer activity, time of day, cloud cover, type of helicopter, experience of observers).

Plot sampling using sightability models.— This method is similar to quadrat sampling except that 1) it includes a model developed using logistic regression methods to account for undetected deer based on a variety of sightability covariates, 2) size of sampling units can be considerably larger than those typically used for quadrat sampling, and 3) sample unit boundaries can be based on terrain features such as drainages instead of cadastral units or GPS coordinates (Ackerman 1988, Samuel et al. 1987, Freddy et al. 2004). A sightability model is developed for a specific survey intensity (i.e., survey time at a given elevation and airspeed per sampling unit area) by relating detectability of radiomarked deer to variables such as habitat, group size, deer activity, screening cover, terrain, snow cover, type of helicopter, and observer experience. Sightability models account for a more comprehensive set of detectability variables than generic sightability factors often used with intense quadrat sampling and allow the contribution that each variable makes to detectability to be evaluated using a stepwise approach. Once the sightability model is developed for a specific survey intensity, covariates supplant the need for determining detection probabilities using radiocollared deer. Even when survey intensity is kept relatively constant, sampling units should be similar in size to help eliminate variables such as increased observer fatigue when larger units are surveyed. Population size can be extrapolated from a set of representative sampling units.

Advantages

- Provides a probabilistic population estimate that includes a sightability correction.
- Once established, sightability covariates are easier and less expensive to measure than detection probabilities.
- Larger sampling units can be flown than with quadrat sampling as long as the sightability model was developed using sampling units similar in size to those being flown and sampling intensity is consistent.
- Larger sampling units are usually less affected by some potential sources of error than small quadrats (e.g., pushing deer out of the sample unit before they are detected, determining whether a deer is in or out of the sample unit, double counting the same deer when densities are high).
- Stratified random sampling of sample units produces precise estimates for lowest costs.

Disadvantages

- High initial costs to develop sightability models. Radiomarked deer must be used to develop different sightability functions for a wide variety of habitats and conditions.
- Relatively high ongoing costs due to extensive helicopter time required to conduct surveys on a management unit basis.
- A sightability model only applies to the specific conditions for which it was developed. Transferability of sightability models to habitats, survey intensities, and conditions different than those used to develop the models is not recommended and could result in highly biased results.
- Variance is likely to increase as detectability decreases.
- Population size can be underestimated if all deer in detected groups are not accurately counted (Cogan and Diefenbach 1998).
- Sampling units based on geographical features such as drainages may not be random, but drawing sampling units under stratified random sampling produces unbiased estimates.

Assumptions

- Probability of detecting deer is >0 and detectability can accurately be predicted using sightability covariates under a variety of circumstances (i.e., model captures all significant variation in sighting probabilities where it will be used).
- Sampling units are representative of the overall sampling frame and those sampling units are analogous to randomly distributed units.
- Deer in detected groups are accurately counted.

Techniques

Unlike quadrat methods that rely on small sampling units to increase sightability, use of sightability covariates allows sampling units to be larger and less intensively flown as long as applicable models have been developed. Sampling units are often defined based on geographical features such as drainages instead of constant-sized quadrats. Similar to quadrat and transect methods, precision of population estimates using sightability models can often be increased by stratifying the sample area by habitat and deer density. Ideally, sampling units should be selected at random or spatially balanced. However, when terrain features such as drainages are to be used as sample units, sample units should be selected to be as representative as possible of each stratum. Population size can be extrapolated from a set of representative sampling units. Sampling units may be stratified according to deer density, thereby reducing variability of a population estimate. All deer in detected groups must be accurately counted to avoid underestimating population size (Cogan and Diefenbach 1998). Sightability survey techniques were described in detail by Unsworth et al. (1994, 1999a).

Mark-resight and mark-recapture.— Mark-recapture methods use the ratio of marked (i.e., identifiable) to unmarked deer in population samples to estimate population size (Thompson et al. 1998). The population of interest must be defined in time and space and identified as being geographically and demographically closed or open. Basic mark-recapture models include the Petersen or Lincoln Index (Caughley 1977) for closed populations and the Jolly-Seber Model (Jolly 1965, Seber 1982) for open populations. These basic models have limited practical value because the assumptions required are usually violated when applied to field situations. To address the need for more practical assumptions, a variety of more complex and flexible mark recapture models have been developed that often require computer-assisted solutions (i.e., no closed form estimator is available). The programs MARK and NOREMARK have been specifically developed for this purpose (White 1996, White and Burnham 1999).

More traditional mark-recapture methods are usually based on sampling without replacement whereby the method of recapture (i.e., being caught in a trap) effectively prevents an individual from being counted more than once per sampling occasion. Although these methods can be very useful for small, inconspicuous, or furtive species, actual recapture is seldom feasible or desirable for more conspicuous large mammals such as deer. As a result, mark-recapture methods that use resighting, with or without replacement, instead of recapture have been developed for more conspicuous species. These mark-resight methods allow relatively noninvasive monitoring instead of actual recapture and subsequent marking of unmarked deer, thereby reducing stress on the deer and costs.

Mark-resight methods have been used to effectively estimate localized mule deer numbers (Bartmann et al. 1987, Wolfe et al. 2004) and newer mark-resight models that incorporate maximum likelihood have improved this method and its potential application to mule deer (McClintock et al. 2009a, b). Unfortunately, mark-resight methods may not be practical for estimating deer abundance on a large scale (e.g., management unit) because of the cost and time required to mark adequate numbers of deer and conduct resighting surveys. As an alternative, quasi mark-resight approaches have been developed that use mark-resight data to calculate correction factors (i.e., detection probabilities) for incomplete counts (Bartmann et al. 1986, Mackie et al. 1998) or that use simultaneous double-counting to obviate the need for marking deer (Magnusson et al. 1978, Potvin and Breton 2005).

Advantages

- Usually considered one of the most reliable methods for estimating abundance of wildlife populations when sample sizes are adequate and assumptions are not critically violated.
- Unlike most other sampling methods, mark-resight methods explicitly account for detectability (even deer with essentially no detectability).
- Multiple resighting surveys (aerial or ground) can be done over time to increase precision and allow modeling of individual heterogeneity in detection probabilities among individual deer (Bowden et al. 1984, Bowden and Kufeld 1995, McClintock et al. 2009a, b).
- Provides a probabilistic estimate of population size and, with some more advanced models, allows some demographic parameters to be estimated.
- Can be applied using a wide variety of distinct marks (e.g., tags, collars, radio transmitters, paint, DNA, radioisotopes, physical characteristics, simultaneous duplicate counts) and resight methods (e.g., motion-triggered infrared cameras, hair snags, pit tag scanners, hunter harvest).

Disadvantages

- Can be expensive and labor intensive to achieve an adequate sample of marked deer, ensure marks are available for resighting, and conduct resighting surveys.
- Usually not practical over a large geographical area with a widely distributed species such as mule deer.
- Although the precision of mark-resight estimates is determined by a variety of factors (e.g., number of marks, detection probabilities, number of resight occasions), confidence intervals can be wide (e.g., 95% CI > ±25% for practical applications.
- Dependent on a variety of assumptions, that if violated, can result in spurious results. Methods with less restrictive assumptions may result in reduced precision and accuracy.
- Marked deer may become conditioned to avoid resighting.
- Some quasi mark-resight methods such as simultaneous double-counts can be much less reliable and inherently biased because of individual deer heterogeneity.

Assumptions (Assumptions vary depending on the estimator being used [White 1996]). Basic assumptions include

- Population in the area of interest is to a large extent geographically and demographically closed unless gain and loss are equal or can be reliably estimated.
- Each deer in the population has an equal probability of being marked and marks are distributed randomly or systematically throughout the population of interest.
- Number of marks available for resighting in the sampling area is known or can be reliably estimated.

- Each deer in the population, marked or unmarked, has an equal probability of being sighted or individual sighting probabilities (i.e., resighting heterogeneity) can be estimated.
- Marks are retained during the resight sampling period.
- Deer are correctly identified as being marked or unmarked when sighted.

Techniques
Most mark-resight population estimates of wild ungulates use radiomarked animals. Radiomarks have the advantages of allowing confirmation of the number of marked deer available for resighting within the area of interest and identification of individual deer. Radiomarks have some disadvantages however (e.g., deer usually need to be captured to attached radios, equipment is expensive, radios can fail). In lieu of radiomarks, a variety of other marks have been used with mixed success for deer including ear tags, neck bands, a variety of temporary marks (e.g., paint balls, Pauley and Crenshaw 2006), and external features such as antler characteristics (Jacobson et al. 1997). Regardless of the marking method, marked deer should not be more or less visible than unmarked deer (e.g., fluorescent orange neck bands could make marked deer stand out more than unmarked deer). Nor should the marking method influence the resighting probability of marked versus unmarked deer (e.g., deer captured and marked using helicopter netgunning may avoid a helicopter more than unmarked deer during resighting surveys). Marks can be generic or individually identifiable. The latter has the advantage of allowing estimation of individual detection probabilities which can greatly improve some models.

Collection of DNA from scat or hair has become an increasingly popular method for identifying individual animals in mark-recapture studies. Use of DNA has the major advantages that deer do not need to be handled for marking, sampling is non-invasive and relatively easy, and the technique can be applied to situations where sighting surveys are not feasible (e.g., densely vegetated habitats or furtive species). Potential downsides include genotyping errors and variable relationships between the DNA source (e.g., fecal pellets) and the deer. Brinkman et al. (2011) used DNA from fecal pellets to estimate free-ranging Sitka black-tailed deer (*O. h. sitkensis*) abundance using the Huggins closed model in Program MARK.

Model choice should be carefully considered before beginning mark-resight surveys because different models are based on different assumptions. Mark-resight models that have been used over the years include the joint hypergeometric estimator (JHE, Bartmann et al. 1987), Bowden's estimator (Bowden 1993, Bowden and Kufeld 1995), and the beta-binomial estimator (McClintock et al. 2006). Bowden's estimator has been one of the most useful mark-resight models for deer and other wild ungulates. Unlike some other models, Bowden's estimator does not assume all deer have the same sighting probability (i.e., allows for resighting heterogeneity), populations can be sampled with or without replacement (i.e., individual deer can be observed only once or multiple times per survey), and all marks do not need to be individually identifiable. More recently, maximum likelihood estimators have been developed with similar practical assumptions. These estimators include 1) the mixed logit-normal model (McClintock et al. 2009b) when sampling is done without replacement and the number of marks is known, and 2) the Poisson-log normal model (McClintock et al. 2009a) when sampling is done with replacement or the exact number of marks is unknown. These maximum likelihood methods have the major advantage of allowing information-theoretic model selection based on Akaike's Information Criterion (Burnham and Anderson 1998). Methods for Monitoring Mule Deer Populations 42 Program NOREMARK was specifically developed to calculate population estimates based on resight data when animals are not being recaptured (White 1996). The program includes the JHE (Bartmann et al. 1987), Minta-Mangel (Minta and Mangel 1989), and Bowden's (Bowden 1993, Bowden and Kufeld 1995) estimators. More recently, the mixed logit-normal (McClintock et al. 2009b) and the Poisson-log normal (McClintock et al. 2009a) mark-resight models have been included in Program MARK along with a variety of other mark-recapture models (White and Burnham 1999, White et al. 2001, White 2008).

A quasi-mark-resight method that can be more effectively applied on a management unit scale, particularly when deer are fairly detectable, is to correct minimum counts for the resight rate of a sample of marked deer (Bartmann et al. 1986, Mackie et al. 1998). This approach does not use the ratio of marked to unmarked deer to estimate population size per se, but rather the ratio of observed marked deer to total marked deer to adjust samplebased estimates for incomplete detectability similar to methods used for correcting transect and sample area counts discussed previously. Mark-resight adjustment factors can be survey-specific (i.e., based on resight of marked deer during the survey) or generic (i.e., based on previous resight probabilities under similar conditions).

Simultaneous double-counting is another quasi form of mark-resight whereby a population estimate is derived based on the ratio of total number of deer counted (marked deer) to number of duplicated sightings (resighted deer) using independent observers (Magnusson et al. 1978, Potvin and Breton 2005). For ungulates, simultaneous doublecounting is usually done from a helicopter or fixed-wing aircraft and can be applied to a wide area because it has the obvious advantage of not requiring marked deer. Two observers in the same or different aircraft independently record the location, time, and group characteristics of all deer observed. For population estimation, this method assumes all deer are potentially detectable and observers are independent. Both assumptions are often questionable and there is inherent bias towards underestimating true population size to an unknown extent, which raises substantial concern about the appropriateness of this approach. In cases where sighting probabilities of deer are low (<0.45, Potvin and Breton 2005) or unknown, simultaneous double-counts are more appropriately interpreted as adjusted minimum counts rather than population estimates. To adjust for the inherent bias of the simultaneous double-count method, the method can be used in combination with a known sample of marked deer or sightability covariates to adjust the estimate for sighting probabilities (Lubow and Ransom 2007).

Thermal imaging and aerial photography.— Thermal imaging and aerial photography frequently appeal to the public as ostensibly practical methods to census wild ungulates. Although these methods have some potential for estimating mule deer numbers under the right conditions, they have often failed to show much advantage over standard counting methods because of highly variable detection rates (Haroldson et al. 2003, Potvin and Breton 2005).

Advantages

- Create a visual record that can be reviewed, analyzed, and archived.
- Do not rely on real time observations that could be in error.

Disadvantages

- Potential inability to 1) detect deer under cover, 2) differentiate deer from the background, and 3) differentiate mule deer from other species.
- Highly variable results that can be influenced by a wide variety of factors.
- Require relatively expensive equipment and flight costs, but often result in little or no benefit over standard counting methods.
- Thermal imaging flights must be conducted within a narrow range of environmental conditions.

Assumptions

- A high percentage of deer can be individually detected and accurately differentiated from other species and inanimate objects.

Techniques

Thermal imaging typically uses a wide-angle FLIR system mounted on a helicopter or airplane. Random or systematic transects are most commonly flown, but a variety of sampling designs are possible. The system can make a video record of the flight that can be reviewed and analyzed at a later date. Thermal imaging cannot penetrate dense vegetation and differentiating deer from inanimate objects is sensitive to temperature gradients and heat loading. Night flights when deer are more likely to be in the open and heat loading is minimal are seldom practical from a safety standpoint. Surveys using FLIR are usually relegated to a narrow window of time after daybreak. Species identification can be problematic in areas where there are other large species such as livestock, elk, white-tailed deer, pronghorn, and bighorn sheep (Ovis spp.). Although FLIR surveys often assume detection probabilities approaching 1, actual detection rates can be highly variable (Haroldson et al. 2003, Potvin and Breton 2005). Therefore, FLIR surveys can have little advantage over visual counts because both methods usually must be corrected for incomplete detectability. Population estimation using aerial photography involves making a photographic record of the area of interest from an altitude that does not cause disturbance to the deer. Use of aerial photographs has had little utility for deer because they are relatively small and seldom in areas with little or no cover. An attempt to use aerial photographs in Colorado to quantify elk numbers in open areas during winter was unsuccessful because individual elk could not be reliably identified (CDOW, unpublished data).

Population Modeling

Population modeling can be used to provide biologically realistic, mathematical simulations of deer populations based on demographic parameters that can be estimated using routinely collected field data. Modeling allows populations to regularly be estimated at a scale that would seldom be feasible with sample-based population methods. There are 2 basic types of population models: cumulative and point-estimate. Cumulative models use a balance sheet approach of adding (recruitment and immigration) and subtracting (mortality and emigration) deer over time from an initial population, whereas point-estimate models predict population size at a single point in time independent of prior history. Cumulative models can be evaluated using objective model selection criteria based on how closely model predictions align with field observations over time and how many parameters are used. Evaluation of point estimate models is generally more subjective or requires comparison with sample-based estimates. Cumulative models allow multiple sources of data to be integrated and considered over many successive years. This can result in a much more data-rich estimate of population size than single-point estimates because all relevant sources of data over time are considered. Because initial population size and the numbers of deer to add and subtract annually are seldom known, cumulative models rely on parameters that are more easily estimated to allow population gain and loss to be calculated. These parameters typically include harvest and wounding loss, post hunt sex and age ratios, natural survival rates, and, in some cases, immigration and emigration rates. In practice, field estimates of some of these parameters are often not available, and even when they are measured, they often contain sampling error as well as process variance (White and Lubow 2002, Lukacs et al. 2009). Therefore, it is usually necessary to roughly estimate or adjust some parameters to better align model outputs with observed values. Most cumulative population models for deer are based primarily on alignment of modeled and observed post-hunt B:D ratios. Cumulative models work the best when 1) the data set extends over several years, 2) field data are unbiased, and 3) adult male harvest rates are fairly high. All models are dependent on the quantity and quality of data used. The public and some wildlife professionals can often be highly skeptical of modeled population estimates for mule deer (Freddy et al. 2004). Although there can be legitimate reasons for this skepticism, it is too often focused on how models work rather than quality of data going into models, with the latter being a crucial component. In addition to their use for estimating population size, population models can also be useful for predicting outcomes of different management actions, evaluating density-dependent effects, and understanding effects of stochastic events on population dynamics.

Damage Control Methods

Two fundamentally different approaches may be used to address overabundant deer: damage control and damage mitigation. Damage control deals with the management of the damage inflicted by overabundant deer, whereas damage mitigation deals with methods to reduce the numbers of the overabundant deer. Because deer become overabundant in response to anthropogenic resources, damage control measures may limit access to resources and result in mitigation of deer abundance.

Many methods exist to manage damage resulting from high deer densities in urban situations. In most cases, use of multiple methods usually increase the success of damage control measures. For deer management in urban settings to be successful, attention should be paid to both damage control methods and mitigation techniques. At times, public support may be greater for damage control than for mitigation, but both approaches can help achieve clearly defined objectives more quickly. (Pierce and Wiggers, 1997)

Fencing

Fencing may be constructed to create a physical barrier which will exclude deer from accessing areas where they can cause damage, or they are not wanted. When properly constructed and maintained to assure efficacy, fencing can be an extremely effective damage control technique (Conover, 2001). Fencing may be constructed along a roadway to minimize deer vehicular accidents, but in most cases in populated areas, it is used to protect private property such as gardens, ornamental trees, landscaping or small orchards. Consideration needs to be given to the cost of construction and maintenance of the fencing in comparison to the value of the property being protected.

Wildlife agencies in general will not cover fencing costs. Landowners, municipalities or neighborhood associations should expect to provide the financing to construct and maintain whatever type of fence is chosen.

Many types of fencing and construction techniques are available. An excellent synopsis is found in Curtis et al, 2017. Attention to detail in fence construction and maintenance is critical for fencing to be an effective deterrent to deer damage.

Nonelectric Fencing

Wire fencing that is not electrified can create an effective physical barrier to deer when constructed properly. There are numerous material and construction options including woven-wire, chain-link, barbed wire, or larger diameter high-tensile smooth wire. Common exclusion fencing should not have spikes or spears on posts. Deer can easily become impaled or tangled on these fences. They are not appropriate for areas of medium or high deer densities. Fencing that is not electrified must be tall enough (at least 3 meters) to prevent deer from jumping over. It must also make solid contact with the ground, so deer can't crawl under. It should also be constructed such that the strands are close enough together (8-10 inches apart) and taunt enough (200+ pounds of tension) so that deer can't slide between them. It is also important to maintain an area of cleared ground about 6-10 feet wide around the periphery of the fence, so deer have an opportunity to see the fence before they make contact and potentially damage the fence or harm themselves.

If the goal is to protect a small, single tree, trees can be fenced individually with the use of woven wire type fence that is only 4 feet high, as long as the area enclosed is not large enough for a deer to jump into and the fence is far enough away from the tree to prevent browsing. Larger trees that are browse resistant due to height, can be protected from antler rubbing by using a plastic tree wrap (Vexar ®), tubing (Tubex ®) or a woven wire cylinder.

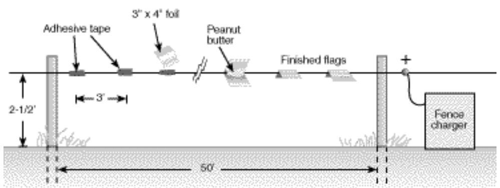
Advantages:
Woven wire fencing constructed of quality components should be expected to last 20-30 years with little maintenance.

Disadvantages:
Initial costs of fencing material and construction are high. Some types of fencing may be prohibited in certain municipalities due to it not being aesthetically pleasing. Professionals are typically needed to install this type of fencing.

Electric Fencing
Electric fences provide inexpensive protection for many gardens. They are easy to construct, do not require rigid corners, and use readily available materials. The fences are designed to attract attention and administer a strong but harmless electric shock (high voltage, low amperage) when a deer touches the fence with its nose. Deer become conditioned to avoid the fence. These fences are easily installed and removed. The major cost associated with temporary

electric fencing is the fence charger. Such fences require weekly inspection and maintenance.

The peanut butter fence has been shown to be an effective and inexpensive fence design in a number of field conditions. It is best used for gardens, nurseries, and yards that are subject to moderate deer pressure. Check the fence weekly for damage by deer and for grounding vegetation.



Peanut butter fence

A single strand of 17-gauge wire is suspended about 30 inches above the ground by 4-foot fiberglass rods at 30- to 60-foot intervals. Wood corner posts provide support. Aluminum foil "flags" (foil squares 4 inches by 4 inches folded over the wire) are attached to the wire at 20- to 50-foot intervals using tape or paper clips to hold them in place. Aluminum flashing can also be used and has the advantage of not being damaged or blown off. Closer spacing may be necessary near existing deer trails and during the first few months the fence is used, when deer behavior is being modified. The underside of the flags is baited with a 1:1 mixture of peanut butter and vegetable oil. The smell attracts the deer, which touch or sniff the flags and receive an electric shock. The flags should be rebaited every 4 to 8 weeks, depending on weather conditions. As deer learn to avoid the shock of the fence, bait can be reduced or eliminated.

The effectiveness of the original peanut butter fence has been greatly enhanced by using polywire or polytape, rather than the 17-gauge wire. It has the advantage of being more visible to deer, especially at night. It is also easier to roll up and remove. Polywire has a life expectancy of 5 to 7 years.

Polywire is composed of three, six, or nine strands of metal filament braided with strands of brightly colored polyethylene. A wider polytape is also available and has the advantage of being stronger and more visible, but also more expensive. Although both polywire and polytape come in a wide variety of colors, many users claim that white provides the greatest contrast to most backgrounds and is easier for deer to see, especially at night. Loss of voltage over long distances of polywire/polytape can be a problem. Purchase materials with the least electrical resistance (ohms per 1,000 ft) for these applications. In its simplest application, an electrified single strand of polywire is suspended about 30 inches above the ground by 4-foot fiberglass rods at 20- to 50-foot intervals and baited in the same way as the original peanut butter fence. This basic design can be enhanced. A second wire can be added to increase effectiveness: one wire placed 18 inches from the ground and the top wire at 36 inches above the ground. This prevents fawns from walking under the fence and also increases the chance that one wire will remain electrified if deer should knock the fence over. Usually only the top wire is baited. In small areas, such as home gardens, more wires can be added on taller poles if desired, and closely spaced bottom wires can keep out rabbits and woodchucks. It is important that vegetation be mowed or removed under the fence so it does not short out.

Fiberglass rods usually do not provide enough support for use as corner posts. At corners it is better to use 4-foot metal fence stakes with a bottom plate that provides stability when it is pushed into the ground. A piece of thin-walled 1-inch PVC pipe can be slipped over the metal stake to act as an insulator with the polywire or polytape wrapped around a few times. This allows the stringing of the wire with sufficient tension to hold the flags. A variety of wooden posts with plastic insulators will also work well.

While single or multiple strands of electric fencing may be somewhat effective (baited or un-baited), electric fencing constructed with an offset of double-fence design (with a taller two-strand fence on the outside and a shorter one strand fence about 38 inches to the inside) is also very effective. This type of electric fence creates a three-dimensional barrier that is both physical and psychological and will discourage deer from jumping over or crawling under to avoid electrocution. As with the peanut butter fence, polywire or polytape should be used for fence construction for maximum visibility to deer.

When using electric fencing in general, at least 3000 volts should be maintained at the farthest end of the fence for effectiveness. An area around the periphery of the fence should be cleared for at least 6-10 feet, so that deer see the fence before making contact.

The use of electric fences in and around home sites can cause concern for children and visitors. One option is to put the fence charger on a timer so that it comes on only from dusk to dawn. This method provides adequate protection in areas where deer are not a problem during the daytime hours. Electric fences should also be signed to warn away unsuspecting wanderers.

Advantages:
Electric fencing tends to be cheaper to construct than woven wire fencing (discussed below).

Disadvantages:
Electric fencing is a bit more expensive to maintain than non-electrified fencing. Weeding is necessary to prevent the fence from shorting out and vigilance is required to remove fallen branches or repair breaks that can render the fence useless. During periods of deep snow, strands of the fence in contact with snow must be disconnected. Also, electric fencing may be prohibited in some municipalities.

Tree Shelters

The tree shelter is a transparent, corrugated polypropylene tube that is placed around seedlings at the time of planting. The tube is supported by a 1-inch by 1-inch wooden stake located next to the shelter. An ultraviolet inhibitor is added to the polypropylene to prevent it from breaking down too rapidly when exposed to sunlight. The shelter disintegrates after 7 to 10 years.

A 4-foot shelter is commonly used and will prevent deer from browsing on tree seedlings. A 5-foot shelter may be needed in areas with excessive browsing or snowfall. The tube has the added benefit of promoting rapid height growth of the seedling by acting like a mini greenhouse.

Repellents

Repellents can help reduce deer damage to gardens and ornamental plants. Repellents are most valuable when integrated into a damage-abatement program that includes several repellents, fencing, scare devices and herd management.

There are two kinds of repellents: contact repellents and area repellents. Apply contact repellents directly to plants; their taste repels deer. They are most effective on dormant trees and shrubs. Contact repellents may reduce the palatability of garden items and should not be used on plants or fruits destined for human consumption.

Area repellents deter deer by odor and should be applied near plants you want to protect. Border applications of area repellents protect larger areas at relatively low cost. Because such repellents are not applied directly to plants, they can be used to protect home garden crops grown for human consumption.

People who utilize repellants should understand several basic principles:

- Repellents do not eliminate browsing, they only reduce it; therefore, repellent success should be measured by the reduction, not elimination, of damage. Even if minimal damage is intolerable, 8-foot fencing is the best option.
- Rainfall will wash off many repellents, so they will need to be reapplied. Some repellents will weather better than others.
- Repellents reduce antler rubbing only to the extent that they help keep deer out of an area.
- The availability of other, more palatable deer food dictates the effectiveness of repellents. When food is scarce, deer may ignore both taste and odor repellents. In addition, deer may become habituated to certain repellants over time, reducing their effectiveness.
- If you use repellents, do not overlook new preparations, products, or creative ways to use old ones. New products are constantly appearing on the market.
- Growers who are facing a long-term problem should compare the costs of repellents and fencing over time.
- Repellents that work in one area may not work elsewhere, even for similar crops and conditions.

<u>Application of commercial repellents</u>
Application methods for commercial repellents range from machine sprayers to manual backpack sprayers. Remember, as labor intensifies, costs rise.
Apply contact repellents on dry days when temperatures are above freezing. Young trees should be completely treated. The cost of treating older trees can be reduced by limiting repellent application to the terminal growth within reach of deer (6 feet above the deepest snow). New growth that appears after treatment is unprotected.

As a preventive measure, the first repellent application should take place within two weeks of budbreak. During the growing season, repellents should be applied as necessary to protect new growth, usually every three to four weeks. For dormant season protection, midfall and early winter applications are recommended. Fall applications may also prevent antler rubbing.

Regardless of the type of application used, every program should be planned in advance and implemented on schedule. Periodic monitoring is essential to determine the necessity and timing of subsequent applications.

Available commercial repellents
The following discussion of repellents may be incomplete, but it indicates the variety of materials available. Repellents are grouped by active ingredient and include a brief description of use, application rates and costs. Product labels provide all necessary information on use and must be followed to the letter to achieve maximum success.

- Putrescent egg solid: This contact repellent smells and tastes like rotten eggs. It has been reported to be 85 to 100 percent effective in field studies. Apply it to all susceptible new growth and leaders. Applications weather well and are effective for two to six months.
- Ammonium soaps of higher fatty acids: This is an area repellent that smells like ammonia and is one of the few registered for use on edible crops. Applications can be made directly to vegetables, ornamentals and fruit trees. Its effectiveness is usually limited to 2 to 4 weeks but varies because of weather and application technique. Reapplication may be necessary after heavy rains.
- Thiram (11 to 42 percent tetramethylthiuram disulfide). Thiram is a fungicide that acts as a contact (taste) deer repellent. It is sold under several trade names. It is most often used on dormant trees and shrubs. A liquid formulation is sprayed or painted on individual trees. Although thiram itself does not weather well, adhesives can be added to the mixture to resist weathering.
- 2.5% capsaicin. This contact (taste) repellent is registered for use on ornamental, Christmas and fruit trees. Apply it with a backpack or trigger sprayer to all susceptible new growth, such as leaders and young leaves. Do not apply to fruitbearing plants after fruit set. Vegetable crops also can be protected if sprayed before the development of edible parts. Weatherability can be improved by adding an antitranspirant such.
- Benzl diethyl (2,6 xylylcarbomoyl) methyl, ammonium saccharide (0.065%), thymol (0.035%): Repels deer with its extremely bitter taste. Apply once each year to new growth. It is not recommended for use on edible crops. It can be applied at full strength on trees, ornamentals and flowers.

Noncommercial repellents
All noncommercial are odor-based repellents that are applied to trees, shrubs and vines. When using noncommercial repellents, make sure you are using a registered material for that application. For example, "home remedies" such as mothballs are not registered for this use, and they should not be considered for this purpose. To deter deer in an urban or suburban environment, use scents that are not naturally found in those areas. Three noncommercial repellents are tankage, human hair and bar soap. All are odor-based repellents.

- Cayenne pepper and egg solutions: Cayenne pepper and/ or eggs can be mixed with water and sprayed directly on non-edible plants to protect them from browse. There are numerous online recipes available. These repellants should not be used on edibles and will need to be reapplied periodically and after rain.
- Hair bags (human hair): Human hair is a repellent that costs very little but has not consistently repelled deer. Place two handfuls of hair in fine-meshed bags (onion bags, nylon stockings). When damage is severe, hang hair bags on the outer branches of trees with no more than 3 feet between bags. For larger areas, hang several bags, 3 feet apart, from fence or cord around the perimeter of the area to be protected. Attach the bags early in spring and replace them monthly through the growing season.
- Bar soap. Studies and numerous testimonials indicate that ordinary bars of soap applied in the same manner as hair bags can reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or string. Each bar appears to protect a radius of about 1 yard. Any tallow-based brand of bar soap will work.

Landscape plants

While virtually no plant is “deer proof”, there are several ways to control deer damage through plant selection. Sayre et al. (1992) noted that damage can vary regionally and by differences in site characteristics. Some site characteristics that may affect the amount of deer damage on a particular landscape planting are:

- Proximity to other more/less desired plants
- Travel behavior of the deer in the area
- Amount on landscaping planted
- Deer density in the area
- Types of plants used in landscaping
- Level of deer resistance to the plants used
- The amount of natural food available in an area (which can differ annually)
- Artificial feeding in the area

Plant Selection
A simple search online can generate many lists of plants that are "deer resistant". However, many of those lists as they are often generated not off of any scientific research but rather on anecdotal information or by simply copying plants from another existing list. However, there are three lists that have utilized some scientific research into plant resistance of deer damage. A three-year study in **Wildwood, Missouri** led to a list of native plants resistant to deer. **Cornell University, NY** also conducted a study of deer resistant plants and published Dr. Brigden's List of Plants Deer Do Not Like to Eat. Finally, the **Cincinnati Zoo, OH** conducted a survey of over 400 nurserymen, educators, naturalists, and garden enthusiasts of deer resistant plants that commonly appeared on over 40 different lists that were collected from around the Midwest. Their survey resulted in a condensed list of plants most frequently agreed upon by those surveyed that were deer resistant.

Another consideration that should be used in landscape design and plant choices is the use of native versus non-native plants.
Native plants may persist better than nonnative plants because native plants have evolutionarily grown in the presence of deer and have learned to sustain deer damage. However, often the selection of native plants at standard nurseries can make locating native plants challenging. However, increasingly nurseries are beginning to offer a wider selection of native plants. Efforts should be made to plant species that are native to the area and avoid invasive species.

By incorporating many of the other damage control options in conjunction with dealing with landscape planting there tends to be higher success in protecting the plants.

Harassment and Scare Tactics

Harassment and scare tactics are used to frighten deer from areas where they may cause damage or where they are not wanted. Efforts to frighten deer should be initiated as soon as sign of deer activity is noticed. Once deer have established a movement or behavior pattern or become accustomed to feeding in a particular area, the behaviors are difficult to modify.

Noise Making Devices

Various types of noise making devices such as fireworks, gun shots or gas exploders may be effective at frightening deer from an area. Noises should be made at irregular intervals, primarily during times of greatest deer movement.

Advantages
Devices that frighten deer are generally inexpensive.

Disadvantages
Loud noises are often considered a nuisance to humans as well, and as such, may not be allowed within city limits. Efficacy is often short term as deer quickly habituate to noises that do no harm them.

Guard Dogs

Guard dogs may be used to frighten deer from an area. Typically, the dog's movement should be restricted by an invisible fence encircling the area to be protected. A single dog can be expected to cover only a small area unless the dog is taught to patrol at times of day when deer movement is greatest, typically dawn and dusk.

Advantages
Deer will not habituate to the dog.

Disadvantages
Care of dogs can be time consuming, and the invisible fencing to restrict dog movement can be costly to construct and maintain.

Supplemental or Diversionary Feeding

Supplemental or diversionary feeding of deer may be considered as a method to draw deer away from urban areas where they are not wanted. However, this practice may actually exacerbate existing problems and create new ones. (The Wildlife Society

2007). Increasing access to anthropogenic foods will likely attract even more deer into an area where there may already be an overabundant population thus increasing conflicts Likewise,concern about the spread of Chronic Wasting Disease and other diseases should be paramount, as concentrating many deer at one feeding area can exacerbate and promote the transmission of disease.

With supplemental feeding, deer will continue to browse on natural vegetation, with increased damage near feeding sites. Fed deer may become reliant on supplemental food and they are more likely to become tame as they associate food with people, increasing the likelihood of conflict with or even danger to humans.

Roadside warning devices

Motorist warning devices.—Many options to reduce motorist speed or alert motorists of potential for deer-vehicle collisions are available (Romin and Bissonette 1996, Putnam 1997, Farrell et al. 2002). These range from static signs that reduce speed limits to technologically-advanced animal detection systems in which signs are activated only when wildlife are present. The intent behind all motorist warning systems is to alert the driver to potential hazards with wildlife on the roadway and cause the driver to slow enough to completely avoid a collision or collide at a slower speed to reduce the severity of the accident (Huijser et al. 2009).

Permanent signs are likely the earliest form of motorist warning to reduce wildlife-vehicle collisions. On many roads, departments of transportation have placed signs with silhouettes of wildlife in an attempt to forewarn motorists of potential for collisions with wildlife. Little research has been conducted on effectiveness of permanent signs, however there is a general consensus that they are ineffective for long-term mitigation of deer-vehicle collisions because motorists tend to largely ignore them. If permanent signs are used, placement should focus on high deer-vehicle collision area to reduce motorist complacency (Pojar et al. 1975, Knapp and Yi 2004, Found and Boyce 2011*b*). Temporary signs appear to be more effective than permanent signs as signs are in place for a shorter period of time, increasing the likelihood for motorists to note and react to new signage. Sullivan et al. (2004) documented a 50% decrease in collisions with mule deer during migrations using temporary warning signs with flashing lights along 5 highways in 3 different states. Hardy et al. (2006) also reported that portable dynamic message signs were more effective at reducing driver speed than permanent signs along I-90 in Montana.

Signs that are activated by wildlife should be the most effective at reducing motorist speeds because there is limited opportunity for motorists to become habituated to them. Animal detection systems have been in existence since the late 1970s, and their performance has varied. Ward et al. (1980) documented a 100% reduction in deer-vehicle collisions, although their data was limited. Huijser et al. (2009) tested various models of detection systems and found that their reliability was influenced by a range of environmental conditions. Detection systems that cover large expanses of road and require many signs and detection devices fail more often due to environmental factors such as vegetation, rain, and snow. Overall, many systems have been tested in field settings and most were unreliable, producing substantial false positives or negatives (Huijser and McGowen 2003). The systems that were most effective were used on lower traffic volume roads and combined with fencing to limit wildlife access to the road at a finite location. This reduced the potential for electronic malfunction (see below; Gordon et al. 2004, Gagnon et al. 2010). Recent studies in Arizona on animal-activated systems that include technologically-advanced software which acquire and identify specific targets before signaling their presence have had fewer incorrect classifications; electromagnetic sensors are still being tested in Colorado. Remote detection and warning of wildlife at roadways remains an area of active research and development.

Wildlife "crosswalks" are a combination of fencing and gaps in the fence that allow animals to cross roadways at designated areas. Crosswalks have been minimally tested, though Lehnert and Bissonette (1997) reported moderate effectiveness of crosswalks along 2 and 4-lane highways in Utah. These crosswalks included static or continuously activated signs warning motorists of crossing mule deer. Although they documented minimal motorist response, likely due to motorists becoming accustomed to and ignoring static or continuously-activated signs, there was still a decrease in mule deer mortality. Gordon et al. (2004) documented a minimal reduction in speeds, overall about 4 mph with the animal activated motorist warning signs along US Highway 30 in Wyoming. When a deer decoy was visible to approaching motorists in combination with the flashing lights, speeds decreased by up to 12 mph. Gagnon et al. (2010)

documented a 97% decrease in elk-vehicle collisions and a nearly 10 mph reduction in motorist speeds at a crosswalk with animal-activated motorist warning sign. Crosswalks can function as an at-grade wildlife crossing in some circumstances, but they should not be used on high-speed highways (Gordon et al. 2004, Gagnon et al. 2010). When using crosswalks in lieu of other wildlife crossings, similar requirements for spacing between crosswalks along the roadway should be considered. Traffic volumes must be taken into consideration for crosswalks as high traffic can provide an impermeable barrier.

Speed reduction zones in areas where wildlife-vehicle collisions occur can reduce potential for more severe accidents. Enforcement of speed limits is key to their success as many motorists ignore speed limit signs. In general, speed reduction zones are considered ineffective at reducing deer-vehicle collisions (Romin and Bissonette 1996, Bissonette and Kassar 2008). Highway lighting is an ineffective method to reduce deer-vehicle collisions (Reed and Woodard 1981, Romin and Bissonette 1996). Anecdotal information indicates that highway lighting can cause areas beyond the lighting to appear even darker to motorists, reducing detection of deer once leaving the lighted area.

Benefits and Challenges

Accurate animal detection systems that reduce motorist habituation combined with funnel-fencing to restrict detection coverage area are effective at reducing motorist speed and alertness (Gagnon et al. 2010). Animal detection systems by themselves when deployed across large expanses of road show little benefit in reducing deer-vehicle collision. Overall, animal detection systems have the potential to be an effective tool in mitigating deer-vehicle collision (Huijser and McGowen 2003). However, in many cases they do not reduce deer-vehicle collisions, primarily due to environmental conditions that cause system failures that lead to excessive false positives, in turn causing motorists to ignore the warning signs, or false negatives that fail to inform the driver of an animal in the road (Huijser et al. 2009). Further research on new technologies and devices that overcome these environmental factors is warranted. When working with transportation agencies on mitigation measures to reduce deer-vehicle collision, it is essential to selectively recommend methods that have a high potential for success. Failure to meet this goal can cause reluctance by transportation agencies to spend time and funding on potential solutions in the future.

Financial Assessment

Motorist warning systems can be relatively inexpensive, yet they are ineffective in many cases. Animal detection systems that provide warning to motorists only when deer or other wildlife are present are the best solution when wildlife crossings are not an option. If possible the warning systems should be combined with funnel fencing and electrified mats, which restrict possible movements of wildlife while crossing the roadway, to reduce potential for malfunction due to environmental conditions. The actual expenses for these types of systems may run from $50,000 to $200,000 depending on complexity and design. Costs for the regular maintenance of the warning system may additionally include full time staff or a private contractor to regularly check on these systems.

Decoy deterrents.—Decoy deterrents are intended to make motorists react to the visual cue of seeing the decoy and respond by slowing down. Research evaluating the effects of deer decoys as a stand-alone deterrent for deer-vehicle collisions is lacking, but several studies have evaluated decoys or simulations used in conjunction with other techniques. Using a cross section of a full-body taxidermy mount, Reed and Woodard (1981) evaluated deer simulations and highway lighting as a potential means to reduce deer vehicle collisions in Colorado. They found that highway lighting did not affect the location of deer crossings, location of accidents, nor mean vehicle speeds. The presence of a deer decoy placed in the emergency lane in lighted view of oncoming traffic, however, decreased mean vehicle speeds by 8.7 mph.

In Wyoming, Gordon et al. (2004) evaluated the effectiveness of the FLASH™ (Flashing Light Animal Sensing Host) system, designed to detect deer presence on the highway and warn motorists by triggering flashing lights associated with a sign. In addition, they experimentally tested various treatments involving the sign, the lights, and the presence of a deer decoy (full-body taxidermy mount of a mule deer doe). Automobiles traveling in the day failed to reduce speeds substantially in response to the activated system, however, speeds at night were reduced an average of 4 mph. Speeds were reduced an average of 12.5 mph in response to flashing lights and a deer decoy placed along the highway.

Benefits and challenges

The limited published research and lack of published management protocol on the use of deer decoys to deter vehicle collisions presents challenges for evaluating their efficacy. Research suggests that vehicles will reduce speeds in presence of deer decoys, but duration and actual application of the technique needs further evaluation. Reed and Woodard (1981) observed brake lights on 51% of the vehicles approaching the deer decoy during night, but evaluation was discontinued because of risk to motorists caused by 5–10% of the vehicles that either slowed drastically or stopped near the simulation. Placing decoys near roads could actually cause vehicle-vehicle collisions, placing substantial liabilities on management agencies that used them. There is currently no plausible rationale for using a decoy for slowing vehicle speed due to the risk of human injury due to human responses.

Financial assessment

Current costs of a full body taxidermy deer mount will range depending on location and taxidermist, but range between $1,500–2,500. Simulated decoys are available for substantially less. The potential for accidents and injuries place a substantial liability on any agency that may choose to use this approach.

Auditory Stimuli.—Several devices have been developed to stimulate an auditory response in deer to alter their behavior to avoid collisions with vehicles. "Deer whistles," which are attached to vehicles and emit a high-frequency sound, are perhaps one of the most common of these devices used by motorists. However, contrary to popular belief, assessments of deer whistles indicated deer did not respond differently to vehicles equipped with whistles than to those that were not equipped (Romin and Dalton 1992, Romin and Bissonette 1996). Scheifele et al. (2003) tested several deer whistles and concluded they were likely to be ineffective based on several aspects of acoustic performance and deer auditory responses. Valitzski et al. (2009) tested vehicle-mounted devices that produced pure tones, similar to sounds produced by deer whistles, at 5 different frequencies. They found deer responses were not adequate to reduce collisions and concluded deer may not have adequate time to react as desired, may not have the ability (neurologically) to process the sound as an alarm such that they respond as desired, or may not perceive the sounds they tested as threatening. Ujvári et al. (2004) found deer demonstrated relatively quick habituation (≤10 days) to sounds of acoustic highway markers activated by passing vehicles. A stimulus system (high-pitched sound in combination with a strobe light) activated by vehicle headlights reduced wildlife-vehicle collisions by 85–93% in Austria (Huijser et al. 2008), but this effect has yet to be replicated.

Incorporation of alarm or distress calls in an auditory stimulus system designed to reduce collisions may warrant additional investigation. Use of such bioacoustics to reduce deer presence in areas of highly preferred forages (e.g., crops, orchards) has produced mixed results. In some cases, deer easily became habituated to bioacoustics or the sounds were deemed ineffective (Belant et al. 1998, VerCauteren et al. 2005). However, Hildreth et al. (2013) documented a 99% reduction in deer entry into baited sites where deer-activated, bioacoustic frightening devices were deployed. Such systems may deter deer from crossing highways, but further testing is needed.

Benefits and Challenges

Primary benefits of auditory stimulus systems are their relative simplicity and low cost. If appropriate sounds could be produced to effectively alter deer behavior in a desired manner, such systems could result in substantial reductions in deer-vehicle collisions. Challenges include lack of effectiveness (i.e., deer do not respond or do not alter their behavior as desired) and habituation of deer to the sounds (i.e., deer may respond as desired for a short time, but responses decline after repeated exposure).

Financial Assessment

Deer whistles and other auditory stimuli are relatively inexpensive, generally between $10–100. However, tests of auditory stimuli have been inconclusive or have shown that the devices were ineffective for reducing deer-vehicle collisions. A technical working group formed to evaluate mitigation methods for wildlife-vehicle collisions concluded neither research nor construction resources should be used for audio signals (in the right-of-way or on vehicles; Huijser et al. 2008). Given the high costs and liability associated with deer-vehicle collisions, advocating use of auditory stimuli devices as a sole deterrent to avoid collisions should be avoided.

Roadway design

Wildlife crossings. —Wildlife crossings (underpasses and overpasses), when combined with funnel-fencing, have been widely recognized as the most effective method to simultaneously reduce wildlife-vehicle collisions while maintaining habitat connectivity (Ward et al. 1980, Clevenger and Waltho 2000, Dodd et al. 2012, Sawyer et al. 2012).

Wildlife crossings are designed so that wildlife can pass safely over or under roads, removing wildlife from roadways, and reducing the effect of traffic on wildlife movements (Gagnon et al. 2007*a*, *b*; Dodd and Gagnon 2011). The numbers of wildlife crossings throughout North America are numerous and continue to grow (Bissonette and Cramer 2008).

Underpasses provide mule deer and other wildlife the opportunity to pass below the highway while allowing traffic to pass overhead. Underpasses and culverts in many cases dually facilitate wildlife and water flow. Underpasses are generally considered the larger of the 2 types and are used to bridge larger areas like rivers and canyons, whereas culverts generally comprise smaller, fully or partially precast concrete or metal pipe better suited for smaller creeks or washes.

Research on the effectiveness of underpasses to safely pass mule deer began in the mid-1970s (Reed et al. 1975, Ward et al. 1980). Underpasses of various sizes and shapes have been shown effective for mule deer passage, but recommendations on optimal size are an ongoing and heavily-debated topic, particularly given cost restraints usually placed on construction projects. Openness ratio ((width x height)/length) is a commonly used term describing wildlife crossings, and many wildlife species prefer to pass through more open structures that appear shorter in length than those that are perceived as long, narrow tunnels. There is conflicting data on the optimal openness ratio for mule deer from recent research and understanding of wildlife behavior (Reed et al. 1975, Foster and Humphrey 1995, Jacobson et al. 2007, Schwender 2013), but width seems more important than height (Foster and Humphrey 1995, Clevenger and Waltho 2000, Cramer 2013) and length is likely even more important than width (Clevenger and Waltho 2000, Cramer 2013). Most studies on mule deer use of underpasses indicate that mule deer are more reluctant to use narrower structures than wider structures. Current studies, specifically for mule deer, indicate that minimum size for underpasses should be 8–10 feet in height and a minimum of 20 feet in width (Gordon and Anderson 2004, Cramer 2013), while length should not exceed 120 feet if possible (Cramer 2013). In areas where underpasses exceed 120 feet, such as 4-lane divided highways, providing an open median may help increase mule deer crossing success by reducing the overall length into 2 shorter sections (Foster and Humphrey 1995, Gagnon et al. 2005). These measurements are considered minimum requirements for mule deer, and planners should develop more open structures where possible to help ensure success of the underpasses. Where possible, culverts should have earthen bottoms to eliminate echoing and provide natural footing. Earthen fill between the top of the culvert and the road is also useful to reduce sound and vibration when vehicles pass overhead. Rip-rap (large rocks used to dissipate water flows) may be used in small amounts to help reduce regular erosion, but a natural soil pathway must be available for wildlife to navigate through the structure. Another method being implemented in Nevada is placing a rip-rap layer under several inches of native soil that will protect the structures during larger storm events, while providing a natural pathway for wildlife. After a large storm event the earthen pathway may require maintenance, but the overall structure will remain stable. In some instances, uncovered rip-rap can be used to guide wildlife into the desired pathway.

Because of their cost, overpasses are used relatively infrequently when compared with underpasses. Although overpasses have been implemented throughout North America for many wildlife species (Clevenger and Waltho 2005, Olsson et al. 2008), relatively few studies have evaluated mule deer use of overpasses until recently. Prior to 2000, only 5 wildlife overpasses existed in North America and limited data are available to evaluate the effectiveness of overpasses. The first wildlife overpass in North America was constructed in Utah along I-15 and is only 21 feet wide. Recent studies show that this 30-year-old overpass successfully facilitates mule deer movement (Cramer 2013). In British Columbia, the 19-foot-wide Trepanier overpass was built to facilitate wildlife movement over the Okanagan Connector (Highway 97C) and use by mule deer has been documented for this structure (Sielecki 2007). In Banff National Park, Alberta, Canada, overpasses were built primarily for the safe passage of grizzly bear across the Trans-Canada Highway, and mule deer benefited from these structures. Of 15 structures for mule deer to select from, 67% of all crossings by deer (mule deer and white-tailed deer combined) occurred at the 2 160-foot-wide overpasses (Clevenger and Waltho 2005).

Mule deer will use both overpasses and underpasses and learn to use them more over time. Recently, studies to evaluate mule deer use of overpasses along US 93 in Nevada documented >13,000 crossings in a 2-year period (Simpson 2012), with >35,000 crossing in the first 4 years (N. Simpson, Nevada Department of Transportation, personal communication). Simpson (2012) found that mule deer preferred overpasses to underpasses, especially in the first years following construction. Mule deer continued to adapt to the underpasses over time. A recent Wyoming study found mule deer preferred crossing US 191 through underpasses rather than overpasses. This study included 2 sites, each with 1 overpass and 3 underpasses, and documented 60,000 mule deer and 25,000 pronghorn crossings in 3 years (H. Sawyer, personal communication). Three overpasses completed along the Trans-Canada Highway in Yoho National Park in 2011 will benefit mule deer along with other species. At this time, overpasses that would facilitate mule deer passage are also planned or under construction in Washington along I-90 and Nevada along I-80, which includes an overpass of 200 feet in width. As the number of overpasses and underpasses increase in mule deer habitat, evaluation of their effectiveness will provide insight to optimal design.

Proper placement of wildlife crossings (underpasses and overpasses) is essential to ensure mule deer encounter them during daily or seasonal movements (Gagnon et al. 2011, Sawyer et al. 2012, Coe et al. 2015). Along large stretches of road, spacing of wildlife crossings needs to be considered. Underpasses need to be close enough together to allow mule deer to encounter them within a reasonable distance. Bissonette and Adair (2008) recommended that wildlife crossings be placed about 1 mile apart for mule deer in areas where deer are frequently hit or regularly cross. Coe et al. (2015) noted that crossings could be placed more irregularly based on actual mule deer migration corridors or data that indicate high deer-vehicle collision areas. Similarly, escape ramps should be placed frequently enough that deer and other ungulates trapped inside fencing are can escape the right-of-way before collisions occur.

Ungulate-proof fencing is likely the most important factor in the success of wildlife crossing structures. When properly designed and located, fences funnel deer towards crossing structures helping to overcome any minor flaws in design and placement. In most cases mule deer will not immediately use crossing structures and a learning period will be required (Gagnon et al. 2011, Sawyer et al. 2012). For example, along US Highway 30 in Wyoming, mule deer took about 3 years to fully adapt to underpasses and fencing (Sawyer et al. 2012). Migratory mule deer are more likely than resident mule deer to use smaller underpasses, when combined with fencing, because of their need to move to seasonal ranges. Installing larger underpasses and culverts will increase permeability, whereas smaller structures increase the likelihood that mule deer may avoid the designed crossing. In areas with reduced permeability, mule deer will find other areas to attempt crossings, such as the end of the fence, jump outs, or small gaps.

Highway retrofitting has been used increasingly to reduce wildlife-vehicle collisions while maintaining habitat connectivity (Gagnon et al. 2010, Cramer 2013). Retrofitting typically employs fencing to funnel wildlife to existing structures that are suitable for wildlife passage. This would include bridges and culverts that already facilitate water flow, but in some cases can include low use roads (Ward 1982). In many cases, implementation of highway construction projects may not occur for decades, and retrofitting can provide a temporary solution. When retrofitting existing structures, each crossing structure must be acceptable for mule deer use; improper combinations of fencing and inadequate crossing structures will completely inhibit mule deer movement across the highway corridor.

Benefits and Challenges

Properly designed and located wildlife crossings with funnel fencing will ultimately provide the most effective method for reducing collisions with mule deer, and other wildlife species in the area must be considered as well. For example, elk generally use similar habitats as mule deer, but may be reluctant to use structures that mule deer may readily use (Dodd et al. 2007, Gagnon et al. 2011, Cramer 2013). When dealing with mule deer collisions and connectivity in areas where there are elk present, designs for elk should be considered which will allow effective use by both species. Another consideration is smaller wildlife that reside in the area. Although recommendations for mule deer provide for about 1-mile spacing between structures, other smaller wildlife may not travel as far to locate a safe crossing opportunity, which may make the roadway a more substantive barrier for these species (Bissonette and Adair 2008). Allowing access to culverts too small for ungulate use may help to facilitate habitat connectivity for some of these smaller species (Clevenger et al. 2001).

Financial Assessment

Wildlife crossings with ungulate-proof fencing are in many cases the most expensive solution, but they are by far the most effective. Culverts generally are the least expensive and can be installed for about $200,000, whereas overpasses and bridges can cost $2–10 million. Sufficient excess fill must be available to maintain grade and install enlarged culverts, or the highway must be raised by obtaining and hauling fill, an alternative so costly as to be prohibitive. Underpasses are usually more practical for transportation departments when they are located in drainages where water flow already requires such an accommodation. Costs to upgrade underpasses in these situations are somewhat less. Overpasses are generally designed solely for wildlife and expenses can be harder to justify. In general, overpasses are 4 to 6 times more expensive than underpasses. In some situations, topography may not be conducive to underpasses and overpasses may be the only option. When considering placement of wildlife-dedicated overpasses, using natural ridgelines where the roadway cuts through a terrain feature can help reduce costs associated with substantial fill requirements. Retrofits of existing structures may be among the least expensive solutions for collision reduction and connectivity for mule deer if adequate terrain features exist.

Nevada observed a 50% decrease in the number of deer-vehicle collisions with each subsequent migration in a single location until the numbers reached ≤2 reported collisions/migration (Simpson et al. 2012). Additionally, an analysis of expenses on the same set of crossing structures showed a financial benefit of $1.58 for every $1.00 in cost for these features (Attah et al. 2012). With the observed decrease in the number of deer-vehicle collisions, and the positive benefit-cost score, the cost of the construction will be recuperated by taxpayers, insurance companies, and management agencies because of the decrease in human injuries and infrastructure damage (McCollister and Van Manen 2010).

Nighttime and seasonal speed limits. —Speed is a factor that influences the probability of collisions in general. At slower speeds, motorists generally have more time to detect, identify, and react to obstacles in their path than if they were travelling at greater speeds. Yet studies that attempt to document the relationship between deer-vehicle collision and posted speed limits provide mixed results and generally do not confirm a relationship (Bissonette and Kassar 2008). Reasons for these mixed results stem from the limited relationship between actual speed with posted speed limit (Bashore et al. 1985) where deer-vehicle collisions are common. Roadway characteristics, deer behavior, deer distribution, landscape, and environmental factors have a greater influence on deer-roadway interactions regardless of posted speed limit (Bashore et al. 1985, Finder et al. 1999, Farrell and Tappe 2007, Found and Boyce 2011*a*, Lobo and Millar 2013). With these overriding factors in mind, strategic use of speed limit reduction during discrete deer movement periods and in locations of concentrated deer-vehicle collision may provide positive results. Temporary warning signs can be effective when used on roads with concentrated deer-vehicle collision peaks and isolated to narrow corridors. Motorists can become complacent with static signage over time (Sullivan et al. 2004). Periodic use of portable message signs can help overcome driver complacency and reduce vehicular speeds more than permanent dynamic message signs (Hardy et al. 2006). Providing a message identifying shorter distances to watch for deer can increase driver attention span for those distances (Hardy et al. 2006). Like most deer species, mule deer are generally crepuscular with increased movements during dusk and dawn. Deer often migrate seasonally, so reducing speed limits at times of the day or year when deer are most active may reduce the probability of wildlife-vehicle collisions. Regardless, given that increased vehicular speeds correlates with increased accident severity and property damage, strategically placed signs both temporally and spatially may ultimately save human lives.

Benefits and challenges

Traffic signage identifying appropriate speed is relatively inexpensive to implement. Enforcement can be difficult, and compliance for most highway signage is variable. If seasonal changes are needed to deal with migration periods, signage can be adjusted with minimal effort. Temporary dynamic message signs work better than standard static speed limit signs (Hardy et al. 2006). Lawful determination of appropriate speed limits can require administrative review and approval.

Logically, reducing vehicle speed should similarly reduce wildlife-vehicle collisions. Yet wildlife often cross unexpectedly, making reduced speed limits less effective in avoiding collisions. For instance, bighorn sheep have a relatively high rate of collisions with vehicles along US Highway 191 in southeastern Arizona (Wakeling et al. 2007) even though the roadway precludes high rates of speed and allows for good visibility. This winding section of US Highway 191 keeps vehicles from exceeding about 35 mph, whereas other nearby sections can be traversed at 55 mph and wildlife vehicle collisions are not correspondingly higher. In this situation, the proximity and juxtaposition of suitable habitat increases the likelihood that bighorn sheep will frequent and cross these roadways.

Additionally, motorists tend to ignore frequent signage designating slow speeds if the roadway itself is suitable for faster traffic. Motorists tend to respond to signs that alert them through specific stimuli, such as flashing lights that only exhibit the stimuli when a particular threat initiates it. Gagnon et al. (2010) noted a nearly 10-mph speed reduction and a 68% increase in motorist braking response over multiple years when warning signs were activated by wildlife at the end of a 3-mile stretch of exclusion fencing. Frequent, static signs that simply note "wildlife crossing" are often ignored, and low speed limits on good roadways (with high frequencies of wildlife crossing attempts) are often overlooked as well. Seasonal signs noting deer or elk migrations are more effective in some instances. Vegetative plantings in highway rights-of-way sometimes attract or obscure wildlife and contribute to causes for wildlife-vehicle incidents.

Colorado experienced the confounding effects of implementing reduced speed zones to amend motorist behavior along a 100-mile section of highway with 14 experimental wildlife speed reduction zones. While data showed a minor improvement on average accident history throughout the total treatment area, 6 of the 14 segments (43%) exhibited worse accident history following implementation. Based on the inconclusive data, Colorado Department of Transportation removed the signage because changing driver behavior was found to be ineffective with the program (Colorado Department of Transportation, unpublished data). Both wildlife agencies and state departments of transportation agree that reduced speed limits are not particularly effective at influencing wildlife-vehicle collisions (Sullivan and Messmer 2003).

Financial assessment

Expenses associated with changing highway speed limit signage are relatively minimal. The administrative cost of the appropriate review and authorization for changes in speed limits is generally higher than that of simply changing out signs. As noted earlier, animal detection systems that provide warning to motorists, like temporary changes in speed limits, only when deer or other wildlife are present are the best solution when wildlife crossings are not an option. The actual expenses for these types of systems may run from $50,000 to $200,000 depending on complexity and design. Costs for the regular maintenance of the warning system may additionally include full time staff or a private contractor to regularly check on these systems. Less expensive is temporary flashing portable signage that may be used seasonally, but costs may still approach $10,000 to implement. Simply changing static speed limit signs are inexpensive, yet ineffective in reducing deer-vehicle collisions.

Mitigation Options

Damage mitigation deals with methods that are typically used by agencies to reducean overabundant deer population. When city leaders are determining how best to mitigate deer issues within their community they often look for the one particular option that best fits their situation. However, the best solution is to implement an integrated approach using multiple mitigation options, rather than rely on one single method (Conover 2002). Authorities must weigh the positives and negatives of allowing each mitigation technique within their city limits. This section will help identify the application and limitations of several techniques. While the various mitigation techniques are divided into broad categories, within each category there are typically several options for tailoring a program to a community's needs, resident's tolerances, and the landscape within a particular city. It must be noted that with any deer management program public support is critical. Having well defined objectives and outcomes for the management program and clearly articulating these to the public should assist with gaining public support.

Regulated Public Hunting

Efficacy: Regulated public hunting is the most economical option for managing deer within an urban area and is the primary option used for overall deer management by state/provincial game/wildlife agencies throughout North America. Depending on the level of usage within an urban area, the initial efficacy can be high. Hunting allows localized management by the residents to address varying levels of deer and conflicts on their properties (as deer numbers go up more deer can be harvested, as deer numbers go down fewer deer can be taken). Hunting, unlike some other forms of management, also allows for the resource to be used for food by hunters and their families, by property owners, or venison can be donated to food assistance programs. The use of regulated public hunting is strongly supported by the North American model of wildlife conservation that has successfully guided deer management in the modern era.

Options: Perhaps the best option for managing overabundant deer is to allow regulated public hunting where hunters follow regulations set by the wildlife/game agency. There is no oversight required by the city or cost associated with this option. An example of a city that uses this technique is **Cuyahoga Falls, Ohio** in the annexed portion of the city. When the city annexed the rest of the township, the allowance for hunting was left intact. Another option is to conduct a controlled hunt within the city limits such has been used in **Princeton, New Jersey and municipalities of St. Louis County, Missouri**. The city chooses the number of hunters that will be allowed to hunt within its boundaries and the locations where those hunters can hunt. The city then advertises for the opportunity for hunters to put their name into a drawing/lottery. Hunters that are successful in the drawing are afforded the opportunity to hunt within the city limits. In most cases the city has identified areas, often city owned/managed properties, where hunting will be allowed.. The city has the ability to set specific rules for the hunt. The final option for hunting is to allow hunting after a hunter/landowner follows a city developed process for allowance of hunting such as in **Columbia, Missouri** where a hunter must attend a 1-hour safety course prior to being allowed to hunt within the city limits. During the course hunters are made aware of the locations where they may hunt, the laws and regulations they must follow, and they are issued a permit that must be displayed in the window of their vehicle while it is parked in an area where they are hunting. Some cities, like **Independence, Ohio,** even require a hunter to take an archery proficiency test prior to being allowed to hunt within the city limits. Hunting within city limits can be carefully regulated so that harvest objectives are met, such as creating a requirement to remove a certain number of does before a buck may be harvested as is done in **Hidden Valley, Indiana**. Cities may also approach their game/wildlife agency to discuss the option for establishing a deer management zone like has been done around **Silver City, New Mexico.** The city worked with the state game agency to designate an "urban management unit" around the city to allow additional deer to be taken in accordance with state deer regulations. While the program does not address deer specifically within the city limits, it does allow hunters to address immigration of deer into the city. Some jurisdictions may even allow baiting as a means of increasing the harvest and more efficiently reducing the deer population. For example, when Connecticut permitted baiting of deer, the hunter success rate was increased by 16.8%.

Limitations: If the initial deer population in an urban area is extremely high (30+ deer/sq mile), it can be challenging for hunters to quickly reduce the deer population to a tolerable level. To be most effective, hunting should be used consistently and on an annualized basis. It should be noted that as the number of restrictions imposed on hunting increase within an urban area, the effectiveness for reducing the deer population will decrease. Any restrictions imposed on hunters such as the types of weapons that may be used, baiting regulations, and permit acquisition, should be supportive of hunters to ensure successful management outcomes. Also, ensuring that hunters arehave access to enough land to hunt so that harvest objectives can be reached is also critical.

It must also be kept in mind that deer are a charismatic species and some citizens will vehemently oppose the use of hunting, while others will be highly supportive. Agencies and or municipalities should be able to clearly articulate to all citizens the objectives and expected outcomes of the use of hunting as a management action. Some citizens may oppose hunting from the aspect of a concern for safety believing that they may be endangered by the discharge of weapons, even arrows from bows or crossbows. Authorities should be able to alleviate these fears by creating regulations that will ensure the safety of the public such as limiting how close to an established dwelling hunters may discharge a weapon and restricting hunting to public areas or private properties by permission only.

Maintenance Required: Open regulated public hunting requires little or no maintenance, however, cities may need to periodically review and update ordinances and/or city rules for hunting to be used most effectively. Periodic changes to regulations may be needed to address the number of hunters as a result of changing deer numbers or the inclusion/exclusion of hunting areas. Hunting can be an excellent tool to manage a deer population and it is likely most effective when used consistently and annually.

Regulatory Aspects: Most agencies encourage the use of hunting where possible but the use of hunting in urban areas may require local ordinance modifications. This has been successfully done by eleven municipalities in the **St. Louis, Missouri** metropolitan area and six communities in the **Cleveland, Ohio** metropolitan area.

Sharpshooting

Efficacy: For a good discussion of sharpshooting deer and how a program can be managed and initiated by multiple agencies working together, see Stradtmann et al. (1995). Because sharpshooting, using trained personnel to systematically remove deer, is highly controlled, the immediate efficacy of it is usually very high if the appropriate number of deer can be removed over a short, 2-4 year, timeframe. Sharpshooting can be an effective technique in smaller areas where the use of hunting is limited. Efficacy is dependent on access to private properties. Managers should be aware that not all property owners will be willing to participate in lethal removal. Typically, to curb population growth, at least 60% of the deer must be removed annually. In **DuPage County, Illinois**, deer densities were estimated at 68 deer/km^2 before four consecutive years of sharpshooting (in 1997, 1998, 1999, and 2000) reduced the population to the desired 15 to 20 deer/km^2 density.

Options: There are a variety of personnel to consider when planning a sharpshooting operation: shooters, baiters, security, and logistics personnel who will handle the deer and day-to-day planning of the operation. While community staff can be used for many of the needed tasks, because of the level of marksmanship needed to shoot deer within an urban area so that public safety is ensured, the use of highly trained personnel is usually needed. One option is to use police personnel, such as SWAT, to shoot deer as is done in **Mentor, Ohio**. Another option is to contract with USDA-Wildlife Services which has been done in **Ann Arbor, Michigan**. This agency, which does a substantial amount of wildlife damage control throughout the United States, uses highly trained federal staff to shoot deer. Another option is to use a non-profit organization, such as White Buffalo, Inc. The cities of **Town & Country, Missouri** and Eden Prairie, Minnesota contract with sharpshooters to harvest deer annually to address their deer population. Another option for deer removal by sharp shooting is to contract with a private contractor, as has been done in **Highland, Utah**.. Often these companies privately contract to control other nuisance wildlife in cities and are permitted by the game/wildlife agency to control deer as well. In most cases the personnel used to shoot deer can provide personnel to meet the other aspects of a sharpshooting program affording a city many options for implementing a program. **Town & Country, Missouri** has an ongoing bait-and-sharpshooting program to reduce and maintain the deer population, through annual culling efforts.

Limitations: Sharpshooting can be one of the most costly options to manage a deer herd especially if the work is contracted out. While a city can save expenses by using their own staff, this usually comes at the expense of either additional cost in overtime for staff or in a loss of man-power for the typical duties of the personnel assigned. To be most effective, staff operating on a sharpshooting operation, including non-law enforcement personnel, will likely need to be dedicated to this program and their normal duties assigned to other city personnel. If the community doesn't own/manage a significant amount of acreage then they must resort to using private property as well. This technique will also require the highest level of city planning of any of the techniques. In most cases deer are processed for food pantries, but identifying a processor that will work within the timeframe as well as being able to handle the volume of deer can pose a challenge at times.

Maintenance Required: Long-term efficacy can be achieved using sharpshooting but, if this is the only technique used, it will usually require indefinite use.

Regulatory Aspects: Depending on which options are used and during what time of the year, state/provincial regulations may require special permitting for the city to conduct a sharpshooting program. In addition, if suppressed weapons are used the city will also need a federal Bureau of Alcohol, Tobacco, Firearms, and Explosives permit which may take several months to obtain.

Live Capture Techniques

Various techniques are available for the safe and humane live capture of deer. Some of the primary methods used are the Stephenson box trap, Clover trap, rocket net and dart gun. These techniques have been evaluated for efficacy and animal welfare concerns (Haulton et al. 2001, Anderson and Nielsen 2002). Netted cage traps and their use is discussed at length by Vercauteren et al. (1999) and they reported only 4% of captured deer (n = 1000+) sustained injuries. Drop nets have also been successfully used for the capture of both white-tailed deer (Ramsey 1968, Conner et al. 1987, DeNiocla and Swihart 1997, Silvy et al. 1997, Lopez et al. 1998, Jedrzejewski and Kamler 2004) and mule deer (White and Bartmann 1994, D'Eon 2003). Net guns fired from helicopters offer yet another technique that has been successfully used (Ballard et al 1998, Webb et al. 2008).

With all of these techniques, if deer are to be released rather than euthanized after capture, handling time should be minimized to reduce stress on the animals (Beringer et al. 1996). Likewise, safety during the capture event of animals and personnel capturing them is also a critical concern. Injury to some animals may occur and some mortality of captured animals due to injury or capture myopathy should be expected. The terrain of the capture location, cost effectiveness and safety concerns may dictate which technique is best used in a given situation.

Those opposed to lethal control of deer often cite live capture and translocation as an option that is more humane than lethal removal with hunting or sharp shooting (see previous discussions of these techniques). However, numerous studies have shown that as a population reduction method, live capture is more expensive, relatively inefficient and does not significantly extend the life span of individual animals that are relocated (Ishmael and Rongstad 1984, O'Bryan and McCollough 1985, Withman and Jones 1990). As a result, while live capture techniques will always have their place in research and management, they should likely not be the first choices for managing urban deer if the goal is to affect a long-term decrease in the population. However, in certain situations live capture may be the only or most desirable option so we will discuss several techniques.

If captured deer are not to be euthanized (relocation is discussed in more detail later) a location that can handle the volume of deer to be relocated, following capture, must be identified and equipment to properly transport the deer is needed. This, coupled with the cost to move the deer, greatly increases the overall cost of a relocation program. Most states have banned the interstate movement of any wild member of the cervid family (with exceptions for elk) Intrastate movements still pose the risk of the potential to spread diseases (e.g., Chronic Wasting Disease, tuberculosis, etc.) and severely limits this option. Further, there may be no other places within a given state or province where having more deer is desirable. It has also been shown that some relocated deer may move back to urban areas and they can increase crop depredation in areas where they have been moved (Ishmael et al. 1995). This may be considered simply as "putting the problem into someone else's backyard" and not an effective solution to the problem

Trapping:

Efficacy: Traps are typically designed to capture only one deer at a time. Other techniques (e.g., drop nets, rocket nets) offer options for multiple capture, but due to this limitation, trapping does not have the highest efficacy rate. Traps should be placed in areas that have high deer usage to increase efficacy. Traps should also be placed away from roads or areas where they can be seen by the public to further increase efficacy and to reduce stress on captured deer.

Options: There are two primary trap types used for trapping deer; the Stephenson box trap or Clover trap... The Stephenson box trap is similar to a cage trap used for capturing raccoons or groundhogs, except that it is much larger. Box traps used for deer capture are typically made of plywood sheets attached to an angle iron frame that is 4x4x6 feet (1.2x1.2x1.8 m) in size. These trapscan be baited, set, and left unattended. Pre-baiting of traps with apples or corn is generally required before traps are actually set, in order to give deer time to habituate to the presence of traps and enter them calmly. The trap is activated by a trip wire. The traps must be checked at regular intervals (at least once daily) so that captured deer are not left in the traps for an extended period. These traps have been used successfully in **Pepper Pike, Ohio** and River Hills, Wisconsin to name a few places.

Clover traps or netted cage traps are similar in size to box traps. They are typically made of mesh netting or, in the case of Clover traps, sometimes chain-link fencing material, covering a metal frame. These traps typically have only one door, whereas box traps sometimes have two doors. Bait, such as corn or apples, is used to attract a deer into the trap. The trap is activated by a trip wire that, once sprung, allows the door to drop and capture the deer. These traps have been used successfully in **Silver City, New Mexico** and in many other places

Traps do not discriminate relative to the deer captured and any deer (buck, doe, fawn) is likely to be caught in the trap. Other forms of capture (e.g., drop nets, rocket nets, net guns, dart guns (discussed later) can be more selective. Once deer are captured there are several options for removing deer from the trap. If deer are to be euthanized, a firearm or captive bolt gun may be used. Captive bolt guns have been used to euthanize deer in traps **Princeton, New Jersey**. Firearms have also been used (.22 caliber rimfire) to euthanize deer in urban settings but their use can only be considered when the landscape where the trap will be placed allows discharge of a firearm, such as was the case in the Village of North Oaks, Minnesota (Jordan et al. 1995) Euthanizing trapped deer is usually the less desirable approach but regulatory considerations often make this the only feasible option for urban deer population control. However, in **Bountiful, Utah** a trap and relocate program was successfully implemented as a technique to help address local urban deer problems.

Limitations: Trapping usually requires some type of bait (corn, apples, etc.) to entice the deer into the trap or area to be trapped. Pre-baiting traps is usually required to engender efficiency once traps are set. Traps should not be set until it is certain deer are entering the trap.
Deer are most susceptible to trapping during late winter to early spring when they are potentially food stressed (Vercauteren et al. 1999).

Maintenance Required: Traps will need to be checked on regular intervals, at least once every 24 hours once set. As needed, traps will have to be repaired or replaced.

Regulatory Aspects: The use of traps will likely require a state or provincial game/wildlife agency permit, especially when deer are relocated. In addition, trap monitoring regulations will likely be arequired to ensure traps are checked and animals dispatched at regular intervals. City and/or state/provincial regulations may also dictate whether baiting can be used.

Cannon/Rocket Nets:

Efficacy: Cannon/rocket netting has been used to capture deer safely and effectively (Hawkins et al. 1968, Dill 1969). Multiple deer maybe be captured at the same time using these techniques, but recommendations are that no more than 3 deer should be captured at once (Beringer et al. 1996).

Options: For a thorough discussion and instructions on the use of rocket/cannon netting see http://wildlifematerials.com/infosheets/Rocket%20Nets%20Capture%20Instructions.pdf . The use of this technique employs nylon netting, electrical wire (for firing the charges), launchers, powder charges, weights (attached to the nets) and a ground blind (for hiding captors). After the netting is set up, wiring connected, and launchers charged, deer are lured into position, typically with bait. Pre-baiting an area for one to two weeks is typically required. A small bait pile (which limits the number of deer that will be feeding at any given time) should be placed 8-10 feet in front of the rolled-up netting and launchers. When deer are in position, captors may select when to fire the nets to capture the desired number, sex or age of deer etc. The capture event itself, compounded by noise of the cannons/rockets and presence of numerous human handlers is stressful for deer, so handling time should be minimized. Also, deer should be restrained with ropes (all four legs tied) and rolled up with brisket down, instead of left lying on their sides, due to the potential of bloating. Deer should be blindfolded immediately after capture (a simple cut off sweatshirt sleeve is effective for this) to reduce stress.

Limitations: There is always the possibility of injury to animals or personnel during the use of these devices. Animals may be injured by being struck by weights when the net is fired over them or after capture since netted animals typically thrash about. Animals may injure personnel attempting to restrain them. Safety of personnel is always a concern with the use of powder charges and safety protocols for wiring charges should be rigorously followed. Public safety may be a concern. The use of loud charges in residential areas may be undesirable. Rocket discharge has been known to start fires, whereas cannons do not. Air cannons (Net Blaster®), which require no explosives to fire the net, may also be used and they are considered safer than those that do use explosives.

Maintenance Required: Nets may need to be repaired and have debris removed after each firing. Rocket threads should be greased occasionally to prevent them rusting shut making it impossible to inset charges. Rockets and cannons must be cleaned after firing.

Regulatory Aspects:
Permitting by the state or provincial game agency is required for the use of this technique.

Drop Nets:

Efficacy: Drop nets have been successfully used for the capture of both white-tailed deer (Ramsey 1968, Conner et al. 1987, DeNiocla and Swihart 1997, Silvy et al. 1997, Lopez et al. 1998, Jedrzejewski and Kamler 2004) and mule deer (White and Bartmann 1994, D'Eon 2003). They have also been used successfully in **Princeton, New Jersey** for urban deer management, and many other places for the safe and efficient capture of deer and other species.
Drop nets require personnel to be on hand to initiate the trap and then handle the deer. While this option is costlier than the use of traps, it allows personnel to determine which deer are trapped and when to initiate the trap. In addition, multiple deer can be trapped at one time if enough personnel are available.

Options: For a thorough discussion and instructions on the use of drop netting see http://wildlifematerials.com/infosheets/Drop%20Net%20Capture%20Instructions.pdf . The use of this technique requires a large drop net (often 50x50 feet or larger), tall poles (usually 8 feet for deer) which are placed at each corner to hold up the net, electrical wire, blasting caps and a ground blind (for hiding the captor who will fire the net). A block and tackle, come-along or other device for stretching the nets is also required. Bait is used to attract deer to the area where the capture will occur, and it should be placed in the center of the area below the net. Areas are typically pre-baited for one to two weeks prior to the anticipated capture. When deer are in position, captors may select when to fire the nets to capture the desired number, sex or age of deer etc. The capture event itself, compounded by noise of the cannons/rockets and presence of numerous human handlers is stressful for deer, so handling time of deer should be minimized. Also, deer should be restrained with ropes (all four legs tied) and rolled up with brisket down, instead of left lying on their sides, due to the potential of bloating. Deer should be blindfolded immediately after capture (a simple cut off sweatshirt sleeve is effective for this) to reduce stress.

Limitations: As with other live capture techniques, there is always the possibility of injury to deer or personnel during the use of these devices. Deer may be injured after capture because netted animals typically thrash about. Deer may injure personnel attempting to restrain them. Safety of personnel is always a concern with the use of blasting caps and safety protocols for wiring should be rigorously followed. Public safety may be a concern. The use of loud charges in residential areas may be undesirable

Maintenance Required: Nets may need to be repaired and have debris removed after each drop.

Regulatory Aspects: Permitting by the state or provincial game agency is required for the use of this technique.

Net Guns:

Efficacy: Net guns fired from helicopters offer another technique that has been successfully and safely used to live capture deer (Barrett et al. 1982, Krausman et al. 1985, DeYoung 1988, Potvin and Breton 1988, Ballard et al. 1998, DelGuidice et al. 2001, Haulton et al. 2001, Webb et al. 2008). We are not aware of the use of this technique for the management of deer in urban areas, however, the situation where it could be used is imaginable.

Options: The use of this technique requires very skilled personnel. Helicopters are typically used to locate and then chase deer until a single deer is in range of the net gun operator, who then fires the net over the deer. Following this, another person is typically dispatched from the helicopter, often referred to as a "mugger", who wrestles the deer to the ground and restrains it. The net gun itself is loaded with a "blank", often .308 caliber, which fires the net. Nets are typically about 15 x 15 feet square with 6-inch mesh, however various manufacturers produce custom nets. This technique is extremely selective as operators choose which animal to pursue and capture. Chemical immobilization of deer is typically not required.

Limitations: This technique can be used in a variety of habitat types and at various animal densities, however, areas must be open enough to assure safe maneuvering of the helicopter. Deer may be injured during capture or suffer myopathy post capture and handling. However, Webb et al. (2008) reported only 1% capture myopathy and a .6% direct mortality during capture. Likewise, besides broken antlers, only 1.6% of deer sustained injury during capture where total capture was 3,350 white-tailed deer.

Maintenance Required: Nets may need occasional repair. Helicopters require maintenance per number of hours used.

Regulatory Aspects: Agency permitting, and FAA regulations apply to this form of live capture.

Darting Guns:

Efficacy: An excellent discussion of the use of chemical immobilization for the capture of wildlife in urban areas is found in Kreeger (2012). Darting guns have been effectively used for the capture of deer (Haulton et al. 2001). Darting guns use a .22 caliber blank or CO2 cartridge to fire a "dart" (flying syringe) that injects an animal with an immobilizing drug upon contact. The effective range is typically no more than 75 meters, and often less. Guns that use CO2 cartridges to fire allow the user to adjust velocity (and hence range) by a metering device. It is critical that the syringe only penetrates the skin of the animal with the needle upon contact, so the operator must make adjustments for the proper velocity or range. A miscalculation could result in the needle not penetrating the skin, or the entire syringe penetrating the skin and potentially killing or severely wounding the deer. Shot placement is also critical and typically the fore or hind quarters are targeted for an intramuscular injection. Darting guns can be fired from the ground, a tree stand or even from a helicopter to capture deer.

Options: Considerable practice may be required to use a darting gun effectively. Correct velocity and range calculation must be made, and each gun should be calibrated with various dart sizes and chemical loads in advance of attempted capture. Various gun and dart types are available and the use of each will require training. Chemically immobilized deer require the monitoring of vital signs, especially respiration and body temperature, should release for relocation be the desired outcome of the capture.

Limitations: The use of chemical immobilization techniques requires training and certification. Use of the correct type of drug (immobilizing agent and antagonist) for the deer, and the correct dosage for weight must be made. A combination of Telazol plus (4.4 mg/kg) and xylazine (2.2 mg/kg) are typically used to immobilize deer, with tolazoline (2.0 mg.kg) acting as an antagonist if needed. However, other drugs combinations may be effective as well. (Kreeger 2012). Deer should also be blindfolded and placed on their brisket and not allowed to lay on their side while immobilized. In addition, a tube for the release of gas may need to be inserted into the mouth.

Maintenance Required: Darting guns should be cleaned to assure accurate firing. Recertification for the use of chemical immobilization is required periodically.

Regulatory Aspects: In addition, to agency permitting to chemically immobilize deer, special regulations govern the purchase, use and storage of the various pharmaceuticals used as immobilizing agents and antagonists. Typically, only a licensed veterinarian would be able to purchase these drugs and some drugs may only be used by them, or in their presence by certified personnel.

Fertility Control

Efficacy: Unless coupled with other management options, fertility control does not typically have an immediate impact on deer densities. Because of the limitations associated with contraception, contraception is not an efficient means of reducing overabundant, deer populations (Swihart and DeNicola 1995, Warren et al. 1995). In addition, often the use of fertility control can increase the longevity of deer further hampering short-term efficacy. Most research has identified the need for over 90% of the female deer within the population to be rendered permanently infertile for it to be effective.

Options: There are two general categories of fertility control: contraceptives and sterilization. Surgical sterilization of does has been conducted in **Town & Country, Missouri**. The City funded the trap and sterilization of 130 does over two years in conjunction with a culling program. The sterilization (ovariectomy and tubal ligation) procedure was successful in that it eliminated reproduction for treated does. However, because deer were then placed back out on the landscape, resulting population decline did not follow. After two years, the city abandoned the sterilization effort due to the high cost ($1,300 per treated doe) and currently conducts annual culling to maintain lower deer densities.

There are two contraceptives developed for deer: PZP, often referred to by the tradename SpayVac ®, which has been used in research studies in cities such as **Bridgeport, Connecticut** and GonaCon ® which has been used in **Princeton, New Jersey**. Only GonaCon ® is EPA approved for use at this time. PZP creates antibodies that blocks the fertilization of the egg by sperm and is only applicable to female deer. GonaCon ®, developed by the National Wildlife Research Center (NWRC), the research arm of the USDA-APHIS Wildlife Services, works by creating antibodies that bind to the gonadotropin releasing hormone (GnRH) which renders the deer, male or female, non-productive by reducing the production of sex hormones. Label use is only for adult females. With GonaCon ® female deer stop going into estrus. Sterilization can be done either in males which **Staten Island, New York** has looked into or females as has been researched in **Fairfax City, Virginia**. In order to reduce production in a polygamous species, the females of a population need to be treated. Because of this any sterilization of males would need to be done in conjunction with a control technique on females. Cornell University in **Ithaca, New York** tried using a combination program using archery hunting and sterilization using tubal ligation on female deer. They surgically sterilized 77 does and combined this with an "earn-a-buck" hunting program for the outlying areas. It became apparent over the course of the study that although the surgery supposedly prevented does from becoming pregnant, it did not remove their estrus cycles, meaning that they constantly cycled into heat—attracting bucks from outside the study area even after the rutting season. Thus, although the birth rate initially decreased, after five years the number of deer on campus remained the same.

Limitations: Reductions in populations may not be apparent for five to ten years or longer, depending on percentage of the population that remains vaccinated, and this timeframe may be too long for those communities dealing with the immediate worry of human-deer conflicts. Deer that are controlled through any of the methods of fertility control generally will endure less stress and therefore potential increased longevity. A metropolitan park district in **Columbus, Ohio** had a deer that was contracepted with PZP live over 20 years. In most cases there is no barrier, such as a fence, that hinders deer wandering into and out of the city. When contraceptives are used, periodic boosters are needed which requires repeated capture of individuals. Over time, the deer become incrementally more difficult to capture and treat. Deer are also susceptible to stress when being captured and/or being sterilized which may lead to their death. Because of the high amount of limitations and low efficacy in most situations, fertility control is considered in most cases to be research oriented and not a technique for population control. PZP is currently not registered for use in the United States as a management tool in part because the deer are unfit for human consumption. Because PZP only works on the egg it is only applicable for use in female deer. In addition, it can induce multiple estrus cycles lengthening the breeding period and movement of bucks into the population. There is no approved contraceptive for use in feed because it is impossible to control dosage levels. Deer must be given any contraceptive by darting or hand injecting. GonaCon® has a 70% efficacy rate and can only be used, as per USDA label instructions, in adult female deer, and must be hand-injected. Based on the efficacy rate in adult does and up to 40% of fawns breeding in highly productive areas, as is the case in NJ, using GonaCon® will result in up to a 29% *increase* in the deer population, without factoring in immigration and mortality sources. **Angel Island, California** attempted to use chemo-sterilization by capturing between 80 and 90% of the female deer population with no success. This was in part because the amount of effort to capture the remaining deer became harder as the number of already captured deer increased. Ultimately, this project was abandoned with only 15 adult does receiving the treatment.

Maintenance Required: For most cities there is no barrier to deer movement, so annual treatment of new deer into the population is required. Annual monitoring of the deer is also required to ensure that at least 90% of the population has been handled. Additionally, the female fawns born of non-contracepted adult does and last year's fawns will need to be trapped and inoculated every year.

Regulatory Aspects: The use of any fertility control will almost certainly require a permit from at least the state game/wildlife agency.

Relocation of the deer

Efficacy: Relocation/translocation of deer is typically not a viable management option, in part because of low survival rates of translocated animals. In 1985, 29 deer were captured at Ardenwood Regional Park in Fremont, **California**. Two of the deer died during the capture. These animals were then released into a wilderness area. A follow-up study determined that by the end of the year, 23 of the 27 deer had died, with three unaccounted for. It was found that the deer were not able to cope with the presence of predators, and most of the deaths were attributed to predation (Mayer et al. 1995).

Similarly, on **Angel Island, California** (Mayer et al. 1995) 215 deer were captured using Clover traps, panel traps, drop nets, and drive nets, and 12 of these deer died during capture. The remaining 203 deer were relocated to a nearby 54,362-acre recreation area. In an effort to monitor the effectiveness of this translocation, 15 deer were fitted with radio collars and monitored during the following six months. Subsequent surveillance determined that only 15% of relocated deer survived the entire year. This high mortality rate was attributed to poor physical condition due to the stress of the Island environment, and a failure to recognize hazards such as predators and traffic (factors not found in their previous habitat).

A translocation program in **River Hills, Wisconsin** (Ishmael et al. 1995) found poor survival rates as well. Of 310 deer translocated to state-owned lands between 1987 and 1992, 54% were reported dead within a year post-release. It was discovered that mortality rates of translocated radio-collared deer were more than twice that reported for ear-tagged deer during the same period (96% compared to 45%).

From 1999-2001, Missouri Department of Conservation cooperated with the City of Town and Country to trap and relocate 90 deer from the St. Louis metropolitan area to a rural area of Missouri. Survival rate for translocated deer was 30% (Beringer et al. 2002). The method was suspended in early 2001 due to the threat of spreading CWD, as well as the low survival rates of relocated deer.

In 2013, the Utah Division of Wildlife Resources used a helicopter and net gun to capture 102 deer in **Parawon, Utah** and released them 144 km away to Holden Utah. Annual survival rates of translocated deer were 52% the first year. During the second year, however, survival rates of translocated deer were 85%, which was similar to survival rates of resident deer in the area (Smedley 2016). This research also showed that younger deer were twice as likely to survive post-translocation compared to older deer, and translocated deer had high site fidelity to release sites (Smedley 2016). No deer died during the capture operation.

Options: See Regulatory Aspects section.

Limitations: Low survival rates of translocated deer is only one factor to consider when evaluating the efficacy of relocation efforts. The potential to spread parasites and disease, such as exotic lice and CWD, should also be heavily considered before initiating an urban deer translocation program. The long-term negative consequences of translocating deer will outweigh the short-term benefits of reducing deer densities if CWD or other diseases are spread to deer populations. Because of these disease risks, most wildlife agencies do not allow the translocation of deer. In states that do allow translocation, it is highly recommended that deer in or near CWD positive areas, or in areas that have not been adequately tested for CWD, should not be translocated.

Another limitation of translocating deer is cost. In Utah, the Division of Wildlife Resources has worked with a few municipalities to translocate deer from city limits (these municipalities are far removed from CWD positive areas, and a high sample size of roadkill and hunter harvested deer that have never tested positive for CWD). Cities generally have personnel committed to help set and bait traps. These cities also pay $200 per deer, and the costs are projected to increase in the future. The Utah Division of Wildlife Resources also employees three full time employees to work with cities to resolve urban deer issues. With high deer densities in many parts of the country, cities and state agencies may not

Summary and Resources

have the funds to remove enough animals to have a measurable impact.

Many parts of the country do not have adequate suitable habitat to release translocated deer. These areas include locations with high human densities, high deer densities, or poor deer habitat. Additionally, trap and relocation efforts will have little benefit if deer populations can quickly reestablish within the trapping area.

Maintenance Required: If translocation is used as a management strategy, an adequate number of deer would need to be moved in order to reduce deer densities. This effort would need to continue until a socially acceptable number of deer is reached in a given area. Efforts should be made to reduce immigration of deer into city limits.

Regulatory Aspects: Most governments recognize that relocations, although possibly of value for experimental research or repopulation, are not an appropriate management tool for overpopulated deer communities. The Southeastern Wildlife Disease Study Cooperative discourages the relocation of wildlife due to the threat of spreading disease. Relocation involves the transport of an entire biological package, including parasites and disease, which could be inadvertently introduced to another population by human efforts. Any relocation would require approval from the state wildlife agency and/or the state department of agriculture. Because of the disease risks, high costs, and other limitations associated with translocating urban deer, most wildlife agencies have policies against translocating urban deer. While there is value in addressing urban deer issues, using translocation as a management strategy has the potential to cause irreversible harm to deer populations if CWD and other diseases are spread.

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METHODS FOR MANAGING
HUMAN–DEER CONFLICTS
IN URBAN, SUBURBAN, AND EXURBAN AREAS

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CONTENTS

PREFACE

What is the Association of Fish and Wildlife Agencies (AFWA)?

The Association of Fish and Wildlife Agencies represents North America's fish and wildlife agencies to advance sound, science-based management and conservation of fish and wildlife and their habitats in the public interest. The Association represents its members on Capitol Hill and before the Administration to advance favorable fish and wildlife conservation policy and funding. It works to ensure that all entities work collaboratively on the most important issues. The Association also provides member agencies with coordination services on cross-cutting as well as species-based programs that range from birds, fish habitat, and energy development to climate change, wildlife action plans, conservation education, leadership training, and international relations. Working together, the Association's member agencies are ensuring that North American fish and wildlife management has a clear and collective voice.

PURPOSE OF DOCUMENT

The Human–Wildlife Conflict Working Group of the Association of Fish and Wildlife Agencies formed a task force in September 2016 to document methods used to manage deer conflicts within areas of high human densities. Throughout this document, we refer to these areas as "populated" areas. Deer conflict situations arise in urban, suburban, exurban, and other areas of high human densities, and the content of this document applies to those areas as well. This document offers management options to communities and agency leadership for resolving common human conflicts with urban deer. It provides an overview of the common issues and identifies common management practices with their associated benefits and challenges. This document is not designed to endorse a specific practice over others because wildlife agencies often adopt management practices for dealing with urban deer conflicts for reasons that are not associated with the efficacy of the practice itself (e.g., social acceptance). Instead, this document describes the various management practices in use, as well as the benefits and challenges associated with each practice, to provide defensible management options to North American agency leadership as they determine which practices will be employed in a particular state, province, region, or situation. In addition, this document can help articulate current information regarding urban deer conflict situations to administrators, leaders, and legislators that oversee urban areas.

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ABSTRACT

Deer (*Odocoileus* spp.) pose specific management challenges when they come into conflict with humans. Although deer were once uncommon throughout North America due to unregulated take and habitat alteration, conservation efforts have restored these species to abundance. Deer now exploit urban, suburban, and exurban areas where human populations provide anthropogenic attractants, either intentionally or inadvertently, which often leads to human–deer conflicts. Although biological and ecological carrying capacity can be defined precisely, in most cases, social carrying capacity is highly dependent on the perceptions and acceptance of deer by humans on a shared landscape. Conflicts may be reduced effectively by eliminating attractants, yet eliminating attractants may not be achieved easily in many locations. Mitigating actions have varying degrees of efficacy and may not be effective or accepted in every situation. Although relocating deer may seem to be an easy solution to some public stakeholders, translocations can spread diseases like chronic wasting disease and may result in high mortality of translocated animals as finding suitable, unoccupied habitat may be difficult to impossible. Resolution to conflict requires close collaboration between wildlife management agencies and municipalities on shared jurisdictions. In this manuscript, we identify the challenges and benefits associated with many human–deer conflict mitigation actions, as well as methods to monitor the response of deer populations to management actions.

Deer, such as this white-tailed deer in Missouri, can take advantage of resources available in urban settings (courtesy of Missouri Department of Conservation).

DEER MANAGEMENT HISTORY

North America is inhabited by white-tailed (*Odocoileus virginianus*), mule deer (*O. hemionus*), and black-tailed deer (*O. h.* spp.). While species populations have fluctuated in response to anthropogenic effects, deer remain a management success story. It is estimated that the white-tailed deer population in the United States was only about 300,000 in the 1930s. Today, the population exceeds an estimated 30 million, a 1,000-fold increase in <100 years. Deer are managed under the North American Model of Wildlife Conservation, and they provide many societal benefits. Deer are the most sought-after game animal on the North American continent, and all North American deer species are enjoyed as a healthy and nutritious table fare. Wildlife viewers value deer as well.

Prior to European settlement, white-tailed deer were common throughout most of North America, providing meat and hides to Native Americans. However, during the 1800s, unregulated hunting, including commercial market hunting, led to the extirpation of white-tailed deer throughout much of its range. During the early to mid-1900s, a widespread conservation movement swept across North America, and many wildlife agencies initiated reintroduction efforts to reestablish white-tailed deer populations. These reintroduction efforts, in combination with eliminating market hunting and newly established and enforced game laws, allowed white-tailed deer populations to grow quickly. This growth continued throughout the twentieth century, and white-tailed deer adapted to living in areas of higher human populations to take advantage of reduced predation and increased forage resources. This growth eventually led to increasing deer populations in many areas highly populated by humans.

While white-tailed deer have demonstrated the greatest numeric challenge in populated areas, mule deer and black-tailed deer have adapted similarly and created new challenges in portions of their range. Concomitantly, state and provincial agencies have had to:

- Reassess how traditional deer management techniques can be used in these populated areas
- Develop new deer management strategies for these populated areas
- Encourage research into additional deer management tools for managing deer in populated areas
- Learn how best to work with government officials and municipal leaders together to address concerns regarding deer

CONCEPT OF CARRYING CAPACITY

When managing deer in populated areas, the question of how many deer should be in a given area is a crucial question. Three types of carrying capacities may be considered in this context: biological, ecological, and social-cultural.

- **Biological Carrying Capacity (BCC) –** The simplest concept is to consider the maximum number of deer that the habitat could support on a continuous, long-term basis. However, biological carrying capacity may not be the desired management objective because a deer population at biological carrying capacity can negatively influence associated plant and animal communities. The BCC in areas with increased availability of artificial food sources may be much higher than in a wildland environment.

- **Ecological Carrying Capacity (ECC) –** The population level at which deer do not influence native plants and animals negatively is referred to as the ecological carrying capacity. Prior to the 1600s and major European settlement of North America, deer densities were likely 3–4 deer/km^2 throughout their range (McCabe and McCabe 1984, 1997). Research in the eastern half of North America suggests the ECC for white-tailed deer is normally in the range of 3–10 deer/km^2 (Healy 1997, Schmitz and Sinclair 1997). Beyond these densities, browsing deer affect the regeneration of certain plant species, which in turn affects other wildlife species that also depend on those habitats (Tilghman 1989, DeCalesta 1994).

- **Social or Cultural Carrying Capacity (SCC or CCC) –** The deer population level at which the local human population can tolerate or accept the problems associated with a deer herd commonly is referred to as the social or cultural carrying capacity. The SCC is related to the identification and state of negative impacts created by deer. Thus, affected local residents will determine the SCC for the deer herd and express sentiments about the desired deer population. However, because the tolerances of multiple stakeholders for deer within a particular area differ, SCC will vary by area.

OVERABUNDANT DEER: WHEN DEER POPULATIONS EXCEED SOCIAL CARRYING CAPACITY IN AREAS DOMINATED BY THE HUMAN POPULATIONS

Mule deer in urban yard, Panaca, Nevada (courtesy of B. Wakeling).

The consequences of overabundant deer (i.e., when deer exceed SCC in populated areas) in urban and suburban settings range from mild to severe. The most significant concerns of the public are human injuries, death, and property damage from deer–vehicle collisions (Connelly et al. 1987, Curtis and Lynch 2001). Collisions with deer are extremely frequent, estimated at >1 million each year in the United States (Conover et al. 1995, Conover 2019). These collisions occur in all landscapes where deer and roads exist, but in general collisions occur more regularly in urban and suburban areas where both deer and motorists are abundant (Nielsen et al. 2003).

Deer–vehicle collisions are costly, averaging $6,717 USD per collision (Huijser et al. 2008).

Between 1990 and 2010, human fatalities from collisions with wildlife, mostly deer, increased 104% (Sullivan 2011). In addition, many deer are killed in these collisions, potentially resulting in reduced recreational opportunities and other intrinsic benefits deer provide (Huijser et al. 2008). An estimated 92% of deer involved in collisions die from the trauma (Allen and McCullough 1976). Human–deer conflicts in Princeton, New Jersey, USA increased following enactment of a no-firearms discharge law within the township in the 1970s, and a 436% increase in deer–vehicle collisions followed between 1972 and 1982 (Kuser 1995). The inability to regulate deer numbers can influence the number of conflicts and collisions.

Another major concern of the public is the risk of disease transmission from deer (Connelly et al. 1987, Curtis and Lynch 2001). As with many species of wildlife that reside in close proximity to human dwellings, deer serve as reservoirs and vectors of zoonotic diseases. Lyme disease is contracted by humans through an injection of the bacterium, *Borrelia burgdorferi*, during the bite of a deer tick (*Ixodes* spp.; Adams et al. 2006). These ticks require large mammals, such as deer, as a host for feeding and mating during the adult stage of the tick. The ticks lay eggs that hatch, after which the nymphs feed on small mammals or birds and become infected with the *B. burgdorferi*. The nymphs or adults then can move onto humans and bite, infecting the human. Incidents of Lyme disease have risen since the mid-1990s, with 2015 representing one of the highest years on record with 28,453 cases (www.cdc.gov/lyme/stats). Most cases occur among states in the northeast United States, but an increasing number of cases are being reported throughout the Midwest region of the country in recent years. Other Lyme-like diseases, such as ehrlichiosis and Bourbon virus, are of increasing concern throughout portions of North America. Incidence of ehrlichiosis has increased dramatically since the mid-1990s. Isolated but serious cases of Bourbon virus and Heartland virus in Missouri have raised concerns about deer densities and human exposure to tick-borne diseases.

Deer in urban and suburban settings can become overabundant, reaching densities of 78 deer/km^2 (Magnarelli et al. 1995). Overabundant deer browse heavily on forest understories and alter the vegetation composition of plant communities (Adams et al. 2006). This in turn may influence the distribution and abundance of species at multiple trophic levels that depend on those plant communities. It also modifies the relative abundance of species that compete with deer (Waller and Alverson 1997). This type of intensive herbivory is not confined to forests.

Urban and suburban households experience damage to gardens, yards, and ornamental plants from deer herbivory that averages $73 USD per household (Conover 2001*a*). Although rare, deer may be aggressive toward humans in areas of high human density where deer are habituated to humans and abundant (Hubbard and Nielsen 2009). For example, 13 attacks on humans were reported at Southern Illinois University–Carbondale during 2005, including injuries to humans involving broken and dislocated bones, lacerations, scrapes, and bruises. These attacks were believed to involve female deer (i.e., does) protecting fawns. Other attacks on humans have included male deer (i.e., bucks) during the breeding season, likely in mistaken bouts for dominance (Conover 2001*a*).

CHALLENGES WITH OVERABUNDANT DEER AND MUNICIPALITIES

In many parts of the United States and Canada, deer populations have increased in urban environments. City officials often are asked and expected to solve urban deer-related issues, but many challenges must be overcome to address issues and reduce conflicts. The first challenge is to identify the problem and set clear objectives to achieve success. This can be difficult because social tolerance for deer in municipalities varies, with some residents viewing deer as beneficial and others viewing deer as a detriment. This lack of consensus among residents is a source of controversy for elected officials, as polarized constituents may propose fundamentally different solutions to address deer-related challenges. Residents in favor of having deer within populated areas promote the philosophy that local citizens need to learn to live and coexist with wildlife. Those opposed to urban deer often call for strategies to decrease deer densities to reduce deer–vehicle collisions, address zoonotic disease risks to humans, alleviate damage to lawns and gardens, and address public safety concerns.

One challenge that city officials are faced with is the lack of management authority over wildlife species. Management authority of deer generally rests with the state or provincial wildlife management agency. Municipal officials must work with state or provincial agencies to establish and achieve defined objectives. Where city leaders believe urban deer are a wildlife agency's problem and not a shared responsibility, little progress will be made in reducing conflicts. Coordination and collaboration are critical.

Wildlife management agencies primarily manage deer population size through regulated public hunting. Cities usually have ordinances and other laws that prohibit the discharge of firearms within city limits due to safety concerns in areas of high human density. The inability to use hunters to regulate deer populations eliminates the primary tool used by wildlife agencies to reduce herd size. Humans in urban areas often have greater mutualistic views of wildlife and may not consider utilitarian views of hunting acceptable (Manfredo et al. 2018). Yet, in some areas, the public is becoming increasingly accepting of hunting as a management tool and a means to obtain locally grown, organic protein (i.e., locavores). Exacerbating the problem, many municipalities lack ordinances that prohibit the feeding of deer, creating a refuge for deer and increasing their abundance.

Jurisdictions with the most pronounced deer problems generally are those with high deer abundance and restricted hunting regulations (Conover 2001*b*). These regulations may apply to an entire state or province (such as restrictions in the state of New York, USA due to fears of low deer numbers in the mid-1900s), or they may be related to weapons restrictions at the municipal level (no weapon discharge within town limits or within a certain distance of houses). Many suburban communities integrate green spaces, such as large gardens or recreational areas, within close proximity to houses, making discharge of weapons unsafe under normal conditions. Changes to regulations (e.g., allowances for harvest) may take years to enact, and communities even may be reluctant to approve hunting methods with limited range and noise, such as archery hunts. Consequently, communities struggle to find acceptable solutions while the deer population and human conflicts with deer continue to increase (Messmer et al. 1997).

In 6 different New England communities during the late 1980s, human–deer conflicts began to emerge as a threat to human safety from increased vehicle collisions, an increase in detected cases of Lyme disease, and increased nuisance complaints due to deer browsing in local gardens (Northeast Deer Technical Committee 2009). These jurisdictions recognized the need for deer population control, but varying levels of public support limited their abilities to implement uniform strategies in a timely manner. Even the creation of local deer management committees and a comprehensive consultation process failed to achieve consensus in the 2 largest communities; in these communities, resolution was delayed for >10 years as pressure from animal rights groups and local residents limited implementation of deer management committee recommendations.

In Cayuga Heights, New York, 40 meetings were held over 3 years, finally resulting in an experimentation stage before a management solution could be agreed upon 2 years later. In another instance, intervention from the local Humane Society in Amherst, New York resulted in suspension of a bait-and-shoot program implemented 2 years earlier. Several consultants were hired by the town to determine the best course of action. Three years passed with the deer population continuing to cause nuisance to the local community before an agreement was made to implement a 1-year immunocontraceptive study followed by bait-and-shoot operations (Northeast Deer Technical Committee 2009).

In many situations, solutions to deer conflict issues require the joint coordination of multiple jurisdictions. In Cook County, Illinois, USA, the legal custodian of wildlife is the Illinois Department of Conservation; the legal custodian of the habitat is the Cook County Forest Preserve District (Jones and Witham 1995). A successful urban deer management program requires the cooperation of all levels of government, with funding, staffing, and communication distributed in ways that promote shared responsibility (Messmer et al. 1997).

CHALLENGES FOR WILDLIFE AGENCIES IN MANAGING DEER IN POPULATED AREAS

State and provincial wildlife agencies face constraints when attempting to solve urban deer issues. Similar to most cities, a wildlife agency's operational funds (generated primarily through license sales) are limited, and many do not have a dedicated budget to address urban deer issues. Limitations imposed on the use of federal funds raised through excise taxes (i.e., Wildlife Restoration Funds) for nuisance wildlife management also hamper the agency's capacity to respond. Historically, wildlife agencies were slow to hire staff in urban settings at the same rate at which urban deer problems developed.

In desert landscapes, cultivated agriculture can be appealing to mule deer (courtesy of B. Wakeling).

Another set of challenges for state and provincial wildlife agencies is prioritizing which communities to help and how many resources to devote to the problems. Some wildlife agencies have well-defined plans or policies outlining the processes they will take to help communities manage urban deer conflicts. These plans may set criteria, provide direction and consistency, and define management options when working with elected city officials. In the absence of urban deer plans or policies, objectively prioritizing which municipalities to help and allocating resources may be difficult.

Community leaders often call upon wildlife agencies to remove urban deer, but each technique has specific limitations (Messmer et al. 1997). Lethal removal by sharpshooters with firearms may not be viable in many instances, but even in situations where it may be feasible, having properly trained staff and the necessary equipment may be problematic. Trap and cull measures may be perceived as safer, but substantial expense, equipment, and expertise are required. Culling efforts should target removal of resident deer, as deer that migrate through urban areas may cause few problems. In addition, relying primarily on removing deer provides only temporary relief if other attractants are not removed.

In many cases, lethal removal is unacceptable socially, and wildlife agencies are asked to translocate urban deer (Messmer et al. 1997). Aside from mortality from capture-related stress (e.g., capture myopathy), moving urban deer can be expensive, may be prohibited by legal statute, is logistically challenging, and may spread wildlife diseases to healthy deer herds where the animals are released. Cost–benefit analyses should be conducted prior to translocation efforts, and disease histories and risks should be factored into the decision-making processes (Western Association of Fish and Wildlife Agencies [WAFWA] 2014). Wildlife agencies should do all they can to prevent the spread of disease, particularly chronic wasting disease (CWD). Translocating deer involves a great amount of risk and could have negative biological impacts on deer populations or economic consequences for commercial interests (e.g., livestock) if disease is spread from 1 population to another.

Fertility control is another socially popular alternative to culling and translocation. These efforts are expensive, highly invasive, logistically challenging to implement, and not entirely effective (WAFWA 2015).

Black-tailed bucks sparring in Washington (courtesy of O. Duvuvuei).

WORKING TOGETHER TO MANAGE DEER IN POPULATED AREAS

State wildlife management agencies and municipalities must work collaboratively to effectively manage deer in populated areas. Deer management is not simply finding a way to harvest deer in situations where conflicts arise. Developing a plan to eliminate, mitigate, or reduce conflicts is essential. Many of wildlife management's greatest challenges arise at the intersection of issues with poorly defined, tenuously understood, or sometimes competing management authorities. The findings of biological science and the decisions of experts traditionally relied upon to make management decisions must integrate the varying desires of the public, especially when managing urban wildlife (Decker et al. 1996, Mangel et al. 1996, Organ and Ellingwood 2000, Riley et al. 2002).

DEFINING SUCCESS WHEN MANAGING DEER IN POPULATED AREAS

Identifying the challenges of both populated areas and wildlife agencies is an important first step in addressing urban deer conflict issues. Urban deer management has 3 main components: (1) determining where we are, (2) identifying where we want to be, and (3) bridging the gap between the 2 places. Determining where we are involves understanding the densities and growth rates of deer in a given area, the number of deer–vehicle collisions, the amount of property damage that is occurring, and the social tolerance of citizens toward deer. Identifying where we want to be involves determining what success looks like for a given municipality. Wildlife agencies should work with municipalities to define goals and objectives in some form of management or action plan and clearly lay out what results need to be achieved. Examples of defining success can involve working toward reaching a socially acceptable deer density (number/area), reducing deer–vehicle collisions (number/time period or number/km of roadway) and property damage (e.g., deer eating flowers or plants in gardens [yards depredated/time period]), and surveying the public to obtain their opinions (public satisfaction). Estimating the actual number of deer in a community is nearly impossible to determine (DeNicola et al. 2000).

When defining success, wildlife agencies should work directly with elected officials because they represent the voice of the citizens. Having elected officials help determine a socially acceptable number of deer for a given city will help wildlife officials know how to best address urban deer issues, and it will provide direction when neighboring landowners disagree about how many deer should be in a given area.

Determining how to bridge the gap between the 2 places involves selecting a strategy to achieve the defined management goals and objectives. Each strategy has benefits and drawbacks, and each must be evaluated critically before being implemented. If communities and wildlife agencies are going to make progress toward solving urban deer challenges, they must communicate well and work together in a true partnership. Determining what success looks like and implementing agreed upon strategies to achieve goals are important components to addressing urban deer issues.

BIOLOGY OF DEER IN POPULATED AREAS

Wildlife populations residing in human-populated areas face stresses that differ from their counterparts in rural settings (Ditchkoff et al. 2006). Due to these stresses, wildlife living in populated areas may modify their behavior or life-history strategies to avoid or cope with the different stresses. For deer, behavioral modifications may include shifts in habitat use, diets, feeding behavior, movement patterns, and home range sizes, whereas life-histories may differ in reproductive rates, survival, and disease transmission rates.

BEHAVIORAL ADAPTATIONS

Although deer appear to avoid human disturbance when possible, they easily habituate to human development and readily use residential areas that contain sufficient cover (Swihart et al. 1995, Kilpatrick and Spohr 2000). Compared to their wildland counterparts, deer in human-populated areas make use of different habitat types, such as golf courses, lawns, and ornamental shrub rows. With human development, anthropogenic food sources (e.g., wildlife feeders, gardens, ornamental plants) are introduced to the landscape, and deer modify their behavior and movements to exploit these artificial food sources. For example, suburban deer in Connecticut, USA browsed heavily near houses because of the anthropogenic food sources found near the human dwellings (Swihart et al. 1995).

In general, size of deer home range decreases as development and human dwellings increase (Kilpatrick and Spohr 2000, Grund et al. 2002, Storm et al. 2007, Hygnstrom et al. 2011). This could be a result of habitat composition and configuration across the rural-urban gradient and an increase in movement barriers (e.g., highways, railroads, housing developments, and fences) as human development increases (Storm et al. 2007, Wakeling et al. 2015). Wildlife living among developed areas may be forced into smaller home ranges due to limited access to smaller patches of suitable habitat (Ditchkoff et al. 2006). Alternatively, deer living in populated areas may be able to exploit higher concentrations of food and other resources, which allows them to decrease home range size while still meeting annual needs (Tufto et al. 1996, Kie et al. 2002, Saïd and Servanty 2005).

Similar to that observed among deer in rural settings, movement of deer in developed areas varies by season. During the non-growing season (fall, winter), deer move more than they do during the growing seasons (spring and summer; Storm et al. 2007). As food becomes more scarce during the non-growing season, deer increase their movements. Additionally, deer in populated areas tend to shift their movements toward dwellings in the winter (Kilpatrick and Spohr 2000, Grund et al. 2002, Storm et al. 2007), where supplemental food sources exist and radiant heat and wind breaks are provided by buildings (Swihart et al. 1995, Grund et al. 2002).

BIOLOGICAL ADAPTATIONS

Deer can become overpopulated in urban areas due to many variables, some of which include a lack of natural predators, reduced hunting pressure, increased recruitment, and favorable habitat conditions. Due to anthropogenic food sources, resources often are less limiting for deer in populated areas, and individuals retain good health despite high population densities (Etter et al. 2002, DeNicola et al. 2008). Urban landscaping often provides a consistent source of food for the deer in urban areas, and deer remain in good health when at medium-low densities.

Because of differences in hunting pressure, road densities, and predator ecology, deer experience different rates of mortality in rural, exurban, and suburban areas. Deer survival in populated areas is generally higher than survival rates in rural landscapes due to lack of hunting and natural predators (Etter et al. 2002, Bateman and Fleming 2012). This difference in survival is greater for male than female deer because, outside the exurban environment, male deer are more frequently harvested in regulated hunting seasons.

As nutrition improves, wildlife reproductive rates increase. When coupled with higher offspring survival, the result ultimately is higher densities (Robbins 1993). Because of the favorable conditions, deer may experience higher reproduction in urban settings than in rural populations (Etter et al. 2002), as the artificially abundant food sources allow females to reproduce without the density-dependent effects experienced by deer in non-urban landscapes.

Anthropogenic influences can limit deer abundance in some areas. Barriers to movement and other stresses may affect deer breeding success and offspring survival (Wakeling et al. 2015). Ditchkoff et al. (2006) documented a high rate of fawn abandonment near populated areas, possibly as a result of human disturbance. Anthropogenic factors such as deer–vehicle collisions, entanglement in lawn structures, drowning in pools, and attacks by domestic dogs represent potential mortality threats for urban deer (Harveson et al. 2007).

Deer–vehicle collisions are the principle cause of mortality for deer in areas where deer and humans coexist (Etter et al. 2002, Wakeling et al. 2015). As road density increases, deer–vehicle collisions make up a larger portion of deer mortalities (Forman and Alexander 1998). Although does are killed by vehicles in proportion to their availability on the landscape, bucks are killed at a higher rate than their availability because of their increased movements associated with breeding (Olson et al. 2014, Wakeling et al. 2015).

Although natural predator densities may be lower in human-dominated areas than in rural habitats, domestic pets can prey on wildlife at rates similar to natural predators (Ditchkoff et al. 2006). Additionally, Ditchkoff et al. (2006) found that coyote (*Canis latrans*) predation on white-tailed deer neonates in urban areas exceeds rates found in rural areas. As deer populations approach and exceed carrying capacity, suitable hiding cover for neonates may become scarce, thus increasing predation risks and resulting in lower fawn survival (Piccolo et al. 2010). For fawns in 1 overpopulated area, the primary cause of mortality from birth to 14 days was emaciation, whereas coyote predation was the primary cause in older fawns (Sams et al. 1996). Low fawn survival may explain why some high-density populations in developed areas do not experience growth despite high adult survival and fecundity (Etter et al. 2002).

DISEASE AND ENVIRONMENTAL DIFFERENCES

Land use and land cover alterations have changed the amount and configuration of habitat available to wildlife. In the western United States, human development has encroached on deer winter range where deer congregate seasonally. Human development restricts the available habitat in these seasonal areas with high deer densities and further concentrates deer into smaller areas. Local factors such as home gardens, palatable ornamental shrubs, and supplemental feeding around residences can concentrate deer at a few locations on the landscape and result in smaller home ranges (Peterson and Messmer 2011). Large numbers of animals in close proximity for extended periods of time increases the likelihood of exposure to any diseases that individual deer may carry.

The landscape changes in developed areas may accelerate contact rates with infectious agents and influence the dynamics of disease transmission (Ditchkoff et al. 2006, Joly et al. 2006, Miller et al. 2007). As a result, deer disease prevalence in human-populated areas can be greater than that found in rural landscapes and can become a major source of mortality (Ricca et al. 2002, Ditchkoff et al. 2006).

Prevalence of CWD was almost twice as high in developed areas than in undeveloped landscapes (Farnsworth et al. 2005), but variations in prevalence occur. Because development tends to reduce hunting pressure and increase survival, adult deer, particularly adult males, tend to live longer in human-developed areas, allowing disease pathogens more time to infect others. Because of this, males were 2–2.5 times more likely to test positive for CWD in human-populated versus rural landscapes while the difference in CWD prevalence was relatively insignificant for females (Farnsworth et al. 2005).

High deer densities and concentration areas, such as that resulting from human development and supplemental feeding, are factors that most likely resulted in the establishment of self-sustaining bovine tuberculosis (TB) in a free-ranging deer population in Michigan, USA (Schmitt et al. 1997). The unnatural concentrations and close contact that results from human development and baiting provides ideal conditions for the transmission of bovine TB through inhalation of infectious aerosols and ingestion of contaminated feed (Whipple and Palmer 2000).

THE ROLE OF WILDLIFE AGENCIES IN MANAGING DEER

The basis of North American wildlife law is the Public Trust Doctrine. This doctrine recognizes that, although natural resources like wildlife belong to the public, government is entrusted with the conservation of wildlife for the benefit of current and future generations. A state's fish and wildlife resources are generally conserved by an elected or appointed board or commission that sets laws and regulations to manage deer as trustees according to this doctrine and employs experts who collect data and provide recommendations pertinent to each state's deer population as trust managers (Smith 2011). State fish and wildlife agencies are the best resource for providing biological data, local effects of deer on the environment, laws pertaining to wildlife, advice on how to determine if a deer overabundance issue exists, and the options to address issues. State agencies also monitor the health and disease status of the deer herd and issue any permits necessary for various management activities, such as hunting, capture and tagging, culling, contraception, sterilization, and

Deer damage on Arborvitae (courtesy of G. Westerfield).

The Northeast Section of The Wildlife Society, in their position statement titled ***Managing Chronically Overabundant Deer***, suggests the following steps to formulating a deer management plan in developed areas:

1. Identify positive and negative deer impacts.
2. Define objectives to measure progress towards alleviating or eliminating negative impacts and continuing or enhancing positive impacts.
3. Collect data on problematic deer impacts.
4. Review management options.
5. Invoke decision-making process – legal, social, logistical, and economic.
6. Develop and implement a communication plan.
7. Ensure state wildlife agency and local government agencies have the ability to authorize regulated harvest where special local hunts may be needed and enhance management authority where possible.
8. Identify permitting requirements.
9. Implement management actions.
10. Monitor changes in deer impact levels.
11. Review and modify management actions.

translocation. The public is entitled to hold trustees responsible for managing wildlife and may redress management actions through judicial venues or subsequent elections.

Many states have specialized programs or regulations for managing overabundant deer where hunting is not practical or desirable. They also offer a wealth of technical information on options for addressing deer from a homeowner and a community perspective. Most wildlife agencies will make staff available to a municipality to provide educational presentations, review information and data pertaining to the issue, and to answer questions on management options.

Although state agencies are the experts in deer management, the community and its leadership generally determine SCC for wildlife (Messmer et al. 1997). If problems are detected, the community should work with the wildlife agency to develop an objective and methods to achieve that objective.

Deliberative discussions are needed to assess local community values, economic effects, available science, and resident feedback. These conversations often are emotional, and reaching consensus may be difficult and time-consuming. State wildlife agencies can guide communities in methodologies to gather resident opinion through non-biased surveys and identification of objective indices to monitor deer populations or human–deer conflict. No single deer population index will be acceptable in all situations, and indices of conflict may be more suitable to measure and manage, including metrics such as levels of deer–vehicle collisions, property damage, environmental degradation, incidence of disease, and tolerance levels of residents.

Generally, communities require a substantial amount of time to reach the point of majority consensus and plan development. Implementation actions to address overabundant deer could take time to develop. Meanwhile, deer populations, which can double every other year, can continue t expand, and conflicts may increase commensurately. The amount of human resource investment depends on the selected management activity; some programs can rely primarily on volunteers, whereas other tasks may require municipal employees or contractors. Each community should assist in selecting the best option from among those with scientific integrity for their situation. Deer population management requires annual maintenance because deer populations can grow even after management objectives are reached. Any deer management program should be evaluated annually for progress toward the objective, revised to improve efficiency, and adapted to current biological and social conditions.

SURVEYS AND MONITORING

We describe specific methods below that are often used by state wildlife agencies to estimate deer populations. Some methods are less appropriate than others for use in the varying landscapes of urban, suburban, and exurban areas. However, our goal was to describe all methods that could potentially be useful. Investigators involved in individual projects, whether they be agencies or community leaders, will need to make decisions as to what is most appropriate in terms of the field methods employed and the analysis of information gathered.

Random observations that are not collected in a structured fashion can be misleading or widely inaccurate. A statistically valid design is important to ensure that data are comparable and measures are repeatable so that valid comparisons regarding treatment and effects can be inferred. A statistical euphemism states, the plural of anecdote is not data.

Population trend is the directional movement in relative abundance or other key parameters through time (*sensu* Skalski et al. 2005), which is discussed with great detail as applied to deer monitoring in Keegan et al. (2011). Trend indices are measures that correlate with population abundance (or other parameters); thus, trend indices indicate whether a population has increased, declined, or remained stable over time. Trend indices sometimes are used to infer magnitude of annual changes and, if collected over multiple years, they can be analyzed to provide a quantitative estimate of magnitude of population change by linear or nonlinear modeling. Trend indices can be either direct (involve direct counts of

Mule deer can cause substantial damage by feeding and bedding in alfalfa fields (courtesy of B. Wakeling).

deer) or indirect (involve counts of indirect evidence of deer presence, such as scat or tracks).

Despite widespread use of trend indices in wildlife management, there is much uncertainty regarding the usefulness of these indices (Lancia et al. 2005), including debate as to whether they should be used at all (Anderson 2001, Williams et al. 2001). Also, statistical power of trend indices to detect an actual change in population abundance often is low. Consequently, changes in population size have to be quite large (e.g., halving or doubling of the population) to be detected by trend indices. Similarly, statistical theory underlying trend indices has received little study (Skalski et al. 2005). Despite these questions, trend indices are used frequently, primarily because of cost-efficient application over large geographic areas.

Trend indices are used most frequently to index changes in population abundance, although they may be used to index trends in age structure, adult sex ratios, or productivity or recruitment ratios. Although a great variety of trend indices exist, the underlying assumption is that there exists a homogenous (across time, habitats) and proportional relationship between a change in the trend index and a change in abundance or other population parameter. Thus, before using any trend index, managers need to consider 3 key questions:

1. Does a change in abundance result in a change in the index?

2. What is the relationship between deer abundance and the index? Frequently, the relationship is assumed to be linear, but often is not.

3. Are the data for the index collected consistently over time and is the sampling representative of the population? Both of these must be true for a trend index to have any real relationship to abundance.

The primary problem with most trend indices is that the relationship between the index and abundance has not been determined. Despite this, trend indices are treated as if they accurately and precisely reflect population abundance even though such a relationship has not been demonstrated. Because of this uncertainty, trend indices should be used to determine if a relative (as opposed to absolute) change in abundance has occurred. A second important problem among trend indices is difficulty in meeting statistical sampling assumptions. Failure to meet explicit assumptions or apply methods to account for unmet assumptions may result in failure of an index to adequately reflect change in populations.

For most deer trend indices, the relationship between index and deer abundance is not only unknown, but likely not consistent. Rather, it varies over time and among areas due to changes in environmental factors (season, habitat, weather, deer behavior), human influences (hunter behavior, differing observers), and sampling protocols (sampling effort, survey type). A variety of techniques are used to deal with this variation. First, sampling strategies frequently are systematic (i.e., focused on a particular arrangement or number of samples) or stratified random (i.e., divides a sample into groups by some defining characteristic) as opposed to purely random, because these techniques reduce sampling error versus purely random sampling. These standardized sampling strategies attempt to account for vegetation type or other environmental attributes that vary among survey areas or times. By accounting for these differences when designing a survey, the overall index should better represent the entire population.

Systematic or stratified random surveys are easier to implement than completely randomized designs, especially when surveys are associated with roads or trails that are not located randomly across the landscape. A potential negative effect of systematic sampling is the possibility of not capturing all of the environmental variation across the landscape because the sampling is not random

This problem can be overcome by ensuring that stratification (blocking) includes all relevant variables in the stratification (e.g., all habitats likely to be used by deer). A second way to deal with environmental variables that may affect the relationship between abundance and the index includes standardization of survey methodology, which can account for weather and observer effects. Third, important environmental factors can be included and accounted for in models to relate abundance to the index under "constant" conditions.

Many trend indices (such as pellet-group counts, harvest-per-unit-effort, track surveys) have been extrapolated to provide estimates of population abundance, creating considerable overlap between trend indices and abundance estimators. Methods most commonly used as abundance estimators require additional assumptions for extrapolation from index to abundance that is beyond this discussion of trend indices and will be covered in the Abundance and Density section.

MINIMUM AERIAL COUNTS AND CLASSIFICATION

A minimum count represents the absolute minimum number of deer known to be present in a given area (while recognizing an unknown proportion of the population was not seen or counted). Counts and classifications frequently are accomplished through helicopter or fixed-wing airplane surveys; however, several other techniques (e.g., ground counts, spotlight counts) also yield minimum counts. Counts are standardized to effort, such as numbers seen per hour of flight time or kilometers of survey route.

Advantages

- Sample sizes obtained from aircraft usually are greater than ground-based methods because of increased visibility.
- Helicopter counts provide more accurate counts and better sex and age classification than do ground-based counts because of ability to observe deer in inaccessible areas, longer observation times, closer proximity to deer, and ability to herd deer to provide optimal viewing opportunities (however, observing undisturbed deer from the ground with enhanced optics also allows accurate classification). This may not be true if substantial vegetative cover substantially obscures aerial observation of deer or allows only glimpses of deer.
- A segment of the public strongly favors census and minimum counts over sample-based population estimation. Sample-based estimates frequently are called into question and dismissed by the public if they do not mirror perceptions.
- An absolute minimum population estimate that is clear and accepted by the public (sampling techniques, statistical inference, and probability are poorly understood by many constituents).

Note: the last 2 bullets represent challenges to agencies in educating constituents about the value of sampled-based methods.

Disadvantages

- There are very few cases where a deer census is possible. Radio-marking studies have shown even very intensive efforts covering 100% of an area fail to account for all individuals due to concealment or observer factors (Bartmann et al. 1986).
- Costs are high compared to most other indices and generally would be prohibitive except for small, confined areas.
- Although presumed to be more accurate than ground-based methods, validation may be lacking in specific urban environments, particularly for fixed-wing aircraft.
- It is significantly more hazardous for biologists than ground-based methods.

- Minimum counts frequently are smaller than annual harvests, causing the public to question survey data and permit allocations.

- Motion sickness or pilots with insufficient survey experience can result in poor viewing opportunities and highly biased data (e.g., large proportions of groups flee to cover before classification).

- Relationship to true population size often is unknown or uncertain.

Assumptions

- Census – all members of the population in a given area are detected and accurately counted

- Minimum count – members of the population counted in a given area are representative of the actual population.

- If minimum counts are collected across time, a consistent proportion of the population is counted.

- Sex and age classes are identified correctly if population components are separated.

- Detectability is similar across sex and age classes or counts are conducted during biological periods where free intermixing occurs between sex and age classes (Samuel et al. 1987, Bender 2006).

Techniques

Both population censuses and minimum counts are conducted from either helicopter or fixed-wing aircraft, with flight protocols (such as airspeed, altitude above ground level [AGL], and spacing of transect lines) and observer behavior (including number of observers, direction of observation, and width of transect lines observed) held constant among surveys. Because population census is seldom feasible for free-ranging deer, remote sensing techniques are being evaluated to increase efficiency and improve detection rates (Lancia et al. 2005). Experimental techniques include use of aerial photographs to count concentrations of individuals or thermal imaging. However, remote methods seem to have limited applicability, particularly with respect to classification. Forward looking infrared (FLIR) sensing has been used for a variety of ungulates with limited success outside of smaller or enclosed areas (Dunn et al. 2002, Drake et al. 2005). Additionally, remotely operated vehicles are being explored as a means to decrease risks to biologists (K. Williams, U.S. Geological Survey, personal communication).

Minimum aerial counts are the most commonly used trend index for deer. Minimum counts are converted to estimates of population abundance in 1 of 3 ways:

1. Correcting counts for different likelihoods of observing deer based on habitats

2. Altering size of sampling units based on habitat (Bartmann et al. 1986, Freddy et al. 2004)

3. Assuming all deer along the aerial transect were seen and estimating the width of the transect using distance sampling methods to correct for varying detection probabilities based on habitat, transect width, or other variables

Uncorrected aerial surveys flown with standardized flight protocols to ensure consistent and near total coverage of sampled areas are converted to deer observed/unit area or deer observed/hour to obtain a population index. Aerial counts for population trend, as contrasted with counts used solely for sex and age composition, usually have much more specific survey protocols

Deer may seek urban, suburban, or exurban landscapes to raise their young as a means to avoid predators and exploit higher quality forage (courtesy of Missouri Department of Conservation).

similar to those required for abundance estimators such as sightability models. Despite this, as with sightability models and similar methods, estimates always will be biased negatively because topography and other visual barriers prevent complete observation of survey units.

SPOTLIGHT SURVEYS AND GROUND COUNTS

Spotlight surveys and ground counts are similar, with spotlight surveys representing a special case of ground surveys. Spotlight surveys are conducted at night when deer may be less reluctant to use open habitats or areas adjacent to roads (Harwell et al. 1979, Uno et al. 2006). Both spotlight surveys and ground counts are used to collect minimum count and herd composition data. Typically, routes are standardized, replicated, and conducted from motor vehicles (especially for spotlight surveys); ground counts may be conducted on foot or from horseback as well. Surveys can be based on continuous observation along a route or restricted to observation points. Distance sampling methods, including stratification by habitats, occasionally are used to extrapolate minimum counts to abundance estimates.

Advantages

- They are easy to conduct, inexpensive compared to aerial surveys, and can cover large geographic areas.
- Fawn-to-doe ratios are produced, similar to those from aerial surveys (Bender et al. 2003).

Disadvantages

- Roads do not occur randomly across the landscape, and their location likely biases proximity of deer (e.g., may be along a riparian area). Buck-age structure and sex-ratio data are likely biased because of poorer sighting conditions and behavior of bucks as compared to helicopter surveys.
- Detection probabilities vary with habitat conditions, weather, observers, and disturbance.
- Amount of traffic along trails or roads can affect proximity of deer.
- Sample sizes are usually low compared to aerial surveys.
- Low light capability of optics influences results.
- They may generate disturbance to adjacent human residents.

Assumptions

- Sample is representative of the population.
- Index reflects changes in population size rather than changes in deer distribution or detectability.
- Roadsides or trails are representative of area in general or non-changing over time, or surveys stratified by habitat.
- Deer are equally observable every time the survey is conducted (e.g., vegetation screening between seasons or years is not variable).

- Methods are consistent among years and groups counted without error.
- Sex and age classes are correctly identified and have similar detectability.
- Observers are equally skilled.
- Extrapolation to population size or density requires further assumptions outlined under distance sampling and sightability models in the Abundance and Density section.

Techniques

Methods used include horseback counts, hiking counts, and counts from motorized vehicles. Ground counts can involve riding, driving, or hiking along a route or among observation points. Surveyors move along a standard route, traveling from 1 location to another that provides a good vantage point for searching for deer. If using specific observation points, the observer moves farther along the survey route until the next observation point is reached. Survey data can be interpreted as minimum numbers counted, numbers observed/km traveled, or used as inputs into distance sampling models to estimate abundance.

Spotlight surveys are conducted in habitats that are representative of the area being surveyed and shortly after dark, when deer are active and may be less reluctant to use areas close to roads. A driver navigates a vehicle along a permanently established route, while an observer(s) shines a spotlight along the side of the route and records all deer seen and classifies deer by sex and age. Typically, number of deer seen/km of route serves as an index to deer abundance, and sex and age composition provides trend information on population demographics. Data may be used as inputs in distance sampling models. However, managers should recognize deer distribution is likely not independent of roads and a rigorous sampling approach is necessary.

For both ground and spotlight surveys, routes should be repeated several times each year to account for variability in survey conditions and reduce the chance of an unusually high or low count being used to index population trend. Occasionally, the highest total among replicated surveys is used to index the population as it reflects the minimum number of individuals known to be present.

HARVEST PER UNIT EFFORT (HPUE)

Harvest per unit effort scales total harvest by some estimate of hunter effort, most commonly the number of hunters or number of hunter-days (i.e., the total number of days hunters actually spent hunting). As the estimate of effort becomes more refined (hunter-days instead of hunters), the trend estimate is considered more sensitive to changes in abundance.

Advantages

- Collecting effort data through harvest surveys is relatively easy and inexpensive.
- It is presumably more accurate than harvest uncorrected for effort.
- There is a strong empirical background in fisheries management.

Disadvantages

- The method is subject to response distortion biases present in social surveys.
- It is vulnerable to changes in hunter behavior.
- Changes in deer vulnerability are influences (e.g., weather conditions, road closures, hunter access, antler restrictions, allocation among weapon types, rutting behavior of bucks).
- High hunter densities may cause interference in harvest rate and bias HPUE estimates.

- Low hunter densities, limited-entry harvest strategies, and mature-buck management strategies can result in significant hunter selectivity and thus influence the relationship between HPUE and deer density.

Assumptions

- Harvest and effort data are accurate and unbiased.
- The population is closed during hunting season except for harvest removals.
- Probability of harvest is constant during the season (can be corrected for differential vulnerability among areas).
- Harvest is proportional to population size.
- Effort measure is constant (i.e., hunters equally skilled).

Techniques

Harvest and effort data are most commonly collected from hunter surveys, electronic or phone check-in of game, or check stations where deer are physically presented. The HPUE index, such as 0.05 deer harvested/hunter-day, is used as a stand-alone trend index to compare changes within a management unit and is considered to be more reflective of actual changes in population abundance than harvest alone because of the accounting for hunter effort (Roseberry and Woolf 1991). However, HPUE does not account for variation in harvest rates due to effects of weather or other factors that could influence harvest. Hence, use of running averages across multiple years reduces the effects of annual variation in these factors. Comparisons among management units differing substantially in vegetation associations is a problem because HPUE reflects both abundance and vulnerability of deer, and vulnerability can change with variations in hiding cover. Roseberry and Woolf (1991) found some HPUE models to be very useful for monitoring white-tailed deer population trends based on harvest data.

TOTAL HARVEST

The simplest trend index is an estimate of total hunter harvest (i.e., total number of deer taken by hunters). This index assumes encounters between hunters and deer, and thus harvest, increase as deer abundance increases and decline as abundance declines.

Advantages

- Data can be easily collected, primarily from surveys of hunter effort and harvest.

Disadvantages

- Annual variation in harvest estimates can be high and thus provides limited inference for population trend.
- Vulnerability to harvest changes occurs with changes in hunter behavior (e.g., regulation changes, equipment changes).
- Vulnerability to harvest changes occurs with environmental conditions (e.g., weather conditions, changes in access, habitat changes).
- Harvest rate varies with hunter and deer density.
- Many potential sources of bias (response distortion) may occur in hunter questionnaires, which are frequently not accounted for.
- Often there are no estimates of variance, thus providing no basis for statistical inference.
- Often accuracy is unknown or poor.
- Generally, these are more effective with very intensive buck harvest strategies, such as open entry seasons.

Assumptions

- Harvest data are accurate.
- Harvest is proportional to population size.
- There is no response or non-response bias if collected through hunter questionnaires.
- Harvest rate (proportion of population harvested) is constant among areas or time periods being compared.
- The deer population is closed during hunting season except for known harvest removals (e.g., no in-season migratory movements).

Techniques

Harvest data most often are collected via hunter surveys or, less commonly, hunter check stations. If season length and other harvest regulations are the same among seasons, then total harvest alone is used as a trend index within management units. Total harvest should not be used as an index among dissimilar management units because of the substantial influence of habitat on deer vulnerability. Value of harvest as an index declines as limitations on harvest increase relative to deer abundance (e.g., reducing hunter numbers through limited entry). Harvest indices are based on buck harvest because female harvest often is more limited. If season lengths vary, harvest may be modified to harvest/day or daily harvest modeled as a function of season length or numbers previously harvested, with the latter used to estimate population abundance (Davis and Winstead 1980, Lancia et al. 2005). Age-at-harvest data are used in many population reconstruction models (Williams et al. 2001, Skalski et al. 2005).

TRACK SURVEYS

Track surveys involve counting numbers of individual tracks or track sets that cross a road or trail, usually with direction of movement limited to 1 way to reduce double counting (McCaffery 1976). Surveys are conducted following clearing of roads or trails of old track sets by dragging or following snowfall that covers previous tracks. Data are used as a relative index or minimum count but can be used to calculate densities (Overton 1969).

Advantages

- The method is simple to conduct, relatively inexpensive, and cover a large geographic area.
- It may be used for preliminary sampling to implement a more robust method.

Disadvantages

- The method is not statistically rigorous.
- There is difficulty in distinguishing among individuals or species if several ungulate species are present.
- It is dependent on activity levels and movement patterns.
- It is dependent on proper weather or substrate conditions for accurate counts.
- Multiple counts of the same individuals are very likely.
- Mild or severe weather conditions that influence use of seasonal ranges in some years may result in unreliable data.
- The number of individuals may be indiscernible when deer travel in groups.

Assumptions

- Methods are consistent among years and groups of deer are counted without error.
- Index reflects changes in population size rather than changes in deer distribution or activity levels.

- Extrapolation to population density requires further assumptions (Overton 1969).

Techniques

Tracks are counted along dirt or sand roads, which are dragged before counting, or during deer migrations, usually when leaving winter ranges. In the former, roads are dragged to obliterate any tracks that are present; then routes are revisited after some time period (often weekly, assuming no disturbance to survey substrate [e.g., rain that washes away tracks]). The index is presented as number of track sets/km if collected over the same amount of time annually but can be converted into density by making several assumptions about deer movement patterns (Overton 1969). For winter range counts, survey routes are established so they run perpendicular to travel routes between winter and spring ranges and counted periodically after the start of migration to spring ranges (Wyoming Game and Fish Department 1982). Only deer tracks moving away from winter ranges are counted, with counts run after fresh snowfall or after dragging routes to clear existing tracks. The index in this case presents the minimum number of individuals counted or number of tracks/km if routes are run for the same time period each year (usually the entire migration period).

PELLET COUNTS

Pellet group surveys involve counting the number of fecal pellet groups encountered in plots or belt transects. Mean number of groups can be used as a trend index or converted to estimates of population size by integrating defecation rates and number of days indexed (Marques et al. 2001). Pellet group counts for population trend are conducted most frequently on winter ranges. Because habitats are not uniform and pellet group distribution depends on relative habitat use, pellet group transects are stratified among vegetation types (Neff 1968, Härkönen and Heikkilä 1999). For greatest accuracy, permanent transects that are cleared of old pellet groups after each survey should be used to eliminate confusion in aging pellet groups.

Advantages

- The method is easy to conduct, little equipment is needed, and it can cover a large geographic area.
- It has been correlated with other trend indices including aerial counts and hunter observations (Härkönen and Heikkilä 1999).
- It can provide data on relative use of habitats (Leopold et al. 1984).

Disadvantages

- Power to detect trends is frequently low, particularly for low-density populations.
- Size and shape of plots (e.g., belt transects vs. circular plots) and sampling effort strongly affect results (Härkönen and Heikkilä 1999).
- Bias is associated with inclusion or exclusion of groups lying along plot boundaries.
- It is difficult to distinguish species in the field if several species of ungulate are present.
- It is more appropriate for areas of seasonal concentration such as winter ranges.
- Degradation of pellets varies in different environmental conditions and with populations of scavengers such as dung beetles (Coleoptera).
- For abundance estimation, there is little validation of most commonly used daily defecation rates, which vary with season and diet.
- It is labor-intensive to conduct over large area.
- There is potential for observer bias in aging pellet groups if transects are not cleared after each counting.

- It does not account for deer that defecate in the plot only once before leaving the survey area.

Assumptions

- Methods are consistent among years and groups are counted without error.
- Index reflects changes in population size rather than changes in deer distribution, activity levels, or behavior.
- Extrapolation to population abundance requires further assumptions including (1) constant defecation rates, (2) exact knowledge of time of use in days, and (3) population density uniform throughout range.

Techniques

This method involves clearing permanent plots or belt transects of accumulated pellet groups and returning after a specified time period to count the number of new pellet groups. Number of pellet groups/unit area or transect serves as the index to abundance. Pellet group surveys often are used on winter ranges at the end of winter. Pellet group counts are converted to densities by dividing by the estimated number of times a deer defecates/day and number of days plots were exposed. For example, if assuming a deer defecates 10 times/day, and 700 pellet groups/acre are found after 10 days, it is assumed 7 deer were present (7 deer × 10 days × 10 pellet groups/day/deer; Neff 1968, Härkönen and Heikkilä 1999). Although used as a trend index or abundance estimator, pellet group counts are more valuable in determining relative habitat use patterns (Neff 1968, Leopold et al. 1984, Härkönen and Heikkilä 1999).

Pellet group data are inherently non-normal in distribution, so more complex analysis techniques are useful in teasing out inferences. The negative binomial distribution (Bowden et al. 1969, White and Eberhardt 1980) is particularly useful for examining pellet group data.

Suburban archery deer hunt (courtesy of Missouri Department of Conservation).

HUNTER OBSERVATION SURVEYS

Hunter observation indices involve having hunters record the number, and occasionally sex and age classes, of deer seen during hunts. Because hunter numbers and effort can be large and are confined to a relatively narrow time frame, numbers of animals seen and herd composition samples collected by hunters can be large and have been correlated with other independent estimates of population size, trend, and composition (Ericsson and Wallin 1999).

Advantages

- A tremendous number of person-days of effort are obtained with little cost to agencies.
- In some cases, large sample sizes are provided

- It has been correlated with other trend indices and with aerial survey data (for other species).
- The hunting public is provided with a sense of ownership of population data.
- Little agency time is required to corroborate other trend indices.

Disadvantages

- The method is sensitive to responses and biases of hunters.
- Untrained observers may not count or classify deer accurately.
- Independence of observations is unknown (but can be accounted for if double counts are assumed when constructing confidence intervals around ratio estimates).
- Detection of target species varies among habitats and thus changes in distribution may be confused with changes in population size unless stratified by habitat.
- Relationships between observation index and abundance vary among areas.
- Precision of estimates is low or undefined.

Assumptions

- Numbers of deer are observed and recorded without bias.
- Sex and age classification are correctly identified and reported.
- Number of hunter-days is consistent or observations are standardized per hunter day.
- Hunters are equally skilled in detecting deer (for abundance trend only).

Techniques

Hunters are provided data forms and asked to record numbers and sex and age classes of deer seen during their hunts and number of days (or similar measure of effort) hunted. Data are converted to a standard measure of effort, such as deer seen/hunter-day for the trend index (Ericsson and Wallin 1999). Data for deer seen/hunter-day are compared within an area between years to estimate annual rate of change in population size. Because ability to detect (observe) deer varies among habitats, this index (as well as all other direct indices) should not be used to compare management units differing in habitats. Although infrequently used for mule deer, estimates of annual population change and calf:cow ratios obtained from this method have been shown to be similar to aerial survey counts for moose (*Alces alces*; Ericsson and Wallin 1999). These data are much less expensive to collect, suggesting this method may provide a usable index for deer management with further development of the technique.

ABUNDANCE AND DENSITY

Estimates of abundance or density (i.e., abundance per unit area) over broad geographical areas are desired to empirically manage deer populations. Because deer are widespread and often inconspicuous, total counts have proven to be impractical, even when localized and in fairly open habitats. As a result, statistically based sampling methods offer the only realistic way to estimate deer numbers on the scale of most management units. Cover and terrain can make deer inconspicuous; therefore, methods used to estimate abundance must account for incomplete detectability of deer in the sampling areas. Based on studies with radio-marked deer and counts of known numbers of deer in large enclosures, detectability is considerably <100%, even when the census effort is very intensive (McCullough 1979, Bartmann et al. 1986, Beringer et al. 1998). To help address problems related to widespread distribution and incomplete detectability, abundance and density estimates are made during winter when deer are more concentrated and more visible against snow cover. Estimates of deer abundance and density are further complicated because numbers are dynamic, and populations are seldom geographically discrete. Deer are born, die, immigrate, emigrate, and move back and forth across management unit or sampling frame boundaries. Methods for estimating abundance and density must take into account whether the population of interest is assumed to be geographically and demographically closed or open during the sampling period. Population modeling offers an alternative to sample-based population estimation by using demographic parameters such as harvest mortality, sex and age ratios, and survival estimates to predict population numbers. Unfortunately, the public can be highly skeptical of credible model-based population estimates that do not conform to their perceptions because actual deer are not being counted (Freddy et al. 2004).

Young deer in urban setting (courtesy of G. Westerfield).

DISTANCE SAMPLING

Distance sampling can be used to estimate number of deer within a fixed distance away from a line or from a point based on distribution of decreasing detection probabilities as distance increases (i.e., deer farther away are harder to see; Buckland et al. 2001, 2004; Thomas et al. 2010). Population size can be extrapolated from numbers of deer in a sample of line transects or plots stratified by deer density or habitat. Distance sampling for ungulates occurs along transects from a fixed-wing airplane or helicopter and has been used primarily for species such as pronghorn (*Antilocapra americana*) that occur in relatively flat, open habitats (Johnson et al. 1991, Guenzel 1997, Whittaker et al. 2003, Lukacs 2009).

A similar method has been evaluated for mule deer in pinyon (*Pinus* spp.)-juniper (Juniperus spp.) habitat in a large enclosure with relatively small bias (White et al. 1989). Use of distance sampling for roadside surveys or spotlight surveys is not recommended because the assumption that deer distribution is independent of transect location is unlikely to be valid when roads are used as transects. Violating the assumption of independent distribution can result in biased estimates.

Advantages

- A robust method provides relatively few constraining assumptions compared to other methods.
- The method provides a probabilistic estimate that accounts for detectability and does not require marked deer if all deer on the line of travel are assumed to be 100% detectable.
- It can be relatively inexpensive if used in open and flat areas where use of fixed-wing aircraft is practical.
- It is easy to design and conduct using geographic information system (GIS) software and global positioning system (GPS) units.
- The method can be applied to ground mortality transects as well as aerial population surveys.

Disadvantages

- It is only realistic in open areas with little terrain relief where deer close to the line of travel are almost 100% detectable. However, this can be addressed using modified survey and statistical methods. For deer, this method should be limited to habitats such as upland plains, open agricultural areas, or perhaps some sagebrush (*Artemisia* spp.)-steppe winter ranges. Even in these habitats, a helicopter would be required as the sighting platform to achieve acceptable detectability.
- Confidence intervals can be wide (e.g., 95% CI > ±25%) when there is high variability in deer densities among transects within a stratum.
- It is dependent on assigning individual deer or clusters of deer to the correct distance interval or accurately determining distance from the line of travel. This can be problematic, especially with high densities of deer.
- Observer fatigue can become an issue during prolonged surveys.
- It can be expensive if a helicopter is used.

Assumptions

- All deer on the line of travel are detected or accurately estimated.
- Distances are measured accurately, or deer are recorded in the correct distance band.
- Detection probability decreases as distance from the line of travel increases.
- Deer distribution is not related to transect distribution.
- All deer within a detected group are accurately counted (if group or cluster is the sampling unit). If the individual is the sampling unit, th

assumption no longer applies.

- Deer are detected in their original position before any movement related to the survey effort. Deer are not recounted during the survey.

Techniques

Aerial distance sampling for ungulates usually involves:

1. Establishing a set of lines of known length across the area of interest that delineate centerlines of a set of fixed-width transects.

2. Flying along each line while maintaining height AGL as constant as possible (with fixed-wing aircraft the flight path may be offset from the line to compensate for the blind spot directly below the aircraft).

3. Assigning individual deer or clusters of deer concurrently to fixed-width bands that delineate specific distance intervals away from and perpendicular to the line of travel.

Transects usually are parallel and systematically spaced across the area of interest with a random starting point. Stratification based on deer density or habitat can be used to help reduce variance. As an alternative to 2 and 3 above, actual distances of deer or clusters perpendicular to the line can be determined using a laser range finder and the sighting angle. However, for species such as mule deer that often occur in numerous, small groups, use of distance intervals rather than actual distances is much more practical (Guenzel 1997). Fortunately, little bias results from assigning deer to distance intervals as opposed to measuring actual distances (Thomas et al. 2010). Distance intervals can be delineated using strut markers (fixed-wing aircraft) or window markers (helicopters) that have been calibrated for a specific AGL (e.g., usually 25–100 m depending on aircraft type, cover, and terrain) to demarcate distance intervals perpendicular to the line of travel using a specific eye position (Guenzel 1997). The AGL can be measured using a digital radar altimeter or a laser rangefinder mounted on the belly of the aircraft. For each observation, AGL should be saved automatically to a computer to allow distance measurements to be corrected, if necessary, for actual AGL. Effective transect width (i.e., truncation limits) and width of distance intervals depend on predicted detectability (i.e., narrower widths are used as detectability decreases). Typically, 4 or 5 distance intervals are used to estimate an adequate detection function.

Program DISTANCE was designed specifically to estimate population size from distance sampling data (Thomas et al. 2010). This software:

1. Models detection probabilities as a function of distance from the line of travel when 100% detectability is assumed on the line of travel.

2. Allows covariates (e.g., cluster size, habitat, weather conditions) to be considered in the distance model.

3. Allows mark-recapture data to be incorporated.

When detection on the line of travel is not certain, simultaneous double counts using 2 independent observers or a sample of radio-marked deer can be used to correct for incomplete detectability (Kissling and Garton 2006). Cluster size bias can occur using distance sampling because as distance from the line increases, deer in large groups (i.e., clusters) are detected more easily than individual deer or small clusters. Program DISTANCE can correct for cluster bias using regression methods based on the number of deer counted in each cluster relative to their distance from the line.

STRIP-TRANSECT SAMPLING

In areas where cover and terrain make distance sampling infeasible, fixed-width (strip) transect sampling can be used to obtain a minimum count that can be adjusted using generic or survey-specific detection rates based on detectability of marked deer. Population size then can be extrapolated from the sample of strip transects corrected for detection rates. Helicopter line transects have been evaluated for mule deer and white-tailed deer with satisfactory results (White et al. 1989, Beringer et al. 1998). However, Freddy (1991) compared quadrat sampling to transect sampling for mule deer in sagebrush habitat and reported estimates >200% larger when transects and detection probabilities were used compared to quadrat sampling with a generic sightability correction, leaving doubt as to which method was more biased.

Advantages

- Transect sampling can be used in some situations where distance sampling is not feasible because of low detectability or terrain.
- Transect sampling designs are relatively easy to lay out with GIS and are easy to fly with GPS units.
- The method provides a probabilistic estimate of the number of detectable deer that can be adjusted using detection probabilities.

Disadvantages

- Detection probabilities should be determined using a sample of radio-marked deer, and this can add to costs. Depending on diversity of habitats being sampled, different detection probabilities may be required for different strata, transects, and even within individual transects.
- It is relatively expensive because an aircraft is required, and considerable flying may be needed depending on size of the sampling frame, deer distribution, cover, and desired precision. In areas with substantial cover and terrain, transect widths must be reduced.

Assumptions

- Transect width can be determined accurately and deer can be identified correctly as being in or out of the transect.
- Deer do not move out of a transect before detection, and they are not recounted in subsequent transects.
- Marked deer have the same probability of being sighted as unmarked deer.
- Detection rate estimates are unbiased and accurately represent actual detection rates.

Techniques

Transect counts for deer usually are flown using a helicopter. Transect width can be delineated by tape on the windows that has been calibrated for a specific AGL height. Unlike distance sampling, there is no need to demarcate distance intervals. Similar to distance sampling, sample transects run parallel, are spaced evenly across the area to be surveyed, and have a random starting point. Stratification based on deer density or habitat can be used to help reduce variance. Habitat should be homogenous within each stratum to minimize the number of unique detection probabilities required.

PLOT SAMPLING USING QUADRATS

Quadrat sampling is similar to transect sampling except population size is extrapolated from a sample of randomly selected polygons (often square) and, prior to GPS technology, laid out using cadastral coordinates (e.g., section lines). Small (i.e., usually ≤2.6 km^2), intensively surveyed quadrats are used as sampling units in an attempt to improve detectability and stratified based on habitat or prior deer density informatio

Sampling designs can include random, random spatially balanced, and hybrid census and sampling combinations. Quadrat sampling methods for mule deer were described by Kufeld et al. (1980) and Bartmann et al. (1986).

Advantages

- The method provides a probabilistic estimate of number of detectable deer.
- The design is fairly straightforward and can be laid out with GIS (prior knowledge of deer distribution is very helpful) and flown using GPS.
- Handling and marking of deer are not required.

Disadvantages

- It is relatively expensive because a helicopter is required and considerable flying may be needed depending on size of the sampling frame, deer distribution, and desired precision.
- Confidence intervals can be wide (e.g., 95% CI > ±25%) irrespective of sample size, especially when deer occur in an unpredictable or clumped distribution.
- It does not include an inherent detectability correction, so actual population size is unknown. Generic sightability factors can be used to adjust the population estimate, but they can be of questionable value because a number of variables can influence sightability (e.g., group size, cover, terrain, snow cover, time of day).
- When deer densities are high, it can be difficult to keep track of deer that have already been counted.
- Deer may move out of a quadrat in response to the aircraft before they are counted.
- Quadrat methods for estimating mule deer numbers can require considerable helicopter time: 20–40 hours are typical for management units in Colorado, USA [Kufeld et al. 1980]).
- Extensive amounts of flying can cause observer fatigue and result in prolonged surveys because of weather and conflicting work assignments.

Assumptions

- Each quadrat within a stratum that may contain deer has a known (often equal) probability of being selected for sampling.
- Deer are detected at a fairly high rate (e.g., >60%), are not double counted, are not erroneously accounted for by being forced into or out of a quadrat, and are accurately identified as being in or out of a quadrat when close to the perimeter.
- Generic sightability factors accurately represent actual detection probabilities.

Techniques

Quadrat methods use sampling polygons with small areas (0.65–2.6 km^2) to increase detection rates. Smaller quadrats are used in areas with considerable cover, such as pinyon-juniper woodlands, whereas larger quadrats can be used in more open areas, such as sagebrush-steppe. Using similar-sized quadrats tends to decrease among-quadrat variation but is not required. In the past, sampling designs were based on cadastral section lines, but GIS and GPS units have increased design flexibility. Use of GPS units also makes quadrat sampling more practical because quadrats can be flown accurately without landmarks. Stratification is useful for increasing precision and for optimally allocating sampling effort based on expected deer density. When there is sufficient prior knowledge of deer distribution, stratification on a quadrat by quadrat basis is better than by geographical area.

Use of multiple helicopters and crews is recommended to finish counts in a timely manner under preferred conditions when snow cover is present. Quadrats should be flown by first followi the perimeter to identify deer close to the boundary as being in or out. The interior of the quadrat then is flown with sufficient intensity to count all detectable deer. Even though the quadrat method attempts to maximize detectability compared to sampling using transects or larger area units, unknown detectability remains an obvious issue. Survey-specific detection probabilities could be determined by including a sample of radio-marked deer or using sightability covariates, but the small size of the quadrats and high cost of the quadrat method make this impractical in many cases. In lieu of specific detection probabilities, generic sightability factors developed using radio-marked deer in similar habitats have been used to adjust quadrat population estimates. In Colorado, a sightability factor of 0.67 is used for quadrats in pinyon-juniper winter range and 0.75 is used for sagebrush-steppe (Bartmann et al. 1986; Colorado Division of Wildlife, unpublished data). For generic sightability factors to be applicable, quadrats should be flown with as many variables as possible similar to those that occurred when sightability factors were developed (e.g., high percentage of snow cover, same number of observers, quadrats with the same area). However, even when effort is made to keep survey protocols as consistent as possible, the validity of using generic sightability factors can be questionable because of the number of variables that can affect detectability (e.g., group size, deer activity, time of day, cloud cover, type of helicopter, experience of observers).

PLOT SAMPLING USING SIGHTABILITY MODELS

This method is similar to quadrat sampling except that (1) it includes a model developed using logistic regression methods to account for undetected deer based on a variety of sightability covariates, (2) size of sampling units can be larger than those typically used for quadrat sampling, and (3) sample unit boundaries can be based on terrain features, such as drainages, instead of cadastral units or GPS coordinates (Samuel et al. 1987, Ackerman 1988, Freddy et al. 2004). A sightability model is developed for a specific survey intensity (i.e., survey time at a given elevation and airspeed per sampling unit area) by relating detectability of radiomarked deer to variables such as habitat, group size, deer activity, screening cover, terrain, snow cover, type of helicopter, and observer experience. Sightability models account for a more comprehensive set of detectability variables than generic sightability factors often used with intense quadrat sampling and allow the contribution that each variable makes to detectability to be evaluated using a stepwise approach. Once the sightability model is developed for a specific survey intensity, covariates supplant the need for determining detection probabilities using radio-collared deer. Even when survey intensity is kept relatively constant, sampling units should be similar in size to help eliminate variables such as increased observer fatigue when larger units are surveyed. Population size can be extrapolated from a set of representative sampling units.

Advantages

- The method provides a probabilistic population estimate that includes a sightability correction.
- Once established, sightability covariates are easier and less expensive to measure than detection probabilities.
- Larger sampling units can be flown than with quadrat sampling as long as the sightability model was developed using sampling units similar in size to those being flown and sampling intensity is consistent.
- Larger sampling units are less affected by some potential sources of error than small quadrats (e.g., pushing deer out of the sample unit before they are detected, determining whether a deer is in or out of the sample unit, double counting the same deer when densities are high).
- Stratified random sampling of sample units produces precise estimates for lowest costs.

Deer, like this white-tailed deer in Missouri, can prove difficult to enumerate and monitor in urban, suburban, and exurban landscapes (courtesy of Missouri Department of Conservation).

Disadvantages

- Initial costs to develop sightability models are high. Radio-marked deer must be used to develop different sightability functions for a wide variety of habitats and conditions.
- Ongoing costs are high due to extensive helicopter time required to conduct surveys on a management unit basis.
- A sightability model only applies to the specific conditions for which it was developed. Transferability of sightability models to habitats, survey intensities, and conditions different than those used to develop the models are not recommended and could result in highly biased results.
- Variance is likely to increase as detectability decreases.
- Population size can be underestimated if all deer in detected groups are not accurately counted (Cogan and Diefenbach 1998).
- Sampling units based on geographical features may not be random, but drawing sampling units under stratified random sampling produces unbiased estimates.

Assumptions

- Probability of detecting deer is relatively high and can be accurately predicted using sightability covariates under a variety of circumstances (i.e., model captures all significant variation in sighting probabilities where it will be used).
- Sampling units are representative of the overall sampling frame, and the sampling units are analogous to randomly distributed units.
- Deer in detected groups are accurately counted.

Techniques

Unlike quadrat methods that rely on small sampling units to increase sightability, use of sightability covariates allows sampling units to be larger and less intensively flown as long as applicable models have been developed. Sampling units are defined based on geographical features instead of constant-sized quadrats. Similar to quadrat and transect methods, precision of population estimates using sightability models can be increased by stratifying the sample area by habitat and deer density. Ideally, sampling units should be selected at random or spatially balanced. However, when terrain features are used as sample units, they should be selected to be as representative as possible of each stratum. Population size can be extrapolated from a set of representative sampling units. Sampling units may be stratified according to deer density, thereby reducing variability of a population estimate. All deer in detected groups must be counted accurat to avoid underestimating population size (Cogan and Diefenbach 1998). Sightability survey techniques were described in detail by Unsworth et al. (1994, 1999).

MARK-RESIGHT AND MARK-RECAPTURE

Mark-recapture methods use the ratio of marked (i.e., individually identifiable) to unmarked deer in population samples to estimate population size (Thompson et al. 1998). The population of interest must be defined in time and space and identified as being geographically and demographically closed or open. Basic mark-recapture models include the Petersen or Lincoln index (Caughley 1977) for closed populations and the Jolly-Seber Model (Jolly 1965, Seber 1982) for open populations. These basic models have limited practical value because the assumptions required usually cannot be met in field situations. To address the need for more practical assumptions, a variety of more complex and flexible mark-recapture models have been developed that require computer-assisted solutions (i.e., no closed form estimator is available). The programs MARK and NOREMARK have been developed specifically for this purpose (White 1996, White and Burnham 1999).

More traditional mark-recapture methods are based on sampling without replacement whereby the method of recapture (i.e., being caught in a trap) effectively prevents an individual from being counted more than once per sampling occasion. Although these methods can be very useful for small, inconspicuous, or furtive species, actual recapture is seldom feasible or desirable for more conspicuous large mammals such as deer. As a result, mark-recapture methods that use resighting, with or without replacement, instead of recapture have been developed for more conspicuous species. These mark-resight methods allow relatively noninvasive monitoring instead of actual recapture and subsequent marking of unmarked deer, thereby reducing stress on the deer and costs.

Mark-resight methods have been used to estimate localized mule deer numbers (Bartmann et al. 1987, Wolfe et al. 2004), and newer mark-resight models that incorporate maximum likelihood have improved this method and its potential application to deer (McClintock et al. 2009*a, b*).

Unfortunately, mark-resight methods may not be practical for estimating deer abundance on a large scale (e.g., management unit) because of the cost and time required to mark enough deer and conduct resighting surveys. As an alternative, quasi mark-resight approaches have been developed that use mark-resight data to calculate correction factors (i.e., detection probabilities) for incomplete counts (Bartmann et al. 1986, Mackie et al. 1998) or that use simultaneous double-counting to eliminate the need for marking deer (Magnusson et al. 1978, Potvin and Breton 2005). Infrared-triggered cameras (IRCs) have been used to assist in sighting efforts and proven to provide accurate estimates of population size when coupled with the correct statistical methods (Curtis et al. 2009, Hamrick et al. 2013). Curtis et al. (2009) concluded that using program NOREMARK or the Jacobson buck:doe ratio method provided the most reliable estimates when using IRCs.

Advantages

- It is considered one of the most reliable methods for estimating abundance of wildlife populations when sample sizes are adequate and assumptions are not violated.
- Unlike most other sampling methods, mark-resight methods explicitly account for detectability (even deer with essentially no detectability).
- Multiple resighting surveys (aerial or ground) can be done over time to increase precision and allow modeling of individual heterogeneity in detection probabilities among individual deer (Bowden et al. 1984; Bowden and Kufeld 1995; McClintock et al. 2009*a, b*).

- The method provides a probabilistic estimate of population size and, with some more advanced models, allows some demographic parameters to be estimated.

- It can be applied using a wide variety of distinct marks (e.g., tags, collars, radio transmitters, paint, DNA, radioisotopes, physical characteristics, simultaneous duplicate counts) and resight methods (e.g., motion-triggered infrared cameras, hair snags, pit tag scanners, hunter harvest).

Disadvantages

- Achieving an adequate sample of marked deer, ensuring marks are available for resighting, and conducting resighting surveys can be expensive and labor-intensive.

- It is usually not practical over a large geographical area with a widely distributed species, such as mule deer.

- Although the precision of mark-resight estimates is determined by a variety of factors (e.g., number of marks, detection probabilities, number of resight occasions), confidence intervals can be wide (e.g., 95% CI > ±25% of point estimate) for practical applications.

- The method is dependent on a variety of assumptions, which, if violated, can result in spurious results. Methods with less restrictive assumptions may result in reduced precision and accuracy.

- Marked deer may become conditioned to avoid resighting.

- Some quasi mark-resight methods, such as simultaneous double-counts, can be much less reliable and inherently biased because of individual deer heterogeneity.

Assumptions

Assumptions vary depending on the estimator being used (White 1996). Basic assumptions include:

- Population in the area of interest is, to a large extent, geographically and demographically closed unless gain and loss are equal or can be estimated reliably.

- Each deer in the population has an equal probability of being marked, and marks are distributed randomly or systematically throughout the population of interest.

- Number of marks available for resighting in the sampling area is known or can be estimated reliably.

- Each deer in the population, marked or unmarked, has an equal probability of being sighted or individual sighting probabilities (i.e., resighting heterogeneity) can be estimated.

- Marks are retained during the resight sampling period.

- Deer are identified correctly as being marked or unmarked when sighted.

Techniques

Most mark-resight population estimates of deer use radio-marked animals. Radio-marking has the advantage of allowing confirmation of the number of marked deer available for resighting within the area of interest and identification of individual deer. Radio-marks have some disadvantages (e.g., deer need to be captured to have radios attached, equipment is expensive, radios can fail). In lieu of radio-marking, a variety of other marks have been used with mixed success for deer, including ear tags, neck bands, a variety of temporary marks (e.g., paint balls; Pauley and Crenshaw 2006), and external features, such as antler characteristics

(Jacobson et al. 1997). Regardless of the marking method, marked deer should not be more or less visible than unmarked deer (e.g., fluorescent orange neck bands could make marked deer stand out more than unmarked deer), nor should the marking method influence the resighting probability of marked versus unmarked deer (e.g., deer captured and marked using helicopter net-gunning may avoid a helicopter more than unmarked deer during resighting surveys). Marks can be generic or individually identifiable. The latter has the advantage of allowing estimation of individual detection probabilities, which will improve the accuracy of some models.

Collection of DNA samples from scat or hair has become popular for identifying individual animals in mark-recapture studies. Use of DNA has the major advantages that deer do not need to be handled for marking, sampling is noninvasive and relatively easy, and the technique can be applied to situations where sighting surveys are not feasible (e.g., densely vegetated habitats or furtive species). Potential downsides include genotyping errors and variable relationships between the DNA source (e.g., fecal pellets) and the deer. Brinkman et al. (2011) used DNA from fecal pellets to estimate free-ranging Sitka black-tailed deer (*O. h. sitkensis*) abundance using the Huggins closed model in Program MARK.

Model choice should be considered critically before beginning mark-resight surveys because different models are based on different assumptions. Commonly used mark-resight models include the joint hypergeometric estimator (JHE; Bartmann et al. 1987), Bowden's estimator (Bowden 1993, Bowden and Kufeld 1995), and the beta-binomial estimator (McClintock et al. 2006). Bowden's estimator has been one of the most useful mark-resight models for deer and other wild ungulates. Unlike other models, Bowden's estimator does not assume all deer have the same sighting probability (i.e., allows for resighting heterogeneity), populations can be sampled with or without replacement (i.e., individual deer can be observed only once or multiple times per survey), and all marks do not need to be individually identifiable. More recently, maximum likelihood estimators have been developed with similar practical assumptions. These estimators include (1) the mixed logit-normal model (McClintock et al. 2009*b*) when sampling is done without replacement and the number of marks is known, and (2) the Poisson-log normal model (McClintock et al. 2009*a*) when sampling is done with replacement or the exact number of marks is unknown.

These maximum likelihood methods have the major advantage of allowing information-theoretic model selection based on Akaike's Information Criterion (Burnham and Anderson 1998). Program NOREMARK was developed to calculate population estimates based on resight data when animals are not being recaptured (White 1996). The program includes the JHE (Bartmann et al. 1987), Minta-Mangel (Minta and Mangel 1989), and Bowden's (Bowden 1993, Bowden and Kufeld 1995) estimators. More recently, the mixed logit-normal (McClintock et al. 2009*b*) and the Poisson-log normal (McClintock et al. 2009*a*) mark-resight models have been included in Program MARK, along with a variety of other mark-recapture models (White and Burnham 1999, White et al. 2001, White 2008).

A quasi-mark-resight method that can be more effectively applied on a management unit scale, particularly when deer are fairly detectable, is to correct minimum counts for the resight rate of a sample of marked deer (Bartmann et al. 1986, Mackie et al. 1998). This approach does not use the ratio of marked to unmarked deer to estimate population size per se, but rather the ratio of observed marked deer to total marked deer to adjust sample-based estimates for incomplete detectability similar to methods used for correcting transect and sample area counts discussed previously. Mark-resight adjustment factors can be survey-specific (i.e., based on resight of marked deer during the survey) or generic (i.e., based on previous resight probabilities under similar conditions).

Simultaneous double-counting is another quasi form of mark-resight whereby a population estimate is derived based on the ratio of total number of marked deer counted to number of duplicated sightings (resighted deer) using independent observers (Magnusson et al. 1978, Potvin and Breton 2005). For ungulates, simultaneous double-counting is done from a helicopter or fixed-wing aircraft and applied to a wide area because it has the obvious advantage of not requiring marked deer. Two observers in the same or different aircraft independently record the location, time, and group characteristics of all deer observed. For population estimation, this method assumes all deer are detectable and observers are independent. Both assumptions are questionable, and there is inherent bias toward underestimating true population size to an unknown extent, which raises substantial concern about the appropriateness of this approach. In cases where sighting probabilities of deer are low (<0.45; Potvin and Breton 2005) or unknown, simultaneous double-counts more appropriately are interpreted as adjusted minimum counts rather than population estimates. To adjust for the inherent bias of the simultaneous double-count method, the method can be used in combination with a known sample of marked deer or sightability covariates to adjust the estimate for sighting probabilities (Lubow and Ransom 2007).

THERMAL IMAGING AND AERIAL PHOTOGRAPHY

Thermal imaging and aerial photography frequently appeal to the public as ostensibly practical methods to census wild ungulates. Although these methods have some potential for estimating deer numbers under the right conditions, they often fail to show much advantage over standard counting methods because of highly variable detection rates (Wakeling et al. 1999, Haroldson et al. 2003, Potvin and Breton 2005).

Advantages

- A visual record is created that can be reviewed, analyzed, and archived.
- The methods do not rely on real-time observations that could be in error.

Disadvantages

- There is a potential inability to (1) detect deer under cover, (2) differentiate deer from the background, and (3) differentiate deer from other species.
- Highly variable results can be influenced by a wide variety of factors.
- Relatively expensive equipment and flight costs are required but often result in little or no benefit over standard counting methods.
- Thermal imaging flights must be conducted within a narrow range of environmental conditions.
- Thermal imaging cannot penetrate dense vegetation, and differentiating deer from inanimate objects is sensitive to temperature gradients and heat loading.
- Night flights when deer are more likely to be in the open and heat loading is minimal are seldom practical from a safety standpoint.
- Surveys using forward looking infrared (FLIR) are usually relegated to a narrow window of time after daybreak.
- Species identification can be problematic in areas where there are other large species such as livestock, elk (*Cervus elaphus*), white-tailed deer, pronghorn, and bighorn sheep (*Ovis* spp.).

Assumptions

- A high percentage of deer can be individually detected and accurately differentiated from other wildlife species and inanimate objects.

Techniques

Thermal imaging uses a wide-angle FLIR system mounted on a helicopter or airplane. Random or systematic transects are flown, but a variety of sampling designs are possible. The system can make a video record of the flight that can be reviewed and analyzed at a later date. Although FLIR surveys assume detection probabilities approaching 1, actual detection rates can be highly variable (Wakeling et al. 1999, Haroldson et al. 2003, Potvin and Breton 2005). Therefore, FLIR surveys can have little advantage over visual counts because both methods must be corrected for incomplete detectability. Population estimation using aerial photography involves making a photographic record of the area of interest from an altitude that does not cause disturbance to the deer. Use of aerial photographs has had little utility for deer because they are relatively small and seldom in areas with little or no cover. An attempt to use aerial photographs in Colorado to quantify elk numbers in open areas during winter was unsuccessful because individual elk could not be identified reliably (Colorado Division of Wildlife, unpublished data). Recent investigations indicate that this technology may be effective at enumerating fawns associated with radio-marked does under some conditions (P. Jackson, Nevada Department of Wildlife, personal communication).

POPULATION MODELING

Population modeling can be used to provide biologically realistic, mathematical simulations of deer populations based on demographic parameters that can be estimated using routinely collected field data. Modeling allows populations to be estimated at a scale that seldom would be feasible with sample-based population methods. There are 2 basic types of population models: cumulative and point-estimate. Cumulative models use a balance sheet approach of adding (recruitment and immigration) and subtracting (mortality and emigration) deer over time from an initial population, whereas point-estimate models predict population size at a single point in time independent of prior history. Cumulative models can be evaluated using objective model selection criteria based on how closely model predictions align with field observations over time and how many parameters are used. Evaluation of point-estimate models is more subjective or requires comparison with sample-based estimates. Cumulative models allow multiple sources of data to be integrated and considered over many successive years. This can result in a much more data-rich estimate of population size than single-point estimates because all relevant sources of data over time are considered. Because initial population size and the numbers of deer to add and subtract annually seldom are known, cumulative models rely on easily estimated parameters that allow population gain and loss to be calculated. These parameters include harvest and wounding loss, post-hunt sex and age ratios, natural survival rates, and, in some cases, immigration and emigration rates. However, in practice, field estimates of some of these parameters are not available and, even when they are measured, they contain sampling error as well as process variance (White and Lubow 2002, Lukacs et al. 2009). Therefore, it is necessary to roughly estimate or adjust some parameters to better align model outputs with observed values. Most cumulative population models for deer are based primarily on alignment of modeled and observed post-hunt buck-to-doe ratios. Cumulative models work the best when (1) the data set extends over several years, (2) field data are unbiased, and (3) adult male harvest rates are high. All models are dependent on the quantity and quality of data used. The public and some wildlife professionals can be skeptical of modeled population estimates for deer (Freddy et al. 2004). Although there can be legitimate reasons for this skepticism, this often focuses on how models work rather than quality of data going into models, with the latter being a crucial component. In addition to their use for estimating population size, population models are useful for predicting outcomes of different management actions, evaluating density-dependent effects, and understanding effects of stochastic events on population dynamics.

METHODS FOR MANAGING HUMAN–DEER INTERACTIONS

The goal of managing human–deer interactions is to reduce conflicts to a level of acceptable tolerance by the public. Two fundamentally different approaches may be used to address overabundant deer that are creating conflicts: damage prevention and population management. Damage prevention deals with the management of the damage inflicted by overabundant deer. These methods might include making habitat adjustments, modifying human behavior, or incorporating methods like exclusion, repellents, deterrents, or a similar technique. Population management deals with methods to reduce the numbers of overabundant deer. Many techniques and strategies are available to manage human–deer conflicts resulting from high deer densities in urban situations. In most cases, using multiple methods will increase success. For deer management in urban settings to be successful, using an integrated approach that employs both damage prevention and population management is best. At times, public support may be greater for damage prevention than for population reduction, but both approaches can help achieve clearly defined objectives more quickly (Pierce and Wiggers 1997).

Double-braided poly electric fence (courtesy of Missouri Department of Conservation).

DAMAGE PREVENTION OPTIONS TO REDUCE CONFLICTS

FENCING

Fencing may be constructed to create a physical barrier that excludes deer from accessing areas where they can cause damage or where they are not wanted. When properly constructed and maintained to assure efficacy, fencing can be an extremely effective damage control technique (Conover 2001*a*). Fencing may be constructed along a roadway to reduce deer vehicular accidents, but in populated areas it is used to protect private property, such as gardens, ornamental trees, landscaping, or small orchards. Consideration needs to be given to the cost of construction and maintenance of the fencing in comparison to the value of the property being protected. Wildlife agencies generally do not cover fencing costs. Landowners, municipalities, or neighborhood associations should expect to provide the financing to construct and maintain whatever type of fence is chosen. Many types of fencing and construction techniques are available (see Curtis et al. 2017). Attention to detail in fence construction and maintenance is critical for fencing to be an effective deterrent to deer damage.

Non-electric fencing

Fencing that is not electrified can create an effective physical barrier to deer when constructed properly. Numerous material and construction options exist, including woven-wire, chain-link, barbed wire, larger diameter high-tensile smooth wire, or heavy plastic mesh (Northeast Deer Technical Committee 2009). Common exclusion fencing should not have spikes or spears on posts. Deer can become impaled or tangled on these fences. Non-electric fencing may not be appropriate for areas of medium or high deer densities unless it is tall enough (at least 3 m) to prevent deer from jumping over. It also must make solid contact with the ground so deer cannot crawl under and should be constructed such that the strands are close enough together (20–25 cm apart) and taut enough (>90 kg of tension) so that deer cannot slide between them (DeNicola et al. 2000). An area of cleared ground about 1.8–3 m wide around the periphery of the fence must be maintained so deer see the fence before they make contact and potentially damage the fence or harm themselves.

If the goal is to protect a small, single tree, trees can be fenced individually with the use of woven wire type fence that is only 1.2 m high, as long as the area enclosed is not large enough for a deer to jump into, the fence is far enough away from the tree to prevent browsing, and it is supported with stout posts to prevent it from being pushed inward (Northeast Deer Technical Committee 2009). Larger trees that are browse-resistant due to height can be protected from antler rubbing by using a plastic tree wrap (Vexar®), tubing (Tubex®) or a woven wire cylinder.

Advantages

- Woven wire fencing constructed of quality components should be expected to last 20–30 years with little maintenance.
- Heavy plastic mesh deer fencing is economical and effective.

Disadvantages

- Initial costs of some fencing material and construction are high.
- Some types of fencing may be prohibited in certain municipalities by local ordinance or by homeowner associations due to not being aesthetically pleasing.
- Professionals typically are needed to install this type of fencing.

Electric fencing

Electric fences can provide cost-effective protection for many gardens (DeNicola et al. 2000). They are easy to construct and/or remove, do not require rigid corners, and use readily available materials. The fences are designed to attract attention and administer a strong but harmless electric shock (high voltage, low amperage) when a “grounded” deer touches the fence, which then conditions deer to avoid the fence. The major cost associated with temporary electric fencing is the fence charger. Such fences require frequent inspection and maintenance because they may be damaged by wildlife or falling vegetation.

The peanut butter fence (Figure 1) has been shown to be an effective and inexpensive fence design in several field conditions (Northeast Deer Technical Committee 2009). It is best used for gardens, nurseries, and yards that are subject to l

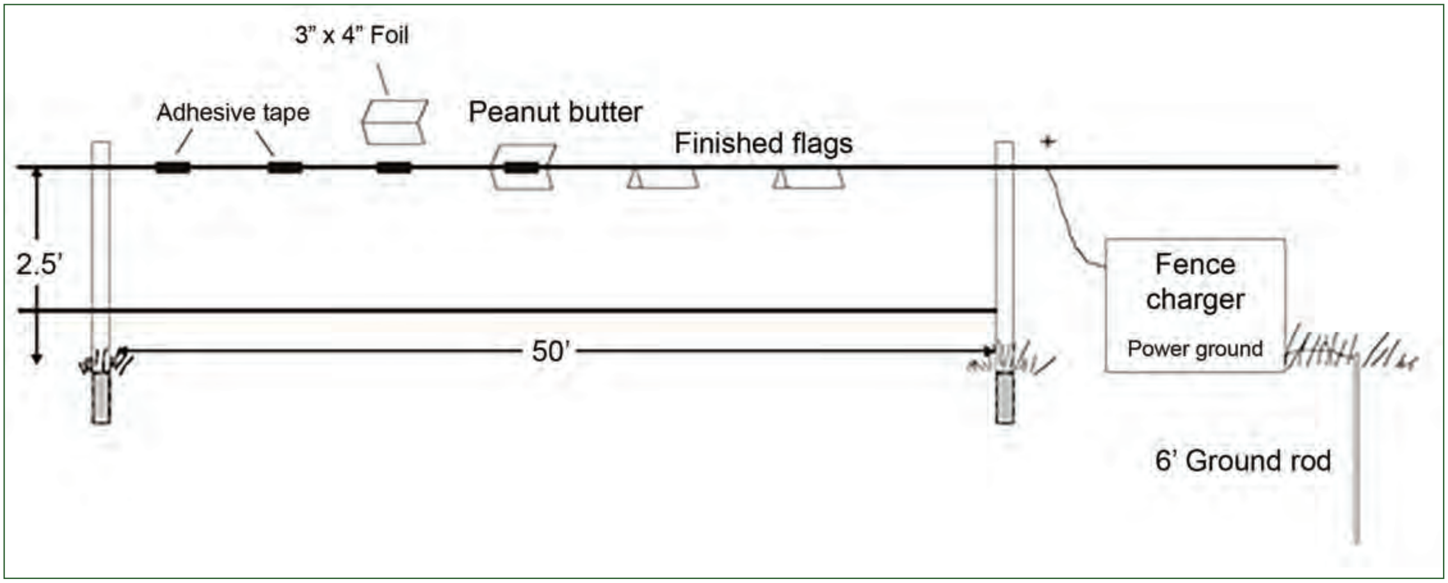


Figure 1. Schematic diagram of a modified electric fence, using peanut butter bait as an attractant (sometimes referred to as a peanut butter fence), which has proven effective at limiting deer access to vegetation, but requires maintenance to retain its efficacy.

to moderate deer pressure. Check the fence weekly to ensure proper voltage is being carried around the entire perimeter, examine for and repair damage, and remove vegetation that has grown into and may short out the fence.

A single strand of 17-gauge wire is suspended about 75 cm above the ground by 1.2-m fiberglass rods at 9–18 m intervals. Wood corner posts provide support. Aluminum foil "flags" (foil squares 10 × 10 cm folded over the wire) are attached to the wire at 6–15-m intervals using tape or paper clips to hold them in place. Aluminum flashing can also be used and has the advantage of not being damaged or blown off. Closer spacing may be necessary near existing deer trails and during the first few months the fence is used, when deer behavior is being modified. The underside of the flags is baited with a 1:1 mixture of peanut butter and vegetable oil. The smell attracts the deer, which touch or sniff the flags and receive an electric shock. The flags should be rebaited every 2–4 weeks, depending on weather conditions (in warm, humid conditions, fences should be rebaited frequently because peanut butter will turn rancid more quickly). As deer learn to avoid the shock of the fence, bait can be reduced or eliminated.

The effectiveness of the original peanut butter fence design was enhanced by using polywire or polytape, rather than the 17-gauge wire. It has the advantage of being more visible to deer, especially at night. It is also easier to roll up and remove. Polywire has a life expectancy of 5–7 years.

Polywire or polytape fencing can be effective at deterring deer (DeNicola et al. 2000). Polywire is composed of 3, 6, or 9 strands of metal filament braided with strands of brightly colored polyethylene. A wider polytape is also available and has the advantage of being stronger and more visible, but it is also more expensive. Although both polywire and polytape come in a wide variety of colors, white provides the greatest contrast to most backgrounds and is easier for deer to see, especially at night. Loss of voltage over long distances of polywire or polytape can be a problem. Purchase materials with the least electrical resistance for these applications.

In its simplest application, an electrified single strand of polywire is suspended about 75 cm above the ground by 1.2-m fiberglass rods at 6–15-m intervals and baited in the same way as t original peanut butter fence. This basic design can be enhanced by adding a second wire to increase effectiveness: 1 wire placed 45 cm from the ground and the top wire at 90 cm above the ground. This prevents fawns from walking under the fence and also increases the chance that 1 wire will remain electrified if deer should physically encounter the fence. Usually only the top wire is baited. In small areas, such as home gardens, more wires can be added on taller poles if desired, and closely spaced bottom wires can keep out smaller mammals. It is important that vegetation be mowed or removed under the fence so it does not short out.

Fiberglass rods usually do not provide enough support for use as corner posts. At corners it is better to use a 1.2-m metal T-post with a bottom plate that provides stability when it is pushed into the ground. A piece of thin-walled 2.5-cm PVC pipe can be slipped over the metal stake to act as an insulator with the polywire or polytape wrapped around a few times. This allows the stringing of the wire with sufficient tension to hold the flags. Wooden posts with plastic insulators will also work well.

Although single or multiple strands of electric fencing may be somewhat effective (baited or unbaited), electric fencing constructed with an offset or a double-fence design (with a taller 2-strand fence on the outside and a shorter 1-strand fence about 100 cm to the inside) provides enhanced deterrence, but at higher cost. This type of electric fence creates a 3-dimensional barrier that is both physical and psychological and may discourage deer from jumping over or crawling under to avoid electric shock. As with the peanut butter fence, polywire or polytape should be used for fence construction for maximum visibility to deer.

When using electric fencing in general, at least 3,000 volts (or up to 4,000–6,000 volts has been used as long as it is of short duration and low impedance) should be maintained at the farthest end of the fence for effectiveness. An area around the periphery of the fence should be cleared for at least 1.8–3 m so that deer may see the fence before making contact.

Tree tube protector (courtesy of G. Westerfield).

The use of electric fences in and around home sites can cause concern for children and visitors or may be prohibited by local ordinance. Where permitted, an option to reduce risk to humans is to put the fence charger on a timer so that it comes on only from dusk to dawn. This method provides adequate protection in areas where deer are not a problem during the day. Electric fences should display warnings placards to alert unsuspecting people.

Advantages

- Electric fencing tends to be cheaper to construct than woven wire fencing (discussed below).

Disadvantages

- Electric fencing is more expensive to maintain than non-electrified fencing.

- Vegetation management is necessary to prevent the fence from shorting out, and vigilance is required to remove fallen branches or repair breaks that can render the fence useless.

- During periods of deep snow, strands of the fence in contact with snow must be disconnected.

- Electric fencing may be prohibited in some municipalities.

TREE SHELTERS

The tree shelter is a transparent, corrugated polypropylene tube that is placed around seedlings at the time of planting. The tube is supported by a 2.54 × 2.54-cm wooden stake located next to the shelter. An ultraviolet inhibitor is added to the polypropylene to prevent it from breaking down too rapidly when exposed to sunlight. The shelter disintegrates after 7–10 years, and wooden posts will rot away sooner. A 1.2-m shelter is common and will prevent deer from browsing on tree seedlings until the sapling grows out of the tube. At that point, foliage from the emerging leader will appear right at nose level of a deer and may be subject to browsing and deformation. A 1.5-m shelter may be needed in areas with excessive browsing or snowfall.

REPELLENTS

Repellents may help reduce deer damage to gardens and ornamental plants (DeNicola et al. 2000, Northeast Deer Technical Committee 2009). Repellents are most valuable when integrated into a damage-abatement program that includes several repellents, fencing, scare devices, and herd management.

There are 3 kinds of repellents: contact repellents, area repellents, and those that incorporate both approaches. Apply contact repellents directly to plants; their unpleasant texture and/or taste repels deer. They are most effective on dormant trees and shrubs. Contact repellents may reduce the palatability of garden plants but should not be used on plants or fruits destined for human consumption.

Area repellents deter deer by odor and should be applied near plants needing protection. Border applications of area repellents protect larger areas at relatively low cost. Because such repellents are not applied directly to plants, they may be suitable for use on home garden crops grown for human consumption; check product labels for any restrictions or cautions on use before application.

People who use repellents should understand several basic principles:

- Repellents do not eliminate browsing; they only reduce it. Repellent success should be measured by the reduction, not elimination, of damage. If minimal damage is intolerable, 2.4-m fencing is the best option.

- Rainfall will wash off many repellents, so they will need to be reapplied. Some repellents weather better than others.

- Repellents reduce antler rubbing only to the extent that they help keep deer out of an area.

- Deer density and the availability of other, more palatable deer food dictate the effectiveness of repellents. When food is scarce or deer density in an area is high, competition increases for available resources. Deer may ignore both taste and odor repellents. In addition, deer may become habituated to certain repellents over time, reducing their effectiveness.

- If you use repellents, do not overlook new preparations, products, or creative ways to use old ones. New products frequently appear on the market.

- Growers who are facing a long-term problem should compare the costs of repellents and fencing over time.

- Repellents that work in 1 area may not work elsewhere, even for similar crops and conditi

Application of commercial repellents

Application methods for commercial repellents range from machine sprayers to manual backpack sprayers. Remember that as labor intensifies, costs rise. Apply contact repellents on dry days when temperatures are above freezing. Young trees should be completely treated. The cost of treating older trees can be reduced by limiting repellent application to the terminal growth within reach of deer (1.8 m above the deepest snow). New growth that appears after treatment is unprotected.

As a preventive measure, the first repellent application should take place within 2 weeks of bud break. During the growing season, repellents should be applied as necessary to protect new growth, usually every 3–4 weeks (DeNicola et al. 2000). For dormant season protection, mid-fall and early winter applications are recommended. Fall applications may reduce antler rubbing.

Regardless of the type of application used, every program should be planned in advance and implemented on schedule. Periodic monitoring is essential to determine the necessity and timing of subsequent applications (DeNicola et al. 2000).

Available commercial repellents

The following list of repellents may be incomplete, but it indicates the variety of materials available. Repellents are grouped by active ingredient and include a brief description of use, application rates, and costs. Product labels provide all necessary information on use and must be followed precisely to achieve maximum success and remain compliant with pesticide regulations (DeNicola et al. 2000).

- **Putrescent egg solid:** This contact repellent smells and tastes like rotten eggs. Apply it to all susceptible new growth and leaders. Applications weather well and are effective for up to1–3 months.

- **Ammonium soaps of higher fatty acids:** This is an area repellent that smells like ammonia and is one of the few registered for use on edible crops. Applications can be made directly to vegetables, ornamentals, and fruit trees. Its effectiveness is usually limited to 2–4 weeks but varies because of weather and application technique. Reapplication may be necessary after heavy rains.

- **Thiram (11–42% tetramethylthiuram disulfide):** Thiram is a fungicide that acts as a contact (taste) deer repellent. It is sold under several trade names and is used most often on dormant trees and shrubs. A liquid formulation is sprayed or painted on individual trees. Although thiram itself does not weather well, adhesives can be added to the mixture to resist weathering.

- **2.5% capsaicin:** This contact (taste) repellent is registered for use on ornamental, Christmas, and fruit trees. Apply it with a backpack or trigger sprayer to all susceptible new growth, such as leaders and young leaves. Do not apply to fruit-bearing plants after fruit set. Vegetable crops also can be protected if sprayed before the development of edible parts.

- **Benzyl diethyl (2,6 xylylcarbomoyl) methyl, ammonium saccharide (0.065%), thymol (0.035%):** This repellant has an extremely bitter taste that repels deer. Apply once each year to new growth. It is not recommended for use on edible crops. It can be applied at full strength on trees, ornamentals, and flowers.

Non-commercial repellents

All non-commercial repellents are odor-based repellents that are applied to trees, shrubs, and vines. When using non-commercial repellents, make sure you are using a registered material for that application. For example, "home remedies" such as mothballs are not registered for this use, and they should not be considered for this purpos

Deer damage on daylilly (courtesy of G. Westerfield).

To deter deer in an urban or suburban environment, use scents that naturally do not occur in the area. Examples of non-commercial repellents are human hair and bar soap. All are odor-based repellents. However, as the density of human occupation increases in an area, effectiveness of scents typically associated with humans (e.g., soaps, shampoos, hair) rapidly lose effectiveness because deer encounter these odors regularly as they move through the urbanized environment and become habituated to them.

- **Cayenne pepper and egg solutions:** Cayenne pepper and/or eggs can be mixed with water and sprayed directly on non-edible plants to protect them from browse. There are numerous online recipes available. These repellents should not be used on edibles and will need to be reapplied periodically and after rain.

- **Hair bags (human hair):** Human hair is a repellent that costs very little but has not consistently repelled deer. Place 2 handfuls of hair in fine-meshed bags (onion bags, nylon stockings). When damage is severe, hang hair bags on the outer branches of trees with no more than 0.9 m between bags. For larger areas, hang several bags, 0.9 m apart, from fence or cord around the perimeter of the area to be protected. Attach the bags early in spring and replace them monthly through the growing season.

- **Bar soap:** Studies and numerous testimonials indicate that ordinary bars of soap applied in the same manner as hair bags may reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or string. Each bar appears to protect a radius of about 1 yard. Any tallow-based brand of bar soap will work.

LANDSCAPE PLANTS

While virtually no plant is deer-proof, there are several ways to control deer damage through plant selection (DeNicola et al. 2000). Damage can vary regionally and with differences in site characteristics. Some site characteristics that may affect the amount of deer damage on a particular landscape planting are:

- Proximity to other more/less desired plants
- Travel behavior of the deer in the area
- Amount of landscaping planted
- Deer density in the area
- Types of plants used in landscaping
- Level of deer resistance to the plants used
- Amount of natural food available in an area (which can differ annually)
- Artificial feeding in the area

Plant selection

A simple search online can generate many lists of plants that are deer-resistant. However, many of those lists are not generated from scientific research, but rather on anecdotal information or by simply copying plants from another existing list. Three lists have been developed using scientific research into plant resistance of deer damage (Northeast Deer Technical Committee 2009).

Fencing can provide protection for young vegetation sprouts, such as this chestnut sprout, from deer browsing until it reaches a height at which it can sustain limited browsing (courtesy of G. Westerfield).

A 3-year study in Wildwood, Missouri, USA led to a list of native plants resistant to deer. Cornell University, New York, also conducted a study of deer-resistant plants and published Dr. Brigden's List of Plants Deer Do Not Like to Eat. Finally, the Cincinnati Zoo in Ohio, USA conducted a survey of >400 nurserymen, educators, naturalists, and garden enthusiasts of deer-resistant plants that commonly appeared on >40 different lists that were collected from around the Midwest. Their survey resulted in a condensed list of plants most frequently agreed upon by those surveyed that were deer-resistant.

Another consideration that should be used in landscape design and plant choices is the use of native versus non-native plants. Native plants are preferred over non-native plants because native plants evolved in the presence of deer and persist despite sustained deer damage. However, the selection of available native plants at standard nurseries is limited and can make locating native plants challenging. Efforts should be made to plant species that are native to the area and avoid invasive species.

HARASSMENT AND SCARE TACTICS

Harassment and scare tactics are used to frighten deer from areas where they may cause damage or where they are not wanted. Efforts to frighten deer should be initiated as soon as deer activity is noticed. Once deer have established a movement or behavior pattern or become accustomed to feeding in a particular area, the behaviors are difficult to modify.

Noise making and bioacoustic frightening devices

Various types of noise-making devices, such as fireworks, gun shots, or gas exploders, may be effective at frightening deer from an area. Noises should be made at irregular intervals, primarily during times of greatest deer movement. Incorporation of bioacoustic frightening devices (alarm or distress calls) into an auditory stimulus system offers another option. Use of such bioacoustics to reduce deer presence in areas of highly preferred forages (e.g., crops, orchards) has produced mixed results. In some cases, deer easily became habituated to bioacoustics or the sounds were deemed ineffective (Belant et al. 1998

VerCauteren et al. 2005). However, Hildreth et al. (2013) documented a 99% reduction in deer entry into baited sites where deer-activated, bioacoustic frightening devices were deployed. Such systems may even deter deer from crossing highways, but further testing is needed.

Advantages

- Devices that frighten deer are generally inexpensive.

Disadvantages

- Loud noises are a nuisance to humans as well, and as such, may not be allowed within city limits.
- Efficacy is often short-term (with noise-making devices), as deer quickly habituate to noises that do not harm them. Bioacoustic frightening devices may have more long-term effect.

Guard dogs

Guard dogs (*Canis familiaris*) may be used to frighten deer from an area. Typically, the dog's movement should be restricted by an invisible fence encircling the area to be protected. A single dog will cover only a small area unless the dog is taught to patrol at times of day when deer movement is greatest, typically dawn and dusk.

Advantages

- Deer will not habituate to the dog (unless the dog is tied up or restricted in its access).

Disadvantages

- Care of dogs can be time-consuming, and the invisible fencing to restrict dog movement can be costly to construct and maintain.

SUPPLEMENTAL OR DIVERSIONARY FEEDING

Supplemental feeding (i.e., intentionally placing food for use by wildlife) or diversionary feeding (intentionally placing food for use by wildlife to reduce unwanted behaviors) of deer often is promoted as a method to draw deer away from areas where they are not wanted. However, this practice actually exacerbates existing problems or creates new ones (The Wildlife Society 2007, Peterson and Messmer 2011). Increasing access to anthropogenic foods will attract more deer to an area where an overabundant population already exists, thus increasing conflicts (DeNicola et al. 2000). Likewise, concern for the spread of diseases should be paramount, as concentrating many deer at 1 feeding area can exacerbate and promote disease transmission.

Even with supplemental feeding, deer continue to browse on natural vegetation, with increased damage near feeding sites. Deer become reliant on supplemental food and are more likely to become conditioned as they associate food with people, increasing the likelihood of conflict with or even danger to humans.

ROADSIDE WARNING DEVICES

Motorist warning devices

Many options to reduce motorist speed or alert motorists of potential for deer–vehicle collisions are available (Romin and Bissonette 1996, Putnam 1997, Farrell et al. 2002). These range from static signs that reduce speed limits to technologically advanced animal detection systems in which signs are activated only when wildlife are present. The intent behind all motorist warning systems is to alert the driver to potential hazards with wildlife on the roadway and cause the driver to slow enough to completely avoid a collision (Huijser et al. 2009).

Permanent signs provide an early form of motorist warning to reduce wildlife–vehicle collisions. On many roads, departments of transportation have placed signs with silhouettes of wildlife to forewarn motorists of potential for collisions with wildlife. Little research has been conducted on effectiveness of permanent signs; however, the general consensus is that they are ineffective for long-term mitigation of deer–vehicle collisions because motorists largely ignore them. If permanent signs are used, placement should focus on high deer–vehicle collision areas to reduce motorist complacency (Pojar et al. 1975, Knapp and Yi 2004, Found and Boyce 2011b). Temporary signs appear to be more effective than permanent signs, as signs are in place for a shorter period of time, increasing the likelihood for motorists to note and react to new signage. Sullivan et al. (2004) documented a 50% decrease in collisions with mule deer during migrations using temporary warning signs with flashing lights along 5 highways in 3 different states. Hardy et al. (2006) also reported that portable dynamic message signs were more effective at reducing driver speed than permanent signs along Interstate 90 in Montana, USA.

Signs that are activated by wildlife should be the most effective at reducing motorist speeds because there is limited opportunity for motorists to become habituated to them. Animal detection systems have been in existence since the late 1970s, and their performance has varied. Ward et al. (1980) documented a 100% reduction in deer–vehicle collisions, although their study was limited. Huijser et al. (2009) tested various models of detection systems and found that their reliability was influenced by a range of environmental conditions. Detection systems that cover large expanses of road and require many signs and detection devices fail more often due to environmental factors such as vegetation, rain, and snow. Overall, many systems have been tested in field settings and most were unreliable, producing substantial false positives or negatives (Huijser and McGowen 2003). The systems that were most effective were used on lower-traffic-volume roads and combined with fencing to limit wildlife access to the road at a finite location. This reduced the potential for electronic malfunction (see below; Gordon et al. 2004, Gagnon et al. 2010). Recent studies in Arizona, USA on animal-activated systems that include technologically advanced software that acquires and identifies specific targets before signaling their presence have had fewer incorrect classifications; electromagnetic sensors are being tested in Colorado. Remote detection and warning of wildlife at roadways remains an area of active research and development.

Wildlife crosswalks are a combination of fencing and gaps in the fence that allow animals to cross roadways at designated spots. Crosswalks have been tested only minimally, though Lehnert and Bissonette (1997) reported moderate effectiveness of crosswalks along 2- and 4-lane highways in Utah, USA. These crosswalks included static or continuously activated signs warning motorists of crossing mule deer. Although they documented minimal motorist response, likely due to motorists becoming accustomed to and ignoring static or continuously activated signs, there was still a decrease in mule deer mortality. Gordon et al. (2004) documented a 7 km/hour (4 mph) reduction in speeds with the animal activated motorist warning signs along U.S. Highway 30 in Wyoming, USA. When a deer decoy was visible to approaching motorists in combination with the flashing lights, speeds decreased by up to 19 km/hour (12 mph). Gagnon et al. (2010) documented a 97% decrease in elk–vehicle collisions and a nearly 16 km/hour (10 mph) reduction in motorist speeds at a crosswalk with an animal-activated motorist warning sign. Crosswalks can function as an at-grade wildlife crossing in some circumstances, but they should not be used on high-speed highways, as animals frightened by passing vehicles may flee and attempt to cross at unsafe spots, increasing the potential for collisions with vehicles (Gordon et al. 2004, Gagnon et al. 2010). When using crosswalks in lieu of other wildlife crossings, similar requirements for spacing between crosswalks along the roadway should be considered. Traffic volumes must be taken into consideration for crosswalks, as high traffic can provide an impermeable barrier.

Speed reduction zones in areas where wildlife–vehicle collisions occur can reduce the risk of more severe accidents. Enforcement of speed limits is key to their success, as many motorists ignore speed limit signs. In general, speed reduction zones are considered ineffective at reducing deer–vehicle collisions (Romin and Bissonette 1996, Bissonette and Kassar 2008). Highway lighting is an ineffective method to reduce deer–vehicle collisions (Reed and Woodard 1981, Romin and Bissonette 1996). Anecdotal information indicates that highway lighting can cause areas beyond the lighting to appear even darker to motorists, reducing detection of deer once leaving the lighted area.

Benefits and challenges

Accurate animal-detection systems that reduce motorist habituation combined with funnel-fencing to restrict detection coverage area are effective at reducing motorist speed and alertness (Gagnon et al. 2010). Animal detection systems by themselves, when deployed across large expanses of road, show little benefit in reducing deer–vehicle collisions. Overall, animal detection systems have the potential to be an effective tool in mitigating deer–vehicle collision (Huijser and McGowen 2003). However, in many cases, they do not reduce deer–vehicle collisions, primarily due to system failures that lead to excessive false positives, causing motorists to ignore the warning signs, or false negatives that fail to inform the driver of an animal in the road (Huijser et al. 2009). Further research on new technologies and devices that overcome these environmental factors is warranted. When working with transportation agencies on mitigation measures to reduce deer–vehicle collisions, it is essential to selectively recommend methods that have a high potential for success. Failure to meet this goal can cause reluctance by transportation agencies to spend time and funding on potential solutions in the future.

Financial assessment

Motorist warning systems can be relatively inexpensive, yet they are ineffective in many cases. Animal-detection systems that provide warning to motorists only when deer or other wildlife are present are the best solution when wildlife crossings are not an option. If possible, the warning systems should be combined with funnel fencing and electrified mats, which restrict possible movements of wildlife while crossing the roadway, to reduce potential for malfunction due to environmental conditions (Wakeling et al. 2015). The actual expenses for these types of systems may cost $50,000–$200,000 USD depending on complexity and design. Costs for the regular maintenance of the warning system include staff or a private contractor to regularly check on these systems.

Decoy deterrents

Decoy deterrents are intended to make motorists react to the visual cue of seeing the decoy and respond by slowing down. Research evaluating the effects of deer decoys as a stand-alone deterrent for deer–vehicle collisions is lacking, but several studies have evaluated decoys or simulations used in conjunction with other techniques. Using a cross-section of a full-body taxidermy mount, Reed and Woodard (1981) evaluated deer simulations and highway lighting as a potential means to reduce deer–vehicle collisions in Colorado. They found that highway lighting did not affect the location of deer crossings, location of accidents, nor mean vehicle speeds. The presence of a deer decoy placed in the emergency lane in lighted view of oncoming traffic, however, decreased mean vehicle speeds by 14 km/hour (8.7 mph).

In Wyoming, Gordon et al. (2004) evaluated the effectiveness of the FLASH™ (Flashing Light Animal Sensing Host) system, designed to detect deer presence on the highway and warn motorists by triggering flashing lights associated with a sign. In addition, the scientists experimentally tested various treatments involving the sign, the lights, and the presence of a deer decoy (full-body taxidermy mount of a female mule deer). Motorists traveling in the day failed to reduce speeds substantially in response to the activated system; however, speed

Reflector sign (courtesy of New Jersey Division of Wildlife).

at night were reduced an average of 7 km/hour. Speeds were reduced an average of 20 km/hour in response to flashing lights and a deer decoy placed along the highway.

Benefits and challenges

The limited published research and lack of published management protocol on the use of deer decoys to deter vehicle collisions presents challenges for evaluating their efficacy. Research suggests that vehicles will reduce speeds in presence of deer decoys, but duration and actual application of the technique needs further evaluation. Reed and Woodard (1981) observed brake lights on 51% of the vehicles approaching the deer decoy during night, but evaluation was discontinued because of risk to motorists caused by 5–10% of the vehicles that either slowed drastically or stopped near the simulation. Placing decoys near roads could actually cause vehicle–vehicle collisions, placing substantial liabilities on management agencies that used them. There is currently no plausible rationale for using a decoy for slowing vehicle speed due to the risk of human injury due to human responses.

Financial assessment

Current costs of a full-body taxidermy deer mount will range depending on location and taxidermist but range between $1,500–$2,500 USD. Simulated decoys are available for substantially less. The potential for accidents and injuries place a substantial liability on any agency that uses them.

Auditory stimuli

Several auditory devices have been developed to stimulate deer to alter their behavior to avoid collisions with vehicles. Deer whistles, wh are attached to vehicles and emit a high-frequency sound, are perhaps one of the most common of these devices used by motorists. Assessments of deer whistles indicated deer did not respond differently to vehicles equipped with whistles than to those that were not equipped (Romin and Dalton 1992, Romin and Bissonette 1996). Scheifele et al. (2003) tested several deer whistles and concluded they were likely to be ineffective based on several aspects of acoustic performance and deer responses. Valitzski et al. (2009) tested vehicle-mounted devices that produced pure tones, similar to sounds produced by deer whistles, at 5 different frequencies. The scientists found deer responses were not adequate to reduce collisions and concluded deer did not have adequate time to react as desired, may not have the ability (neurologically) to process the sound as an alarm such that they respond as desired, or may not perceive the sounds they tested as threatening. Ujvári et al. (2004) found deer demonstrated relatively quick habituation (≤10 days) to sounds of acoustic highway markers activated by passing vehicles. A stimulus system (high-pitched sound in combination with a strobe light) activated by vehicle headlights reduced wildlife–vehicle collisions by 85–93% in Austria (Huijser et al. 2008), but this effect has yet to be replicated.

Benefits and challenges

Primary benefits of auditory stimulus systems are their relative simplicity and low cost. If appropriate sounds could be produced that alter deer behavior in a desired manner, such systems could result in substantial reductions in deer–vehicle collisions. Challenges include lack of effectiveness (i.e., deer do not respond or do not alter their behavior as desired) and habituation of deer to the sounds (i.e., deer may respond as desired for a short time, but responses decline after repeated exposure).

Financial assessment

Deer whistles and other auditory stimuli are relatively inexpensive, generally between \$10 and \$100 USD. However, tests of auditory stimuli have been inconclusive or have shown that the devices were ineffective for reducing deer–vehicle collisions. A technical working group formed to evaluate mitigation methods for wildlife–vehicle collisions concluded neither research nor construction resources should be used for audio signals (in the right-of-way or on vehicles; Huijser et al. 2008). Given the high costs and liability associated with deer–vehicle collisions, advocating use of auditory stimuli devices as a sole deterrent to avoid collisions should be avoided.

Visual stimuli

Various wildlife warning devices have been developed to frighten deer away from roadways through a visual stimulus in an effort to reduce deer–vehicle collisions. These devices are typically illuminated by motorist headlights and consist of reflectors or mirrors mounted on a series of posts alongside the roadway that reflect light to the roadway and roadsides in a moving pattern. The goal is that approaching deer (or other wildlife) will notice the reflected light and flee away from the road or halt on the roadside until the vehicle has passed. The reflectors are hardly noticeable to drivers.

Despite numerous studies on these devices, their effectiveness remains a point of debate. Brieger et al. (2016) has done perhaps the most comprehensive study of the various devices available and concluded that they do not significantly reduce deer–vehicle collisions. More recently, Riginos et al. (2018) found that reflectors covered with a white canvas bag were effective at reducing collisions. They found that in areas where reflectors were covered with white canvas bags versus areas where reflectors were not covered, carcass rates were 33% less, deer stopped before entering the road 20% more often, ran into the road from the right-of-way 11% less often, and fled from the road 12% more often. These are promising results, though more research in this area is needed.

Benefits and challenges

Although many studies have found that reflectors do not reduce collision rates (when measured in terms of carcass counts; Woodard et al. 1973, Waring et al. 1991, Armstrong 1992, Ford and Villa 1993, Reeve and Anderson 1993), other studies conclude that reflectors reduce collision rates from 19–90% (Gladfelter 1984, Schafer and Penland 1985, Pafko and Kovach 1996, Gulen et al. 2006). Obviously, more study in this area is needed. As with auditory stimuli, the benefits of visual stimuli are that they are simple to deploy and may offer some positive benefits in keeping deer off roadways and reducing collisions.

Financial assessments

The use of visual stimuli in the form of reflectors is likely cost prohibitive for large-scale use, though there may be instances where the value may be worth the cost (e.g., where high incidences of deer–vehicle collisions occur in a small, well defined area). Total cost of installation with reflectors, posts, equipment, and labor by 1 company that produces reflectors was estimated to be $4,000–$6,000 per km. The average life of reflectors is up to 12.5 years. Costs amount to $169–$199 per km per year. Maintenance cost per mile per year is $500 ($300 per km per year; Strieter-Lite, Strieter Corp., Rock Island, Illinois, http://www.strieter-lite.com/). In an experiment using reflectors in British Columbia, reflectors cost $10,000 per km to install along both sides of a highway, and maintenance costs ranged from $500–$1,000 per km annually (Sielecki 2004).

ROADWAY DESIGN

Wildlife crossings

Wildlife crossings (underpasses and overpasses), when combined with funnel-fencing, are an effective method to simultaneously reduce wildlife–vehicle collisions while maintaining habitat connectivity (Ward et al. 1980, Clevenger and Waltho 2000, Dodd et al. 2012, Sawyer et al. 2012). Wildlife crossings are designed so that wildlife can pass safely over or under roads, removing wildlife from roadways, and reducing the effect of traffic on wildlife movements (Gagnon et al. 2007a, b; Dodd and Gagnon 2011). The numbers of wildlife crossings throughout North America are numerous and continue to increase in number (Bissonette and Cramer 2008).

Underpasses provide deer and other wildlife the opportunity to pass below the highway while allowing traffic to pass overhead. Underpasses and culverts in many cases dually facilitate wildlife and water flow. Underpasses are larger and used to bridge larger areas like rivers and canyons, whereas culverts generally comprise smaller precast concrete or metal pipes better suited for smaller creeks or washes.

Research on the effectiveness of underpasses to safely pass mule deer began in the mid-1970s (Reed et al. 1975, Ward et al. 1980). Underpasses of various sizes and shapes have been effective for deer passage, but recommendations on optimal size are an ongoing and heavily debated topic, particularly given cost constraints placed on construction projects. Openness ratio ([width × height]/length) is used to describe wildlife crossings, and many wildlife species prefer to pass through more open structures that appear shorter in length than those that are perceived as long, narrow tunnels. There is conflicting data on the optimal openness ratio for mule deer (Reed et al. 1975, Foster and Humphrey 1995, Jacobson et al. 1997, Schwender 2013), but width seems more important than height (Foster and Humphrey 1995, Clevenger and Waltho 2000, Cramer 2013), and length is more important than width (Clevenger and Waltho 2000, Cramer 2013). Most studies on mule deer use of underpasses indicate that deer are more reluctant to use narrower structures than wider structures. Current studies, specifically for mule deer, indicate that minimum size for underpasses should be 2.4–3 m in height and a minimum of 6 m in width (Gordon and Anderson 2004, Cramer 2013).

Deer overpass (courtesy of New Jersey Division of Wildlife).

while length should not exceed 35 m if possible (Cramer 2013). In areas where underpasses exceed 35 m, such as 4-lane divided highways, providing an open median may help increase mule deer crossing success by reducing the overall length into 2 shorter sections (Foster and Humphrey 1995, Gagnon et al. 2005). These measurements are considered minimum requirements for deer, and planners should develop more open structures where possible to help ensure success of the underpasses. Where possible, culverts should have earthen bottoms to eliminate echoing and provide natural footing. Earthen fill between the top of the culvert and the road also reduces sound and vibration when vehicles pass overhead. Rip-rap (large rocks used to dissipate water flows) may be used in small amounts to help reduce erosion, but a natural soil pathway must be available for wildlife to navigate through the structure. Another method being implemented in Nevada, USA is placing a rip-rap layer under several cm of native soil that will protect the structures during larger storm events, while providing a natural pathway for wildlife. After a large storm event, the earthen pathway may require maintenance, but the overall structure will remain stable. In some instances, uncovered rip-rap can be used to guide wildlife into the desired pathway.

Overpasses are not constructed as frequently as underpasses because of their cost. Although overpasses have been implemented throughout North America for many wildlife species (Clevenger and Waltho 2005, Olsson et al. 2008), relatively few studies have evaluated mule deer use of overpasses until recently. Prior to 2000, only 5 wildlife overpasses existed in North America. The first wildlife overpass in North America was constructed in Utah along Interstate 15 and is only 6.4 m wide. Recent studies show that this 30-year-old overpass successfully facilitates mule deer movement (Cramer 2013). In British Columbia, the 5.8-m-wide Trepanier overpass was built to facilitate wildlife movement over the Okanagan Connector (Highway 97C), and use by mule deer has been documented for this structure (Sielecki 2007). In Banff National Park, Alberta, Canada, overpasses were built primarily for the safe passage of grizzly bears (*Ursus arctos*) across the Trans-Canada Highway, and mule deer benefited from these structures. Of 15 structures for mule deer to select from, 67% of all crossings by deer (mule deer and white-tailed deer combined) occurred at the 2 overpasses that were 50 m wide (Clevenger and Waltho 2005).

Mule deer will use both overpasses and underpasses and will increase their use over time. Recently, studies to evaluate mule deer use of overpasses along U.S. Highway 93 in Nevada documented >13,000 crossings in a 2-year period (Simpson 2012), with >35,000 crossing in the first 4 years (N. Simpson, Nevada Department of Transportation, personal communication). Simpson (2012) found that mule deer preferred overpasses to underpasses, especially in the first years following construction. Mule deer continued to adapt to the underpasses over time. A recent Wyoming study found mule deer preferred crossing U.S. Highway 191 through underpasses rather than overpasses. This study included 2 sites, each with 1 overpass and 3 underpasses, and documented 60,000 mule deer and 25,000 pronghorn crossings in 3 years (H. Sawyer, West Inc., personal communication).

Proper placement of wildlife crossings (underpasses and overpasses) is essential to ensure deer encounter them during daily or seasonal movements (Gagnon et al. 2011, Sawyer et al.

2012, Coe et al. 2015). Along large stretches of road, spacing of wildlife crossings needs to be considered. Underpasses need to be close enough together to allow deer to encounter them within a reasonable distance. Bissonette and Adair (2008) recommended that wildlife crossings be placed about 1.6 km apart for mule deer in areas where deer regularly cross roads. Coe et al. (2015) noted that crossings could be placed more irregularly based on actual deer migration corridors or data that indicate high deer–vehicle collision areas. Similarly, escape ramps should be placed frequently enough that deer and other ungulates trapped inside fencing can escape the right-of-way before collisions occur.

Ungulate-proof fencing is likely the most important factor in the success of wildlife crossing structures. When properly designed and located, fences funnel deer toward crossing structures. In most cases, mule deer will not use crossing structures immediately, and a learning period will be required (Gagnon et al. 2011, Sawyer et al. 2012). For example, along U.S. Highway 30 in Wyoming, mule deer took about 3 years to adapt fully to underpasses and fencing (Sawyer et al. 2012). Migratory mule deer are more likely than resident mule deer to use smaller underpasses, when combined with fencing, because of their need to move to seasonal ranges.

Highway retrofitting has been used increasingly to reduce wildlife–vehicle collisions while maintaining habitat connectivity (Gagnon et al. 2010, Cramer 2013). Retrofitting typically employs fencing to funnel wildlife to existing structures that are suitable for wildlife passage. This would include bridges and culverts that already facilitate water flow but in some cases can include low-use roads (Ward 1982).

Benefits and challenges

Properly designed and located wildlife crossings with funnel fencing will provide an effective method for reducing collisions with mule deer and other wildlife species. For example, elk generally use similar habitats as mule deer but may be reluctant to use structures that mule deer may readily use (Dodd et al. 2007, Gagnon et al. 2011, Cramer 2013). When dealing with deer collisions and connectivity in areas where there are elk present, designs for elk should be considered that will allow effective use by both species. Another consideration is smaller wildlife that inhabit the area. Although recommendations for deer provide for about 1.6-km spacing between structures, other smaller wildlife may not travel as far to locate a safe crossing opportunity, which may make the roadway a more substantive barrier for these species (Bissonette and Adair 2008). Allowing access to culverts too small for ungulate use may help to facilitate habitat connectivity for some of these smaller species (Clevenger et al. 2001).

Financial assessment

Wildlife crossings with ungulate-proof fencing are an expensive solution, but they are effective. Culverts are less expensive and can be installed for about $200,000 USD, whereas overpasses and bridges can cost $2–$10 million USD. Sufficient excess fill must be available to maintain grade and install enlarged culverts, or the highway must be raised by obtaining and hauling fill, an alternative that is prohibitively expensive. Underpasses are more practical for transportation departments when they are located in drainages where water flow already requires such an accommodation. Costs to upgrade underpasses in these situations are somewhat less. Overpasses designed solely for wildlife are expensive and may be harder to justify. In general, overpasses are 4–6 times more expensive than underpasses. In some situations, topography may not be conducive to underpasses, and overpasses may be the only option. When considering placement of wildlife-dedicated overpasses, using natural ridgelines where the roadway cuts through a terrain feature can help reduce costs associated with substantial fill requirements. Retrofits of existing structures may provide less expensive solutions for collision reduction and connectivity for mule deer if adequate terrain features exist.

Nevada observed a 50% decrease in the number of deer–vehicle collisions with each subsequent migration in a single location until there were ≤2 reported collisions per year (Simpson 2012). Additionally, an analysis of expenses on the same set of crossing structures showed a financial cost:benefit (Attah 2012). With the observed decrease in the number of deer–vehicle collisions, and the positive benefit-cost score, the cost of the construction will be recuperated by taxpayers, insurance companies, and management agencies because of the decrease in human injuries and infrastructure damage (McCollister and Van Manen 2010).

Nighttime and seasonal speed limits

Speed is a factor that influences the probability of collisions in general. At slower speeds, motorists have more time to detect, identify, and react to obstacles in their path than when traveling at greater speeds (Sullivan et al. 2004). Yet, studies that attempt to document the relationship between deer–vehicle collision and posted speed limits provide mixed results and generally do not confirm a relationship (Bissonette and Kassar 2008). Reasons for these mixed results stem from the limited relationship between actual speed with posted speed limit (Bashore et al. 1985) where deer–vehicle collisions are common. Roadway characteristics, deer behavior, deer distribution, landscape, and environmental factors have a greater influence on deer–vehicle collisions regardless of posted speed limit (Bashore et al. 1985, Finder et al. 1999, Farrell and Tappe 2007, Found and Boyce 2011a, Lobo and Millar 2013). With these overriding factors in mind, strategic use of speed limit reduction during discrete deer movement periods and in locations of concentrated deer–vehicle collisions may provide positive results. Providing a message identifying short distances to watch for deer can increase driver attention span for those distances (Hardy et al. 2006). Deer generally increase movements during dusk and dawn, and mule deer often migrate seasonally; reducing speed limits at times of the day or year when deer are most active may reduce the probability of deer–vehicle collisions. Regardless, given that increased vehicular speeds correlate with increased accident severity and property damage, strategically placed signs both temporally and spatially may save human lives and reduce deer–vehicle collisions.

Benefits and challenges

Traffic signage identifying appropriate speed is relatively inexpensive to implement. Enforcement can be difficult, and compliance for most highway signage is variable. If seasonal changes are needed to deal with migration periods, signage can be adjusted with minimal effort. Temporary dynamic message signs work better than standard static speed limit signs (Hardy et al. 2006). Lawful determination of appropriate speed limits can require administrative review and approval.

Logically, reducing vehicle speed should reduce wildlife–vehicle collisions. Yet, wildlife often cross unexpectedly, making reduced speed limits less effective in avoiding collisions. For instance, bighorn sheep have a relatively high rate of collisions with vehicles along U.S. Highway 191 in southeastern Arizona (Wakeling et al. 2007), even though the roadway precludes high rates of speed and allows for good visibility. This winding section of U.S. Highway 191 keeps vehicles from exceeding about 55 km/hour, whereas other nearby sections can be traversed at 90 km/hour, yet wildlife–vehicle collisions are not correspondingly higher. In this situation, the proximity and juxtaposition of suitable habitat increases the likelihood that bighorn sheep will frequent and cross these roadways.

Colorado experienced the confounding effects of implementing reduced speed zones to amend motorist behavior along a 160-km section of highway with 14 experimental wildlife speed reduction zones. While data showed a minor improvement on average accident history

throughout the total treatment area, 6 of the 14 segments (43%) exhibited worse accident history following implementation. Based on the inconclusive data, the Colorado Department of Transportation removed the signage (Colorado Department of Transportation, unpublished data). Both wildlife agencies and state departments of transportation agree that reduced speed limits are not particularly effective at influencing wildlife–vehicle collisions (Sullivan and Messmer 2003).

Financial assessment

Expenses associated with changing highway speed limit signage are relatively minimal. The administrative cost of the appropriate review and authorization for changes in speed limits is generally higher than that of simply changing highway signs. As noted earlier, animal detection systems that provide warning to motorists, like temporary changes in speed limits, only when deer or other wildlife are present are the best solution when wildlife crossings are not an option. The actual expenses for these types of systems may cost \$50,000–\$200,000 USD depending on complexity and design. Temporary flashing portable signs that are used seasonally are less expensive but still

Top: Suburban archery deer hunt (courtesy of Missouri Department of Conservation). Bottom right: Urban archery deer hunt (courtesy of J. Sumners).

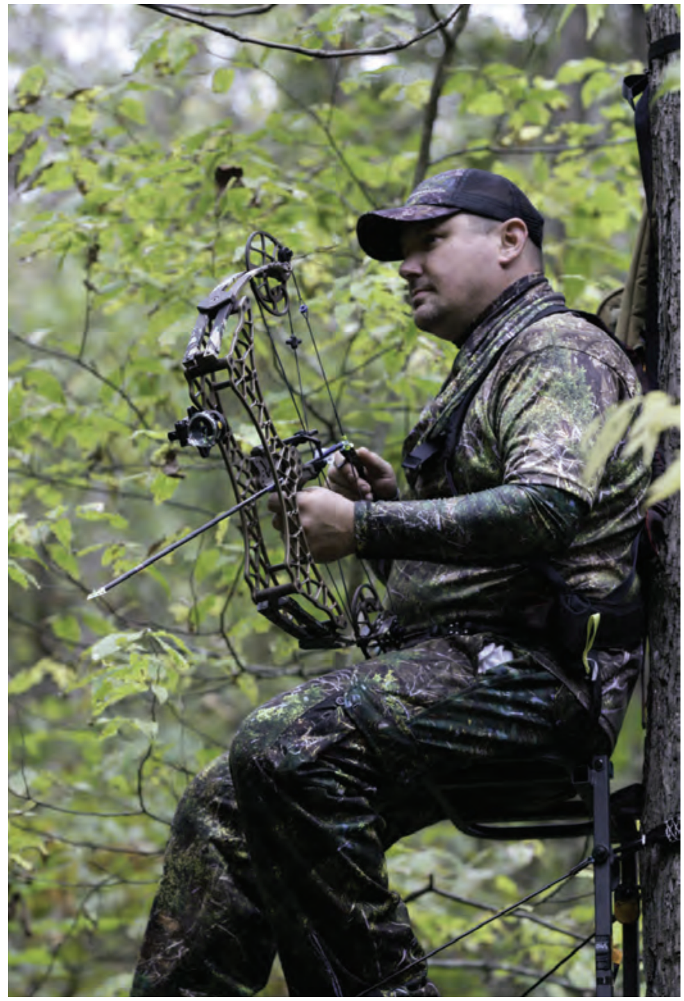
cost $10,000 USD or more to implement. Simply changing static speed-limit signs are inexpensive yet ineffective in reducing deer–vehicle collisions.

POPULATION MANAGEMENT OPTIONS TO REDUCE CONFLICTS

Agencies obviously must consider and evaluate viable, yet publicly acceptable, methods to reduce an overabundant deer population. When city leaders are determining the best option to mitigate deer issues in their community, they often look for 1 specific solution to address their situation. However, the best solution is to implement an integrated approach using multiple mitigation options, rather than rely on a single method (Conover 2001*a*). Regarding population management strategies, authorities must weigh the positives and negatives of allowing each technique within their city limits. This section will help identify the application and limitations of available population management techniques. Although these techniques are divided into broad categories, options exist for tailoring a program to a community's needs, residents' tolerances, and the landscape constraints imposed within a particular city. Any deer management program must have public support, but, to achieve that, well-defined objectives and expected outcomes for the management program must be articulated to the public.

REGULATED PUBLIC HUNTING

The use of regulated public hunting is supported by the tenants of the North American Model of Wildlife Conservation In addition, regulated public hunting is the most economical option for managing deer populations and is the primary tool used for deer management by state or provincial wildlife agencies throughout North America (Conover 2001*b*). However, its use in urban areas needs critical evaluation and unique design to ensure efficiency, safety, and to garner public acceptance. To improve the efficiency of these hunts, careful design, including the use of computer modeling, should be considered (Hubbard and Nielsen 2011). Hunting allows localized management by residents to address varying levels of deer and conflicts on their properties (as deer numbers go up more deer can be harvested, as deer numbers go down fewer deer can be taken).



Suburban archery deer hunt (courtesy of Missouri Department of Conservation).

A few examples of how agencies have used managed hunts are as follows: Cuyahoga Falls, Ohio, uses regulated hunting to address deer conflict issues in the annexed portion of the city (acquisition of an adjacent township) where the prior township's allowance for hunting remained intact following annexation (Ohio Department of Natural Resources, unpublished report). Another option is to conduct a managed hunt within the city limits, similar to that in Princeton, New Jersey (New Jersey Division of Fish and Wildlife, unpublished report), municipalities of St. Louis County, Missouri (Hansen and Beringer 1997), and as was done in Connecticut (Kilpatrick et al. 2002). In New Jersey, the city defines *a priori* the number of hunters allowed to hunt within its boundaries and the locations (often city owned or managed properties) where those hunters can hunt. The city then advertises the opportunity for hunters to enter a drawing (lottery). Hunters drawn from that pool then can hunt within city limits. So long as provisions remain within the framework of the agency's regulations, a city can set specific rules for the hunt. In Columbia, Missouri, hunters must attend a 1-hour safety course prior to being allowed to hunt within the city limits. During the course, hunters are made aware of the locations where they may hunt and the laws and regulations they must follow, and they are issued a permit that must be displayed in the window of their vehicle while it is parked in an area where they are hunting (A. Hildreth, Missouri Department of Conservation, personal communication). Officials in Independence, Ohio require a hunter to take an archery proficiency test before the hunters are allowed to hunt in the city limits (Ohio Department of Natural Resources, unpublished report). Hunting within city limits should be designed so that harvest objectives are met, such as creating a requirement to remove a certain number of does before a buck may be harvested. This strategy is used in Hidden Valley, Indiana (Indiana Department of Natural Resources, unpublished report). Cities can work with their game/wildlife agency to establish a deer management zone. For example, officials in Silver City, New Mexico worked with the state game agency to designate an urban management unit to allow additional deer harvest in accordance with state deer regulations. While the program does not address deer specifically within the city limits, it addresses emigration of deer into the city (New Mexico Department of Game and Fish, unpublished report). Where legal to do so, jurisdictions may seek authorization to allow baiting as a means of increasing the harvest and more efficiently reducing the deer population. For example, when Connecticut permitted baiting of deer, hunter success increased by 17%.

If the initial deer density in an urban area is high (>12 deer/km^2), it can be challenging for hunters to quickly reduce the deer population to a tolerable level. To be most effective, hunting should be used consistently and on an annual basis. It should be noted that as the number of restrictions imposed on hunting increase within an urban area, the effectiveness for reducing the deer population via the open recreational approach will decrease. Any restrictions imposed on hunters, such as weapon type, use of baiting, and permit acquisition, will affect participation and successful attainment of desired management outcomes. Ensuring that hunters have access to enough land to hunt so that harvest objectives can be reached also is critical.

Deer are charismatic and some citizens will oppose deer hunting vehemently; others will be highly supportive (Messmer et al. 1997). Agencies and municipalities should clearly articulate the objectives and expected outcomes of hunting as a management action to all citizens. Some citizens may oppose hunting because of safety concerns, believing that they may be endangered from the discharged weapons. Authorities should address these fears by creating regulations that ensure public safety, such as limiting how close to buildings hunters may discharge a weapon and restricting hunting to public areas or private properties by permission only.

Cities may need to review and, where necessary, modify local ordinances and/or city rules to allow hunting. Periodic changes to imposed policies may be needed to address the number of hunters as a result of changing deer numbers or the inclusion/exclusion of hunting areas.

SHARPSHOOTING

Sharpshooting is a method of using trained personnel to systematically remove deer (Stradtmann et al. 1995). Sharpshooting can be effective in areas where other hunting options are limited. Because sharpshooting is highly controlled, its efficacy can be high if the appropriate number of deer can be removed over a short time frame, and there is access to private properties. Managers should be aware that not all property owners will be willing to participate in lethal removal. Typically, at least 40–60% of the deer must be removed annually to curb population growth, with the majority being female deer. In DuPage County, Illinois, deer densities were estimated at 68 deer/km^2 before 4 consecutive years of sharpshooting (1997– 2000) reduced the population to the desired density of 15–20 deer/km^2 (Etter et al. 1999).

There are personnel requirements to consider when planning a sharpshooting operation: shooters, baiters, security, processors, and logistics personnel who will handle the deer and day-to-day planning of the operation. Although community staff can be used for many of the needed tasks, because of the level of marksmanship needed to shoot deer within an urban area so that public safety is ensured, highly trained personnel usually are needed. One option is to use police personnel to shoot deer, as was done in Mentor, Oh (City of Mentor, Ohio, unpublished reports). Another option is to contract with U.S. Department of Agriculture (USDA)-Wildlife Services, as was done in Ann Arbor, Michigan (City of Ann Arbor 2016). This agency uses highly trained federal staff to shoot deer. Another option is to use nonprofit or private organizations permitted by the wildlife agency to control deer, such as White Buffalo, Inc. The cities of Iowa City, Iowa; Princeton, New Jersey and Solon, Ohio contracted with private sharpshooters to harvest deer annually to effectively reduce their deer populations (DeNicola and Williams 2008).

Sharpshooting can be costly, especially when the work is contracted out. While a city can save expenses by using their own staff, this usually comes at the expense of either additional cost in overtime for staff or in a loss of human resources for the typical duties of the personnel assigned. To be most effective, staff operating on a sharpshooting operation, including non-law enforcement personnel, need to be dedicated to this program and their normal duties assigned to other city personnel. If the community does not own or manage a substantial amount of land, they must gain access to private property as well. Sharpshooting requires a high level of city planning. In many cases, deer are processed for food pantries, but identifying a processor who will work within the time frame, as well as being able to handle the volume of deer, can be challenging. However, demonstrating a commitment to use any resource generated from any culling operation (i.e., venison) is essential to gaining public buy-in and support; few communities will tolerate wanton waste of the resource.

Long-term population reduction can be achieved through sharpshooting programs. In some areas, a sharpshooting program produces a rapid reduction in deer numbers, which may be followed with regulated hunting to maintain the reduced population.

Regulatory considerations

Depending on which options are used and timing, state/provincial regulations may require special permitting for the city to conduct a sharpshooting program. In addition, weapons may require a federal Bureau of Alcohol, Tobacco, Firearms, and Explosives permit, and this can take several months to obtain.

LIVE-CAPTURE TECHNIQUES

Various techniques are available to safely and humanely capture live deer. However, before considering capture strategies, communities must ascertain whether the agency will allow this approach and what the final disposition of captured animals is to be. Capture with intent to relocate and release is illegal in many areas and serves only to transfer habituated or potentially diseased animals to another area.

With all of these techniques, deer may be injured during capture or die from capture myopathy once they are released. If deer are to be released rather than euthanized after capture, handling time should be minimized to reduce stress on the animals (Beringer et al. 1996). Likewise, human safety is also a critical concern. With all captures, injury or death to some animals may occur. The terrain of the capture location, cost effectiveness, and safety concerns may dictate which technique is best used in a given situation.

People opposed to lethal control of deer often cite live capture and translocation as an option that is more humane than lethal removal with hunting or sharpshooting (Messmer et al. 1997). However, numerous studies have shown that as a population-reduction method, live capture is more expensive and relatively inefficient. It also does not significantly extend the lifespan of individual animals that are relocated (Ishmael and Rongstad 1984, O'Bryan and McCollough 1985, Witham and Jones 1990). In certain situations, live capture may be the only or most desirable option.

If captured deer are not to be euthanized, a location that can handle the volume of deer to be relocated must be identified, and equipment to transport the deer is needed. The cost to move the deer greatly increases the overall cost of a relocation program. Most states have banned the interstate movement of any wild member of the cervid family. Intrastate movement of animals may also be illegal and poses the risk of spreading diseases (e.g., CWD, TB). In the east, there are few places in a given state or province where having more deer is desirable and relocated deer may move to urban areas where they resume crop depredation behaviors (Ishmael et al. 1995).

Chronic wasting disease is of substantive management concern and is virtually impossible to eliminate. The Association of Fish and Wildlife Agencies has endorsed specific recommendations regarding managing this specific disease of cervid species (Gillin and Mawdsley 2018). For instance, live animal movement is considered the greatest risk for CWD spread to unaffected areas (see Appendix A).

Trapping

Examples of live-capture methods suitable for deer include the Stephenson box trap, clover trap, rocket net, and dart gun. These techniques have been evaluated for efficacy and animal welfare concerns (Haulton et al. 2001, Anderson and Nielsen 2002). Netted cage traps and their use are discussed at length by VerCauteren et al. (1999), and they reported only 4% of captured deer sustained injuries during trapping. Drop nets have been used successfully to capture both white-tailed deer (Ramsey 1968, Conner et al. 1987, DeNiocla and Swihart 1997, Silvy et al. 1997, Lopez et al. 1998, Jedrzejewski and Kamler 2004) and mule deer (White and Bartmann 1994, D'Eon et al. 2003). Net guns fired from helicopters offer yet another option to successfully capture deer (Ballard et al. 1998, Webb et al. 2008).

Some traps are designed to capture only 1 deer at a time, whereas other techniques (e.g., drop nets, rocket nets) may capture multiple animals at once. Because the number of animals that may be captured within a single event is limited, trapping can be less efficient than other mitigation methods. To increase capture rates, traps should be placed in areas with considerable deer use. Traps should be placed away from roads or areas where they can be seen by the public to increase efficacy and to reduce stress on captured deer.

There are 2 primary trap types used for capturing deer: the Stephenson box trap or Clover trap. The Stephenson box trap is like a cage trap used for capturing raccoons (*Procyon lotor*), or groundhogs (*Marmota monax*), except that it is much larger. Box traps used for deer capture are made of plywood sheets attached to an angle iron frame that is 1.2 × 1.2 × 1.8 m in size. The trap is sprung by a trip wire. The trap can be baited, set, and left unattended. Pre-baiting of traps is required before traps are set to allow deer to habituate to the trap's presence. The traps must be checked at regular intervals (at least once daily) so that captured deer are not left in the traps for an extended period. These traps have been used successfully in Pepper Pike, Ohio, and River Hills, Wisconsin, USA (Ishmael et al. 1995).

Clover traps or netted cage traps are similar in size to box traps. They are made of mesh netting or, in the case of clover traps, sometimes chain-link fencing material, covering a metal frame. These traps have only 1 door, whereas box traps sometimes have 2 doors. Bait is used to attract a deer into the trap. The trap is activated by a trip wire that, once sprung, allows the door to drop and capture the deer. These traps have been used successfully in Silver City, New Mexico (New Mexico Department of Game and Fish, unpublished data) and in many other places.

Traps do not target specific deer cohorts, and any deer (buck, doe, or fawn) is likely to be caught in the trap. Other forms of capture (e.g., drop nets, rocket nets, net guns, dart guns) are more selective. Once deer are captured, there are several options for removing deer from the trap. If deer are to be euthanized, a firearm or captive bolt gun may be used. Firearms have been used to euthanize deer in urban settings, but their use should only be considered when the landscape allows for discharge of a firearm, such as was the case in the Village of North Oaks, Minnesota, USA (Jordan et al. 1995). Euthanizing trapped deer may be less desirable to some members of the public, but regulatory considerations often make this the only feasible option for urban deer population control. However, in Bountiful, Utah, a trap and relocate program was implemented as a technique to help address local urban deer problems (Howard 2018).

Trapping usually requires some type of bait (e.g., corn, apples) to entice the deer into the trap or area to be trapped. Pre-baiting traps is required to engender efficiency once traps are set. Traps should not be set until it is certain deer are entering the trap. Deer are most susceptible to trapping during late winter to early spring when natural food resources are less available (VerCauteren et al. 1999).

The use of traps will require a state or provincial game/wildlife agency permit. Traps need to be checked on regular intervals, at least once every 24 hours once set. As needed, traps will have to be repaired or replaced. City, state, or provincial regulations may dictate whether baiting can be used; where allowed, pre-baiting and baiting throughout the capture period will be required.

Cannon or rocket nets

Cannon and rocket netting have been used to capture deer safely and effectively (Hawkins et al. 1968, Dill 1969). Multiple deer may be captured at the same time using these techniques, but it is recommended that <3 deer be captured at once (Beringer et al. 1996). For a thorough discussion and instructions on the use of rocket or cannon netting, see Wildlife Materials International Inc. (n.d.a). The use of rocket or cannon netting employs nylon mesh netting, electrical wire (for firing the charges), launchers, powder charges, and weights (attached to the nets). After the netting is set, wiring connected, and launchers charged, deer are lured into position, typically with bait. Pre-baiting an area for 1–2 weeks is typically required. A small bait pile (which limits the number of deer that will be feeding at any given time) should be placed 2.4–3 m in front of the rolled-up netting and launchers. When deer are in position, captors may select the time to fire the nets based on the desired number, sex, or age of deer to capture. The capture event itself, compounded by noise of the cannons or rockets and presence of numerous human handlers, is stressful for deer, so handling time should be minimized. Deer should be restrained with hobbles (all 4 legs tied) and positioned with brisket down, instead of left lying on their sides, to reduce bloating. Deer should be blindfolded immediately

Deer netting may be used to exclude deer from specific areas if the height is adequate to preclude deer from jumping over the top (courtesy of G. Westerfield).

after capture (a simple cut off sweatshirt sleeve is effective for this) to reduce stress.

There is always the possibility of injury to animals or personnel during the use of these devices. Animals may be injured by being struck by weights when the net is fired over them or after capture because netted animals typically thrash about. Animals may injure personnel attempting to restrain them. Safety of personnel is always a concern with the use of powder charges, and safety protocols for wiring charges should be rigorously followed. Public safety may be a concern. The use of loud charges in residential areas may be undesirable. Rocket discharge has been known to start fires, whereas cannons do not. The availability of charges for the rockets is becoming an increasing challenge to their use. Air cannons (Net Blaster®), which require no explosives to fire the net, may be used and are considered safer than those that use explosives. Nets may need to be repaired and have debris removed after each firing. Rocket threads should be greased occasionally to prevent them from rusting shut and making it impossible to insert charges. Rockets and cannons must be cleaned after firing. Pre-baiting and baiting should be considered to condition deer to come to the trap site. Permitting by the state or provincial game agency is required for the use of this technique.

Drop nets

Drop nets are suspended on posts above the ground in open areas where deer have been lured with bait. Deer are captured by dropping the net over them, when they are feeding beneath the nets. This technique has been used to capture both white-tailed deer (Ramsey 1968, Conner et al. 1987, DeNiocla and Swihart 1997, Silvy et al. 1997, Lopez et al. 1998, Jedrzejewski and Kamler 2004) and mule deer (White and Bartmann 1994, D'Eon et al. 2003) and may be better suited for urban areas compared with cannon or rocket nets that involve the use of a projectile fired into the air.

Drop nets require personnel to be on hand to spring the trap and handle the deer. While this option is costlier than the use of traps, it allows personnel to determine which deer are trapped and when to drop the net. In addition, multiple deer can be trapped at once if enough personnel are available.

For a thorough discussion and instructions on the use of drop netting, see Wildlife Materials International Inc. (n.d.b). The use of this technique requires a large drop net (often 15 × 15 m or larger), tall poles (usually 2.4 m for deer), which are placed at each corner to hold up the net, electrical wire, blasting caps, and a ground blind. A block and tackle, come-along, or other device for stretching the nets is required. Bait is used to attract deer to the area where the capture will occur, and it should be placed in the center of the area below the net. Areas are typically pre-baited for 1–2 weeks prior to the anticipated capture. When deer are in position, captors may select when to fire the nets to capture the desired number, sex, or age groups. The capture event itself, compounded by noise of the cannons or rockets and presence of numerous human handlers, is stressful for deer, so handling time of deer should be minimized. Also, deer should be restrained with hobbles (all 4 legs tied) and positioned with brisket down, instead of left lying on their sides, to reduce bloating. Deer should be blindfolded immediately after capture (a simple cut off sweatshirt sleeve is effective for this) to reduce stress.

As with other live-capture techniques, there is always the possibility of injury to deer or personnel during the use of these devices. Safety of personnel and deer is always a concern with the use of blasting caps, and safety protocols for wiring should be rigorously followed. Public safety is always a concern. The use of loud charges in residential areas may be undesirable. Nets may need to be repaired and have debris removed after each drop. Pre-baiting and baiting are required to condition deer to come to the trap site. Permitting by the state or provincial game agency is required for the use of this technique.

Net guns

Net guns fired from helicopters offer another technique that has been successfully and safely used to live capture deer (Krausman et al. 1985, DeYoung 1988, Potvin and Breton 1988, Ballard et al. 1998, DelGuidice et al. 2001, Haulton et al. 2001, Webb et al. 2008). We are not aware of the use of this technique for the management of deer in urban areas; however, situations might arise where it is desirable.

The use of this technique requires skilled personnel. Helicopters are typically used to locate and then chase deer until a single deer is within range of the net gun operator who then fires the net over the deer. Following this, another person typically exits the helicopter to restrain the deer. The net gun itself is loaded with a blank charge, often .308 caliber, which fires the net. Nets are typically about 4.6 × 4.6 m square with 15-cm mesh. This technique is selective as operators choose which animal to pursue and capture.

This technique can be used in a variety of habitat types and at various animal densities. However, areas must be open so that the helicopter can maneuver safely. However, Webb et al. (2008) reported only 1% capture myopathy and a 0.6% direct mortality during capture; only 1.6% of deer sustained injury during capture where total capture was 3,350 white-tailed deer. Nets may need occasional repair. Helicopters require maintenance per number of hours used. Agency permitting and Federal Aviation Administration regulations apply to this form of live capture.

Darting guns

Several capture approaches require the administration of chemicals or drugs to restrain, immobilize, or sedate wildlife. Because deer are considered food animals, anytime a tranquilizer, anesthetic, antibiotic, or other chemical substance is injected into the animal, a physical tag must be affixed to the animal to give notice to the public about concerns regarding drug withdrawals and human consumption of that animal. The ear tag should tell the public not to eat the animal without checking on drug withdrawal time. The drug withdrawal time is the time necessary for the drugs to be excreted or metabolized by the body, rendering the meat free of drug residues and safe to eat. The tag should have a phone number for the agency that injected the drug and the appropriate drug withdrawal information. Agencies can contact the Food Animal Residue Avoidance Databank for specific drug withdrawal times for human consumption.

An excellent discussion of the use of chemical immobilization for the capture of wild in urban areas is found in Kreeger (2012). Darting guns have been used to capture deer (Haulton et al. 2001). Darting guns use a .22 caliber blank or CO^2 cartridge to fire a "dart" (flying syringe) that injects an animal with an immobilizing drug upon contact. The effective range typically is ≤40 m. Guns that use CO^2 cartridges to fire allow the user to adjust velocity (and hence range) by a metering device. It is critical that the syringe only penetrates the skin of the animal with the needle upon contact, so the operator must make adjustments for the proper velocity or range. A miscalculation could result in the needle not penetrating the skin, or the entire syringe penetrating the skin and potentially killing or severely wounding the deer. Shot placement is also critical, and typically the fore or hind quarters are targeted for an intramuscular injection. Darting guns can be fired from the ground, a tree stand, or from a helicopter to capture deer. Radio-telemetry darts should always be used in urban and suburban areas. These are used not only to aid in tracking darted deer, but also to recover darts that miss the target or fall out. A charged dart containing a controlled or dangerous substance that is unrecovered in the landscape where a child or other person could find it and become injured by the dart and its contents should always be considered unacceptable.

Considerable practice may be required to use a darting gun effectively. Correct velocity and range calculation must be made, and each gun should be calibrated with various dart sizes and chemical loads in advance of attempted capture. Chemically immobilized deer require the monitoring of vital signs, especially respiration and body temperature, if deer are to be released.

The use of chemical immobilization techniques requires training and certification. The correct type of drug (immobilizing agent and antagonist) for the deer, and the correct dosage for the deer's weight must be made. A combination of Telazol Plus® (4.4 mg/kg) and xylazine (2.2 mg/kg) are typically used to immobilize deer, with tolazoline (2.0 mg/kg) used as an antagonist if needed. However, other drug combinations may be effective as well (Kreeger 2012). Deer should also be blindfolded, placed on their brisket, and not allowed to lay on their side while immobilized. In addition, a tube for the release of gas from the deer's digestive system may need to be inserted into the deer's mouth. Darting guns should be cleaned so guns accurately fire. Recertification for the use of chemical immobilization is required periodically.

In addition to agency permitting to chemically immobilize deer, special regulations govern the purchase, use, and storage of the various pharmaceuticals used as immobilizing agents and antagonists. Some drugs may only be purchased by a licensed veterinarian and used in the presence of certified personnel. For certain drugs, biologists may be able to obtain adequate training and certification through the U.S. Drug Enforcement Agency and state pharmaceutical boards so that the biologists can purchase, administer, and store drugs without a veterinarian on staff.

FERTILITY CONTROL

Unless coupled with other management options, fertility control will not have an immediate impact on deer densities. Because of the limitations associated with contraception, it is not an efficient means to reduce overabundant deer populations. In addition, the use of fertility control can increase the longevity of deer, further hampering short-term efficacy (Swihart and DeNicola 1995, Warren et al. 1995, Boulanger et al. 2012). Most research has identified the need for >85–90% of the female deer within the population to be rendered permanently infertile for this method to be effective (Boulanger et al. 2012).

There are 2 general categories of fertility control: contraceptives and sterilization. Surgical sterilization has been studied as a means of controlling white-tailed deer populations with varying results (MacLean et al. 2006, Merrill et al. 2006, Boulanger et al. 2009, Gilman et al. 2010, Boulanger et al. 2012). In Town and Coun

Missouri, the city funded the trap and sterilization of 130 does over 2 years in conjunction with a culling program. The sterilization (ovariectomy and tubal ligation) procedure was successful in that it eliminated reproduction for treated female deer. However, because deer were placed back on the landscape, there was no population decline (Beringer et al. 2002). After 2 years, the city abandoned the sterilization effort due to the high cost ($1,300 USD per treated doe) and currently culls deer annually to maintain lower deer densities. Another sterilization project was conducted on State Island, New York by White Buffalo Inc. This project focused exclusively on sterilizing (via vasectomy) male deer. The 3-year project was estimated to cost $3.3 million USD (Wolfe 2017). After 3 years, the project ultimately cost $4.1 million USD and sterilized 1,577 male deer at a cost of $12,975 each (Linge 2019). The population was reduced by 15% during the 3-year period. Also, experts disagree on whether the effort will decrease deer–vehicle collisions, incidence of Lyme disease, and reduce other damage caused by deer. The use of contraceptive vaccines have been used experimentally to control white-tailed deer populations (Fagerstone et al. 2010, Rutberg et al. 2013). There are 2 contraceptives developed for deer as of this writing: Porcine Zona Pellucida (PZP), and GonaCon®. The contraceptive PZP is often referred to by the trade-name SpayVac® or Zonastat-D®. It has been used in research studies at the National Aeronautical and Space Agency's Lyndon B. Johnson Space Center in Houston, Texas, USA (Locke et al. 2007). GonaCon® has been used in New Jersey and Maryland (Miller et al. 2008; Gionfriddo et al. 2009, 2011). Only GonaCon is approved for use at this time by the Environmental Protection Agency. Porcine Zona Pellucida creates antibodies that block the fertilization of the egg by sperm and is only applicable to female deer. GonaCon, developed by the National Wildlife Research Center, the research arm of the USDA-Animal and Plant Health Inspection Service, Wildlife Services, works by creating antibodies that bind to the gonadotropin releasing hormone (GnRH), which renders the deer, male or female, non-productive by reducing the production of sex hormones (Miller et al. 2008). Label use is only for adult females. With GonaCon, female deer do not go into estrus. Sterilization can be done either in males or females (as in Fairfax City, Virginia, USA). To reduce production in a polygamous species, the females of a population need to be treated. Because of this, any sterilization of males is required in conjunction with a control technique on females. Cornell University in Ithaca, New York used a combination of archery hunting and sterilization through tubal ligation on female deer. They surgically sterilized 77 does and combined this with an "earn-a-buck" hunting program for the outlying areas. It became apparent over the course of the study that, although surgery prevented does from becoming pregnant, it did not remove their estrus cycles, meaning that they constantly cycled into heat—attracting bucks from outside the study area even after the rutting season. Thus, although the birth rate initially decreased, after 5 years the number of deer on campus remained the same.

Reductions in populations may not be apparent for 5–10 years or longer, depending on percentage of the population that remains vaccinated, and this time frame may be too long for those communities dealing with current human–deer conflicts. Deer populations that are controlled through any of the methods of fertility control generally will endure less physiological stress associated with pregnancy and parturition (although females may still be pursued by bucks during the breeding season) and may have increased lifespans. A metropolitan park district in Columbus, Ohio, had a deer live >20 years that was treated with PZP.

In most cases, there is no barrier, such as a fence, that hinders deer movement into and out of the city. When contraceptives are used, periodic boosters are needed, which requires repeated capture of individuals. Over time, deer become incrementally more difficult to capture and treat. Deer also are susceptible to stress when being captured and/or sterilized, which may lead to their death. Because of limitations and low efficacy in most situations, fertility control is considered to be experimental and not a viable population control technique. Porcine Zona Pellucida currently is not registered for use in the United States as a management tool because treated deer are unfit for human consumption. Because PZP only works on the egg, it is only applicable for female deer. In addition, it can induce multiple estrus cycles that lengthen the breeding period and movement of bucks into the population. There is no approved contraceptive for use in feed because it is impossible to control dosage levels. Deer must be given any contraceptive by darting or hand injections. GonaCon has a 70% efficacy rate and can only be used, as per USDA label instructions, in adult female deer, and must be hand-injected. Based on its efficacy rate in adult does, and because up to 40% of fawns breed in highly productive areas, using GonaCon will result in up to a 29% increase in the deer population, without factoring in immigration and mortality sources. This is what occurred in New Jersey (Gionfriddo et al. 2009). Angel Island, California, USA attempted to use chemo-sterilization by capturing 80–90% of the female deer population with no success. This was in part because it was more difficult to capture the remaining deer as the number of previously captured deer increased. Ultimately, this project was abandoned with only 15 adult does receiving the treatment (Botti 1985).

For most cities, there is no barrier to deer movement, so annual treatment of new deer into the population is required. Annual monitoring of the deer is required to ensure that at least 90% of the population has been treated. Additionally, the female fawns born of non-contracepted adult does and last year's fawns will need to be trapped and treated every year. The use of any fertility control will require a permit from at least the state wildlife agency.

RELOCATION OF DEER

Survival of translocated deer is low compared to resident deer in the release area. In addition, site fidelity to the release area may be low for translocated animals. In 1985, 29 deer were captured at Ardenwood Regional Park in Fremont, California. Two of the deer died during the capture. These animals were then released into a wilderness area. A follow-up study determined that, by the end of the year, 23 of the 27 deer had died, with 3 unaccounted for. The deer were not able to cope with the presence of predators, and most of the deaths were attributed to predation (Mayer et al. 1995).

Similarly, on Angel Island, California (Mayer et al. 1995), 215 deer were captured using clover traps, panel traps, drop nets, and drive nets, and 12 of these deer died during capture. The remaining 203 deer were relocated to a nearby 21,999-ha recreation area. In an effort to monitor the effectiveness of this translocation, 15 deer were fitted with radio-collars and monitored during the following 6 months. Subsequent surveillance determined that only 2 of the relocated deer survived the entire year. This high mortality rate was attributed to poor physical condition due to the stress of being in a new environment, and a failure to recognize new hazards, such as predators and traffic (factors not found in their previous habitat).

A translocation program in River Hills, Wisconsin (Ishmael et al. 1995), found poor survival rates as well. Of 310 deer translocated to state-owned lands between 1987 and 1992, 54% were reported dead within a year post-release. Mortality rates (96%) of translocated radio-collared deer were more than twice that reported for ear-tagged deer (45%) during the same period.

From 1999–2001, Missouri Department of Conservation cooperated with the City of Town and Country to trap and relocate 90 deer from the St. Louis metropolitan area to a rural area of Missouri. Survival rate for translocated deer was 30% (Beringer et al. 2002). The method was suspended in early 2001 due to the threat of spreading chronic wasting disease, as well as the low survival rates of relocated deer.

The Utah Division of Wildlife Resources (UDWR) used a helicopter and net gun in 2013 to capture 102 deer in Parowan, Utah, and released them 144 km away to Holden, Utah. Annual survival rates of translocated deer were 52% the first year. During the second year, however, survival rates of translocated deer were 85%, which was similar to survival rates of resident deer in the area (Smedley 2016). Younger deer were twice as likely to survive post-translocation compared to older deer, and translocated deer had high site fidelity to release sites (Smedley 2016). No deer died during the capture operation. New Mexico Department of Game and Fish also captured mule deer using various trapping methods and translocated them during this same time period. No deer died during the capture efforts, and survival rates and trends of translocated deer were similar to those reported by UDWR. However, site fidelity of the translocated deer was variable. At some release sites, translocated deer displayed high site fidelity, but at another release area, site fidelity was low, with many of the deer leaving the release site (O. Duvuvuei, New Mexico Department of Game and Fish, personal communication).

Another limitation of translocating deer is cost. In Utah, UDWR has worked with a limited number of municipalities to translocate deer from city limits (these municipalities are far removed from CWD-positive areas, and a high sample size of roadkill and hunter harvested deer have never tested positive for CWD). The costs associated with capturing, radio-collaring, disease testing, and translocating each urban deer exceeded $1,000 USD per animal (Howard 2018). Cities generally have personnel committed to help set and bait traps. These cities pay $200 USD per deer (20% of total cost). The UDWR also employs 3 full-time employees and works with many volunteers to help cities address urban deer issues using a variety of strategies. With high deer densities in many parts of the country, cities and state agencies may not have the funds to remove enough animals to have a measurable impact. Many states also do not have adequate habitat to release translocated deer. Additionally, trap and relocation efforts will have little benefit if deer populations can quickly reestablish within the trapping area.

If translocation is used as a management strategy, an adequate number of deer would need to be moved to reduce deer densities. This effort needs to continue until a socially acceptable number of deer is reached in a given area. Efforts should be made to reduce immigration of deer into city limits.

Most governments recognize that relocations, although possibly of value for experimental research or repopulation, are not an appropriate management tool for overpopulated deer communities. Relocation involves the transport of an entire biological package, including parasites and disease, which inadvertently could be introduced to another population by human efforts. Any relocation would require approval from the state/provincial wildlife agency and/or the department of agriculture. Because of the disease risks, high costs, and other limitations associated with translocating urban deer, most wildlife agencies have policies against translocating urban deer.

Chronic wasting disease is of substantive concern in any movement of deer. The disease is essentially impossible to eliminate once spread to a new location. The Association of Fish and Wildlife Agencies has endorsed specific recommendations regarding managing this specific disease of cervid species (Gillin and Mawdsley 2018). Live animal movement is considered the greatest risk for CWD spread to unaffected areas, and the short-term benefits of moving deer from urban areas do not outweigh the long-term, negative consequences of spreading the disease to a new area (see Appendix A: AFWA best management practices for prevention, surveillance, and management of chronic wasting disease). As a result, some states that have translocated deer in the past are eliminating translocation as a management strategy.

SUMMARY

Conflicts among wildlife and humans typically arise from anthropogenic attractants in an area populated by humans. This may be mitigated to varying degrees depending on the species in conflict (e.g., Wilson et al. 2017, Lackey et al. 2018), but deer pose unique challenges due to their ability to habituate to humans, consume agricultural and landscape vegetation, serve as a human food source and watchable wildlife, and because of the risk of debilitating disease transmission. Surveys and monitoring must be conducted to determine the level of conflict, the effect of mitigation, and demonstrate efficacy of various approaches. Management options differ depending on the situation and specific conflict, yet eliminating attractants may be the most efficacious technique available (Messmer et al. 1997). The challenge is that eliminating attractants can be difficult, and mitigation measures are necessary to reduce conflicts. Further challenging the process of mitigation is that many measures themselves are controversial or difficult to implement. The desire to simply relocate animals can be strong but should be resisted because rarely is unoccupied, suitable habitat in which animals can be placed readily available, and the potential risk of spreading CWD or other diseases is ever-present. Wildlife and municipal managers must work together to seek methods to reduce attractants, mitigate conflicts, and perpetuate the conservation of wildlife species that adds to the appreciation of nature in our lives.

Garden fence for deer (top) and fencing to prevent deer access (bottom; courtesy of G. Westerfield).

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APPENDIX A

Approved September 12, 2018, by the Association of Fish and Wildlife Agencies

AFWA Best Management Practices for Prevention, Surveillance, and <u>Management of Chronic Wasting Disease</u>

INTRODUCTION

The Association of Fish and Wildlife Agencies (AFWA) Best Management Practices (BMPs) for the Prevention, Surveillance, and Management of Chronic Wasting Disease (CWD) were developed to provide guidance to fish and wildlife agencies as they address the growing threat of CWD to free-ranging cervid populations. The BMPs are based on the best available peer-reviewed science and field-tested methods, and represent the contributions of more than 30 wildlife health specialists, veterinarians, and agency leaders actively engaged in CWD issues across North America. The BMPs are intended to be adaptable as new information becomes available. They are not meant to be prescriptive or to mandate programs at the state, federal, tribal, or territorial level; they should be regarded as a set of recommendations for agencies to consider as they develop or revise their CWD programs.

The BMPs are arranged under the general headings of Prevention, Surveillance, Management, and Supporting Activities. A best practice is provided for each topic, where appropriate, as are alternative methods that do not mitigate risks as well as the best practice. Many practices fit into more than one of the above headings. Expanded information, additional practices, background, justification, and reviewed literature are available in the accompanying Technical Report.

PREVENTION of CWD Introduction and Establishment

A. **Live animal movement** is regarded as the greatest risk for CWD introduction to unaffected areas.

   1. Prohibit all human-assisted live cervid movements

   2. Alternatives:

      a) Prohibit importation of all live cervids from CWD-positive states and provinces.

      b) Allow movement/importation of cervids from herds that have been monitored for an extended period without detection of CWD or links to herds that have been affected or exposed.

      c) Allow importation of captive cervids from herds certified as low risk for CWD by the USDA CWD Herd Certification Program (see below for more on captive cervids).

B. **Carcass movement** poses a risk for CWD introduction if unused parts from potentially infected carcasses are imported and disposed of improperly.

   1. Prohibit importation from all states of intact cervid carcasses or carcass parts except boned out meat, clean hide with no head attached, clean skull plate with antlers attached, clean antlers, finished taxidermy specimens, and clean upper canine teeth.

   2. Alternatives:

      a) Allow importation of quartered carcasses with no spinal column, head, or central nervous system tissue in addition to the permitted items above.

      b) Prohibit importation, with certain standard exceptions, of intact or whole carcasses from states that have detected CWD in captive and/or free- ranging cervids.

      c) Prohibit importation from specific zones in states where CWD has been detected.

C. Products of cervid origin may pose a risk for CWD introduction as well as an attractant that may congregate normally dispersed animals facilitating CWD transmission and/or establishment.

1. Natural products of cervid origin: Prohibit sales and use of products that include natural urine, feces, scrape material, deer pen soil or other items of cervid origin.

2. Reproductive tissues and material: Prohibit importation of cervid origin reproductive tissues, semen, embryos, germplasm.

3. Alternate practices: Allow sales and use of synthetic scent products; allow importation of products and reproductive materials only from facilities that are certified as low risk for CWD.

D. Unnatural Concentration of Cervids facilitates CWD transmission and establishment if the CWD agent is present.

1. Prohibit baiting and feeding of wild cervids; prohibit placement of minerals, granules, blocks, or other supplements for wild cervids; provide hay and other feed for domestic animals in a manner that does not congregate wild cervids; prohibit sales and use of other cervid attractants such as synthetic scent lures, foods, flavors, scents, pour-ons, sprays, etc.

2. Alternate practices include restrictions on amounts of bait or feed as well as restrictions on baiting and feeding on a temporal and/or spatial basis.

SURVEILLANCE

A. CWD Testing for Cervids.

1. Use only USDA-approved laboratories and methods for CWD testing.

2. Test obex and medial retropharyngeal lymph nodes (MRPLN) collected from dead animals; positive and suspect results should be confirmed by the USDA's National Veterinary Services Laboratories. Minimally test MRPLN for deer and both obex and MRPLN for elk.

    a) Antemortem testing may be useful in whole-herd screening of captive cervids or for sequential testing of individual free-ranging and/or research animals. Current antemortem tests are not adequate to detect CWD on an individual animal basis.

    b) All suspect positive ELISA test and Western blot results should be confirmed with IHC (The Gold Standard test).

B. Surveillance for initial detection of CWD should be an ongoing activity. Early detection is critical to managing CWD effectively and especially for eliminating it when/if possible.

1. Surveillance efficiency may be enhanced by:

    a) Targeting animals more likely to have CWD: clinically affected animals; road- or predator killed animals; mature animals, particularly males.

    b) Spatial targeting via risk assessments based on proximity to affected cervids, unmonitored populations, captive cervids, or other risk factors.

2. Surveillance (and monitoring) should be undertaken at biologically relevant spatial scales and inferences drawn only in the appropriate spatial context in view of the highly patchy distribution of CWD in wild cervids. Consequently, agencies should refrain from drawing statistical conclusions such as "there is 95% certainty that CWD would have been detected if present at 2% prevalence or greater."

3. See https://pubs.usgs.gov/of/2012/1036/pdf/ofr2012_1036.pdf for "*Enhanced Surveillance Strategies for Detecting and Monitoring CWD.*"

C. Surveillance to "monitor" CWD in an affected population

1. Random sampling of harvested animals provides relatively unbiased estimates of infection rates and is the most efficient active sampling method for estimating prevalence or incidence in CWD enzootic populations. Comparisons over time or between locations should be based on a common denominator (e.g., harvested males aged 2 years or older) to assure that reliable inferences are drawn. Consider including vehicle-killed animal surveillance and looking for expansion of current disease foci as well as new disease foci.

2. Practices should include defining biologically relevant spatial units for data collection and evaluation; determining meaningful sample sizes for interpretation; identifying surveillance goals to guide sampling strategies over time; and working within existing management frameworks to maximize opportunities for sample collection while minimizing additional personnel and financial costs to the agency.

MANAGEMENT

A. CWD Response Plans should be developed before CWD is detected and implemented at the first report of CWD within the jurisdiction or within a previously defined distance from its borders, such as in a neighboring state. Plans should include the immediate response to detection as well as long-term management of the disease if it cannot be eliminated. An Incident Command System or other central coordinating group may facilitate the initial response.

1. Essential elements of the response plan should include action plans for each of the following sections: Communications, diagnostics, surveillance, disease management, and research.

B. Initial Response to the First Detection should include:

1. A communications strategy should be designed to build support for response actions.

2. Sufficient testing capacity should be identified to support surveillance/monitoring activities.

3. Surveillance strategies should be implemented through consultation with epidemiologists to determine disease prevalence and geographic distribution of the affected area.

    a) Actions may include special hunts by the public with mandatory CWD testing, culling by sharpshooters and other methods.

4. Disease management activities should begin with recognition that they may be necessary on a long-term basis.

    a) CWD Management Zones should be established on the basis of the location of affected animals and natural history of local populations.

    b) Management activities likely will occur in concert with surveillance actions to define the affected area.

5. Surveillance and management of captive cervids should be in place as part of planning efforts and include fencing design, mandatory testing, inspections, animal ID, quarantine and decontamination protocols, among others (see Captive Cervid section below).

C. Managing CWD Prevalence should include utilizing harvest, sharpshooters or other removal mechanisms combined with statistically appropriate sampling and testing to monitor changes in prevalence. Strategies may include:

1. Targeting the portion of the population most likely to have CWD.

2. Targeting animals in known CWD hotspots.

3. Adjusting timing to most effectively remove infected animals.

4. Reducing cervid density in CWD-positive areas with high animal density.

5. Eliminating practices that promote artificial cervid concentrations to minimize environmental contamination.

6. Utilizing a coordinated, adaptive management approach that allows evaluation of experimental CWD suppression strategies whereby the data gathered from these efforts would be used to develop improved strategies.

7. Restricting or prohibiting intact carcass and high risk material transport out of CWD management zones.

D. **Rehabilitation of Deer and other Cervids** may result in translocation and/or release of infected animals.

   1. Prohibit cervid rehabilitation activities, including animal transport, either statewide or in designated CWD management zones or in other geographic areas where CWD has been detected in wild or captive cervid populations.

   2. Alternative practices: In areas where CWD is suspected but not yet reported, restrict rehabilitation activities to facilities that observe all recommended biosecurity protocols for the safe handling, disposal, and decontamination of prions and prion-infected tissues, materials, and equipment.

E. **Carcass Disposal** is critical to prevent exposure of wildlife to the CWD agent.

   1. Incinerate carcasses in an Environmental Protection Agency-approved conventional incinerator, air curtain incinerator, or cement kiln.

   2. Treat carcasses with high-pressure alkaline hydrolysis followed by burial of the treated material in an active, licensed landfill.

   3. Alternate practices: Composting; centralized sites for disposal of CWD-positive or high risk carcasses. Landfills often are used: although burial does not eliminate infectious prion, carcass parts should be inaccessible to cervids and other animals.

F. **Decontamination and Disinfection Methods for Equipment** require special techniques because of the resistance of the CWD agent to standard disinfectants and sterilization methods.

   1. Effective products and methods include 2% sodium hypochlorite (bleach) solution, autoclaving under specific conditions, or the use of Environ LpH se Phenolic disinfectant.

SUPPORTING ACTIVITIES

A. **Internal and Public Communications** are critical to build support within agencies and among the general public for CWD prevention, surveillance, and management policies, regulations, and activities. Development of an integrated communications strategy and CWD communications plan is recommended. Messages should be developed with thorough understanding of the importance of the human dimensions of wildlife disease management.

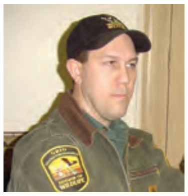
   1. Communications should be open between agency administrators and field employees.

   2. Agencies should maintain accurate, up-to-date websites that contain general information about CWD, jurisdiction-specific CWD information, surveillance and response activities, relevant regulations, public health concerns, recommendations for hunters and information indicating how they can help, reporting procedures for sick or dead ungulates, and test result reporting.

   3. Social science surveys may be conducted to inform management decisions and increase positive stakeholder engagement.

Agenda #1.

AUTHORS



Geoff D. Westerfield

Geoff D. Westerfield received his bachelor's degree from The Ohio State University in 2001 and his master's degree from University of Wisconsin-Stevens Point in 2016. He is currently an assistant wildlife management supervisor for the Ohio Division of Wildlife overseeing the human–wildlife interactions program for Northeast Ohio since 2012. One of his duties is to assist municipalities and park districts in development of deer management programs. Before 2012, he spent 11 years facilitating many other human–wildlife interaction programs for the Ohio Division of Wildlife. He is a member of TheWildlife Society and has held several board positions with the Ohio Chapter of The Wildlife Society and the Ohio Wildlife Management Association.

Justin M. Shannon

Justin M. Shannon has worked for the Utah Division of Wildlife Resources for 11 years as a wildlife biologist, regional manager, big game program coordinator, and currently as the chief of wildlife. He studied wildlife and wildlands conservation at Brigham Young University and graduated with his B.S. degree in 2007 and M.S. degree in 2008. His graduate work involved researching limiting factors of translocated bighorn sheep. His background and expertise are in big game management and conservation.

Orrin V. Duvuvuei

Orrin V. Duvuvuei is the statewide deer biologist and big game migration coordinator for New Mexico Department of Game and Fish. He received a bachelor's degree from Ohio State University in 2007 and a master's degree from Utah State University in 2013 researching greater sage-grouse population dynamics and movements. Prior to his work in New Mexico, he was a wildlife biologist in central Washington working with mule deer, waterfowl, upland birds, and various non-game species. His early professional experience was as a technician on research projects involving white-tailed deer survival and predator–prey interactions, eastern turkey reproductive success, sage-grouse population dynamics, and surveys and monitoring for threatened, endangered, sensitive, and various big game species. He currently serves as a member of the Mule Deer Working Group for the Western Association of Fish and Wildlife Agencies.

Thomas A. Decker

Thomas A. Decker is a certified wildlife biologist and works for the U.S. Fish and Wildlife Service in the Wildlife and Sport Fish Restoration Program. Previously, he has worked for Vermont Fish and Wildlife and for Massachusetts Division of Fisheries and Wildlife, holding several positions including furbearer biologist, director of wildlife, and director of operations. He is a life member of the American Society of Mammologists. He has been a member of The Wildlife Society since 1988 and is a TWS Fellow and NCLI Fellow. He has served on TWS Governing Council and recently finished serving as chair of the Editorial Advisory Board of The Wildlife Professional. He has been active nationally with the Association of Fish and Wildlife Agencies Furbearer Resources Task Force. He has been part of a U.S. Technical Work Group addressing national and international policy, research, and management programs related to the sustainable management of furbearers in the United Sates. He has B.S. and M.S. degrees in fisheries and wildlife biology from the University of Massachusetts at Amherst and a bachelor's degree in geography from Worcester State University.

Nathan P. Snow

Nathan P. Snow works as a research biologist with the USDA National Wildlife Research Center. His research objectives include finding solutions to wildlife damage issues and human–wildlife conflicts and managing threats from invasive species. He applies field and laboratory studies and ecological modeling to address these issues. Currently, he is working to develop new management techniques for invasive wild pigs in the United States and Australia.

Erin D. Shank

Erin D. Shank is an urban wildlife biologist with Missouri Department of Conservation. She works on urban habitat restoration and deer management in the St. Louis area.

Brian F. Wakeling

Brian F. Wakeling received his bachelor's and master's degrees from Arizona State University in 1985 and 1989, respectively. He currently serves as the administrator for the Game Division at the Nevada Department of Wildlife, a position he has held since September 2014. Prior to his service with Nevada, he enjoyed a 26-year career with the Arizona Game and Fish Department, where he spent 12 years conducting research (on turkeys, elk, bighorn sheep, bison, mule deer, mountain lions, bears, and urban lizards) and 14 years in game management, concluding his career with Arizona as the chief of game management. He is a certified wildlife biologist and a certified public manager. He is currently the chair of the Association of Fish and Wildlife Agencies Human–Wildlife Conflict Working Group.

H. Bryant White

H. Bryant White is the program manager of furbearer research and trapping policy for the Association of Fish and Wildlife Agencies. He earned a degree in history from the University of Memphis (B.A.), theology from Harding University (M. Div.), and wildlife and fisheries science from Tennessee Technological University (B.S. and M.S). He currently works to develop best management practices for trapping in the United States and on issues related to the sustainable use of wildlife and human–wildlife conflict resolution.

ASSOCIATION of FISH & WILDLIFE AGENCIES

DEER MANAGEMENT ACTION PLAN

AND URBAN WILDIFE CONTROL PLAN

CITY OF FORT BENTON, MONTANA

OVERVIEW:

A healthy, wild deer population is important to the people of Fort Benton. Wildlife viewing is an esthetic value that will be preserved. Deer hunting in areas surrounding Fort Benton is of high value to the area residents and visiting hunters as well as bring economic value to local businesses. However, high deer numbers and the habits of some individual animals within the city and the interface between city and adjacent rural areas can create situations that threaten human safety and health, damage property, and is not conducive to long term health of the deer population or its habitat.

HISTORY:

A number of Fort Benton citizens have complained that the risk to human safety and the level and potential increase for property damage has reach unacceptable levels. FWP and Fort Benton have addressed this issue utilizing a special game damage hunt in 2004 on the edge of Fort Benton city limits. However in town deer numbers continue to deer - human conflicts have reach unacceptable levels for Fort Benton citizens. On September 19, 2011 the City Council Meeting will present Fort Benton residents with this urban deer management plan and provide for public comment on this draft, addressing problems and identifying solutions to the human health and safety and property damage issues related to deer within Fort Benton city limits.

PURPOSE AND SCOPE of the Action Plan:

1. To reduce the negative impacts to people caused by deer in the city of Fort Benton, Montana.
2. Work with Adjacent Land owners and FWP to manage deer populations near Fort Benton to reduce the potential of those deer from moving into Fort Benton and becoming year round resident deer.

GOALS:

1. Eliminate individual deer within City limits that threaten human safety;
2. To reduce the potential for human-deer interactions and conflicts by lowering resident city deer numbers in the Fort Benton.

3. Respond to seasonal deer population increase from wild deer and the resulting contribution to the resident city deer population and immediate human safety and human-deer interactions and conflicts.

DEER POPULATIONS:

The deer population has two components: those deer that have become year round residents within the city limits “resident city deer”; transient or “Wild Deer” which generally inhabit land immediately adjacent to Fort Benton but move in and out of town based on weather conditions, general daily movement patterns, seasonal movements, and movement into town for security against hunting or other human caused disturbances. These Wild deer become numerous during certain periods of the year resulting in human safety and conflict issues and partly contribute to the resident population.

ACTIONS TO MEET GOALS:

1. Aggressive Deer that threaten human safety will be dispatched as soon as possible after receiving and verification that there is behavior or activities of the deer are an actual threat to human health and safety. Any Montana Peace Officer (including but not limited to FWP wardens, County Sheriff and Deputies, Police Officers of Fort Benton) acting in their official capacities, are the only persons authorized to use firearms for the purpose of dispatching animals within the Fort Benton City Limits. Complaints need to be directed to Fort Benton Dispatch Center (1-406- -), Fort Benton Police Officer (1-406 - -) and/or the local Montana Fish, Wildlife & Parks Warden (1-406- -). All deer removed under this plan must be documented and a record must be maintain by the City of Fort Benton and reported directly to Montana Fish, wildlife & Parks. An Annual report will be developed and will be provided to MT FWP information for each event, including the date of the complaint, nature of complaint, name of the Montana Peace Officer responding, number of deer dispatched, method of removal (lethal control) and the disposition of the deer removed.

2. Resident and wild deer threatening the safety of pets confined to yards may be dispatched if necessary by Montana Peace officers and MT FWP Wardens if hazing and other methods to encourage those animals to leave the area are ineffective. Resident deer causing severe and persistent damage to gardens and ornamental plantings will be addressed by legal public hunting opportunities using appropriate methods, meeting all FWP and State Statutes and ARM rules, and where public safety is not jeopardized. The intent is to minimize human/deer conflict and damage caused by resident deer.

3. Citizens of Fort Benton and residents directly adjacent to Fort Benton must refrain from artificially feeding resident and wild deer Pursuit to MCA 87-3-130. Artifical feed not only is a misdemeanor but also encourages deer to habituate to the urban environment and create human/deer conflict and human health and safety issues. Wild deer that enter the City of Fort Benton are less likely to become resident deer and/or remaining in town for a shorter period when artificial food supplies are not present.

ADDITIONAL INFORMATION:

Note: The City of Fort Benton and it's Citizens recognize that Montana's heritage is based in an urban setting that has the presence of many wild and native species of fish and wildlife and state law recognize the importance of Montana's Public Wildlife Legacy. Minor or occasional property damage caused by wild deer is an acceptable and circumstance of their presence that Montanans' have chosen to accept. This is in accord with the expressed wishes of the citizens of Fort Benton.

Note: Carcasses of deer that must be killed will be given to the local food bank or other suitable charity.

Note: Deer that have been killed due to vehicle deer collision will be removed by the Fort Benton Police Department, The Chouteau County Sheriff, County Road Crew, MT department of Transportation, or if available a local FWP Warden, depending upon the location of the animal.

MANAGEMENT PROCESS:

Using the following strategies will facilitate public hunting:

1. Hunting will be in accordance with all Montana Laws and Regulations.
2. Hunting will be managed with safety as a primary consideration. In some locations assigning and directing hunters to appropriate sites will suffice. In some sensitive locations hunters may be escorted to assure safe and successful harvest.
3. Hunting will be restricted solely to the use of archery equipment in the city limits as defined by Fish, wildlife & Parks Commission big Game Regulations.
4. Only open space property owners approved by the City of Fort Benton will be allowed to have hunting activities occur within their property boundaries. A list of approved property owners that are allowed to provide hunting will be kept on hand and updated as needed by the City of Fort Benton at City Hall. Hunters are required to check in and obtain approval from the landowner, the City, before hunting.

5. Any hunting within the City Limits outside the dates of MT FWP's General Big Game season and General Big Game Archery Season, must be approved prior to hunting by MT FWP Regional Office in Great Falls (Regional Wildlife Manager, Regional Warden Captain, or Regional Supervisor).
6. Regular season hunts will be optimized and special management seasons will be employed when needed and where they are effective.
7. Antlerless (doe/fawn) harvest will be required before having the option of harvesting a resident antlered deer (buck).
8. Hunters will be required to bag and remove the deer viscera from the area where its presence may be offensive or a problem.

Note: hunters, particularly those who might be interested in management hunts but do not need the meat, may have the option of donating their game to the Food Bank or a suitable charity.

MONITORING RESPONSIBILITY:

The City of Fort Benton and Montana Fish, Wildlife & Parks will jointly monitor the implementation and effectiveness of this Action Plan.

The Fort Benton Police Department will accept and forward, complaint calls and will provide assistance of a police officer, when needed in response to complaints about aggressive deer. A Fort Benton Police Officer, Chouteau County Deputy Sheriff, or the MT Highway Patrol Officer will continue to respond to vehicle / deer accidents. The number and type of complaints received, as well as the action taken will be recorded and provided to MT Fish, Wildlife & Parks Regional office in Great Falls in an Annual Report.

Fish, Wildlife & Parks assist the City of Fort Benton in determining the deer population within the City limits and Assist the City in structuring effective management strategies to reduce to an acceptable number the resident deer population in Fort Benton.

Approved property owners will manage the hunting on their respective properties.

PROGRAM LONGEVITY:

Consensus of the City of Fort Benton and the approval of FWP may modify this *"ACTION PLAN"* in writing.

This "*Action Plan"* is effective upon authorization from Fish, Wildlife & Parks and the City of Fort Benton, and it will remain in effect until modified or terminated by the City of Fort Benton or Fish, Wildlife & Parks.

DEER MANAGEMENT ACTION PLAN
AND URBAN WILDIFE CONTROL PLAN
CITY OF FORT BENTON, MONTANA
SIGNATURE PAGE:

REPRESENTING OFFICIALS:

For Montana Fish, Wildlife & Parks:
Name:______________________________ Title: _________________________

Signature:__________________________________Date:__________________

For The City of Fort Benton:
Name:_____________________________ Title:_________________________

Signature:__________________________________Date:_________________

Date ACTION PLAN Authorize: ________________________

The following individuals' signatories represent their respective support for the *"ACTION PLAN".*

For The Chouteau County Commisioners:

Name:_____________________________ Title:_________________________

Signature:____________________________________Date: _______________

Name: ____________________________Title:___________________________

Signature:___________________________________Date:_______________

Name:_____________________________Title:_________________________

Signature:___________________________________Date:_______________

For The Chouteau County Sheriff's Office:
Name:___________________________________Title:___________________

Signature:__________________________________Date:______________

DEER MANAGEMENT ACTION PLAN

CITY OF GLENDIVE, MONTANA

Overview:

A healthy, wild deer population is important to the people of Glendive. Wildlife viewing is an esthetic value that will be preserved. However, high deer numbers and the habits of some individual animals within the City and the interface between the City and adjacent rural areas can create a situation that threatens human safety, damages property and is not conducive to the long- term health of the deer population or its habitat.

History:

A number of Glendive citizens have complained that the risk to human safety and the level of property damage have grown to unacceptable levels. In response to these complaints , a public meeting was held in October of 2009, followed by a second public meeting held on August 30, 2010, with concerned citizens, members of the Glendive City Council and representatives from the Fish, Wildlife and Parks. A Committee Hearing of the City Council was held on November 10, 2010 to discuss the development of an action plan for Deer Management in and adjacent to the City of Glendive. The Dawson County Commissioners and the Dawson County Sheriffs have been contacted in regards to the plan

The Action Plan's PURPOSE and SCOPE are:

To reduce the negative impacts to people caused by the deer in and near the City.

Note: While the management of deer that inhabit Glendive occurs on a larger scale, the restrictions detailed in the PLAN are limited to within the boundaries of the City of Glendive (Exhibit A, attached). This does not preclude additional coordinated efforts with landowners adjacent to and in near proximity to Glendive.

The specific GOALS are:

To eliminate individual deer that threaten human safety;
to reduce the potential for human-deer interactions by lowering deer numbers in the City.

Deer Populations:

The deer comprise two distinct populations. One population is wild and the other resident "city deer". Wild deer generally occupy periphery areas adjacent to Glendive but pass through and occasionally use residential or business areas. These deer do not cause as many problems but over time will contribute to the other population comprising resident deer that remain year-around within the City.

ACTIONS needed to achieve the goals:

A. Free Public hunting will be used as the management tool of choice to control the size of both populations and to keep individuals wary of people which will discourage them from becoming resident deer.

B. Aggressive deer that threaten human safety will be dispatched as soon as possible after receiving a complaint. Montana Peace Officers,(including but not limited to Wildlife & Parks Wardens, the Dawson County Sheriff and Deputies, and Police Officers of the City of Glendive) acting in their official capacities, are the only persons authorized to use firearms for the purposes of dispatching animals within the City Limits. Complaints should be directed to the local Fish, Wildlife and Parks Warden through the Glendive Dispatch Center (377-2364).

C. Resident deer threatening the safety of pets confined to yards will be dispatched if necessary by Fish, Wildlife and Parks. Resident deer causing severe and persistent damage to gardens and ornamental plantings will be addressed by hunting where possible. The intent is to reduce or minimize resident deer where they are causing problems.

D. The people of Glendive must refrain from artificial feed of deer as a way to encourage them to stay near, or return to the city. Pursuit to MCA 87-3-130, it is a misdemeanor violation to feed deer. In addition, the diet is unhealthy and the practice induces the deer to adopt habits that put them in conflict with humans and ultimately means these deer must be destroyed. Wild and wary deer will stay out of trouble but will still be visible to those who enjoy seeing them as them pass through areas occupied by people.

Note 1: Our tradition and state law recognizes the importance of Montana's public Wildlife legacy. Minor or occasional property damage caused by wild deer is a by-product of their presence that Montanan's have chosen to accept. This also is in accord with the expressed wishes of the resident of Glendive.

Note 2: Citizens who find dead deer in town should call the warden who may inspect it and authorize its removal.

Note 3: Carcasses of deer that must be killed will be given to the local food bank or other suitable charity.

Note 4: Deer that have been killed with a vehicle will be removed by the Glendive Police Department, the Dawson County Sheriff's Department or the Montana Department of Transportation depending upon the location of the animal.

Management Process

Using the following strategies will facilitate public hunting of deer:

1. Hunting will be in accordance with all Montana laws and regulations.
2. Hunting will be managed with safety as a primary consideration. – In some locations assigning and directing hunters to appropriate sites will suffice. In more sensitive locations hunters may be escorted to assure safe and successful harvests.
3. Hunting will be restricted solely to the use of archery equipment in the City as defined by Fish, Wildlife & Parks Commission Big Game Regulations.
4. Only open space property owners approved by the City of Glendive may allow hunting on their properties. A list of approved property owners that are allowing hunting will be kept on hand and updated as needed at the Glendive City Hall. Hunters are still required to check-in and obtain approval from a landowner, including the City, before hunting on their property. Additional landowners may be added to the list after being approved by the City and FWP officials
5. Regular season hunts will be optimized and special management seasons will be employed when needed and where they are affective.
6. Antlerless (doe/fawn) harvest will be required before having the option of harvesting an antlered deer (buck).
7. Hunters will be required to bag and remove the deer viscera from areas where its presence may be offensive or a problem.

   Note: Hunters, particularly those who might be interested in management hunts but who do not need the meat, may have the option of donating their game to the Food Bank or a suitable charity.

Monitoring and Responsibilities:

The City of Glendive and Fish, Wildlife & Parks will jointly monitor the implementation and effectiveness of this Action Plan.

The Glendive Police Department will accept, and forward, complaint calls and will provide the assistance of a police officer, when needed in response to complaints about aggressive deer. A police officer, a deputy sheriff, or the highway patrol will continue to respond to auto/deer accidents. The number and types of complaints received, as well as the action taken will be tabulated.

Fish, Wildlife & Parks will continue ongoing efforts to gather hunter harvest data and population trend survey data to determine deer population levels within the City of Glendive and surrounding areas.

Approved property owners will manage the hunting on their respective properties.

Program Longevity:

Consensus of the City of Glendive and approval of Fish, Wildlife & Parks may modify this ACTION PLAN in writing.

This ACTION PLAN is effective upon authorization from Fish, Wildlife & Parks and the City of Glendive, and it will remain in effect until modified or terminated by the City of Glendive or the Fish, Wildlife & Parks.

Representing Officials:

For: Montana Fish, Wildlife and Parks ____

For: The City of Glendive ____

Date of ACTION PLAN Authorization ____

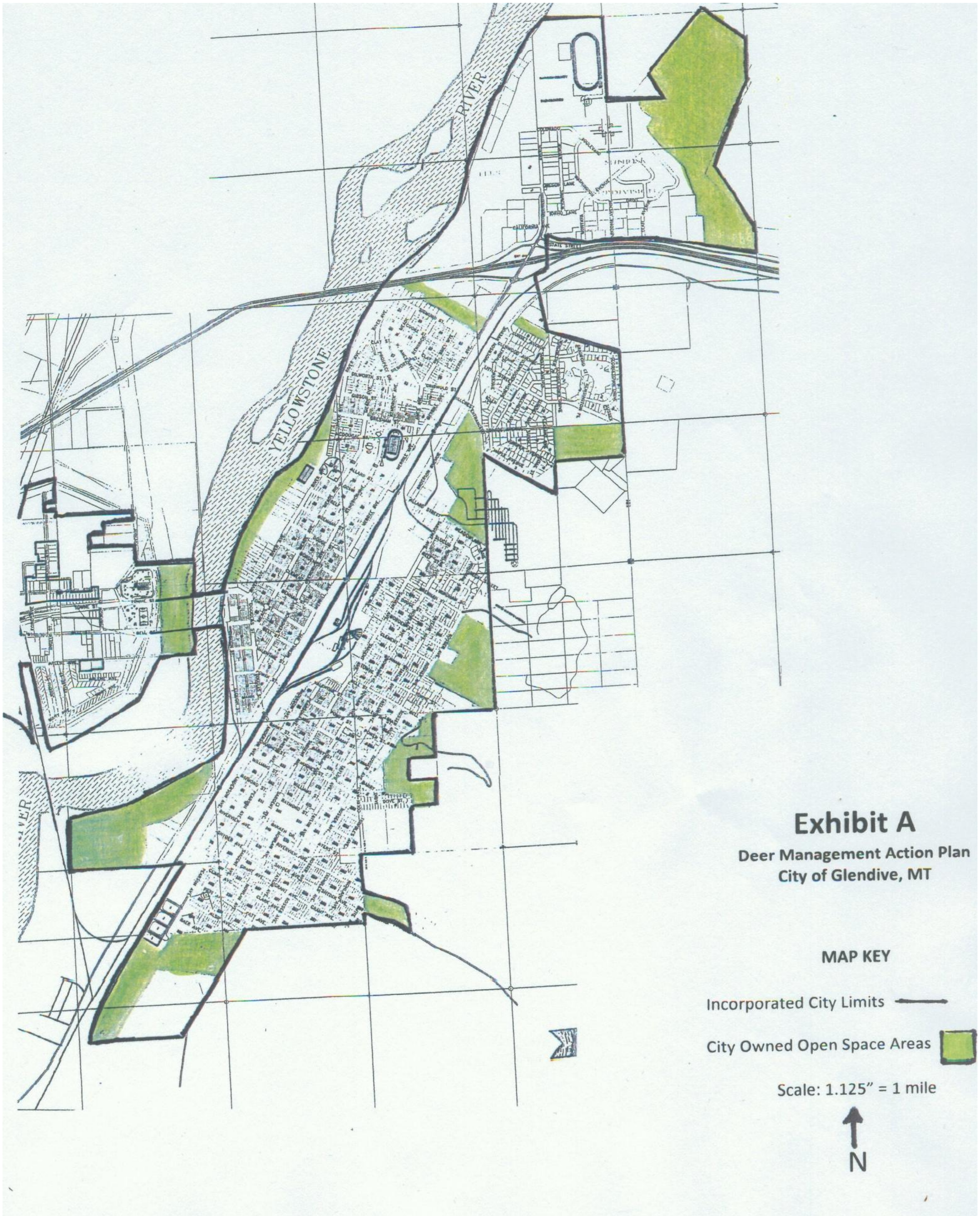
The following individuals' signatories represent their respective support for the ACTION PLAN.

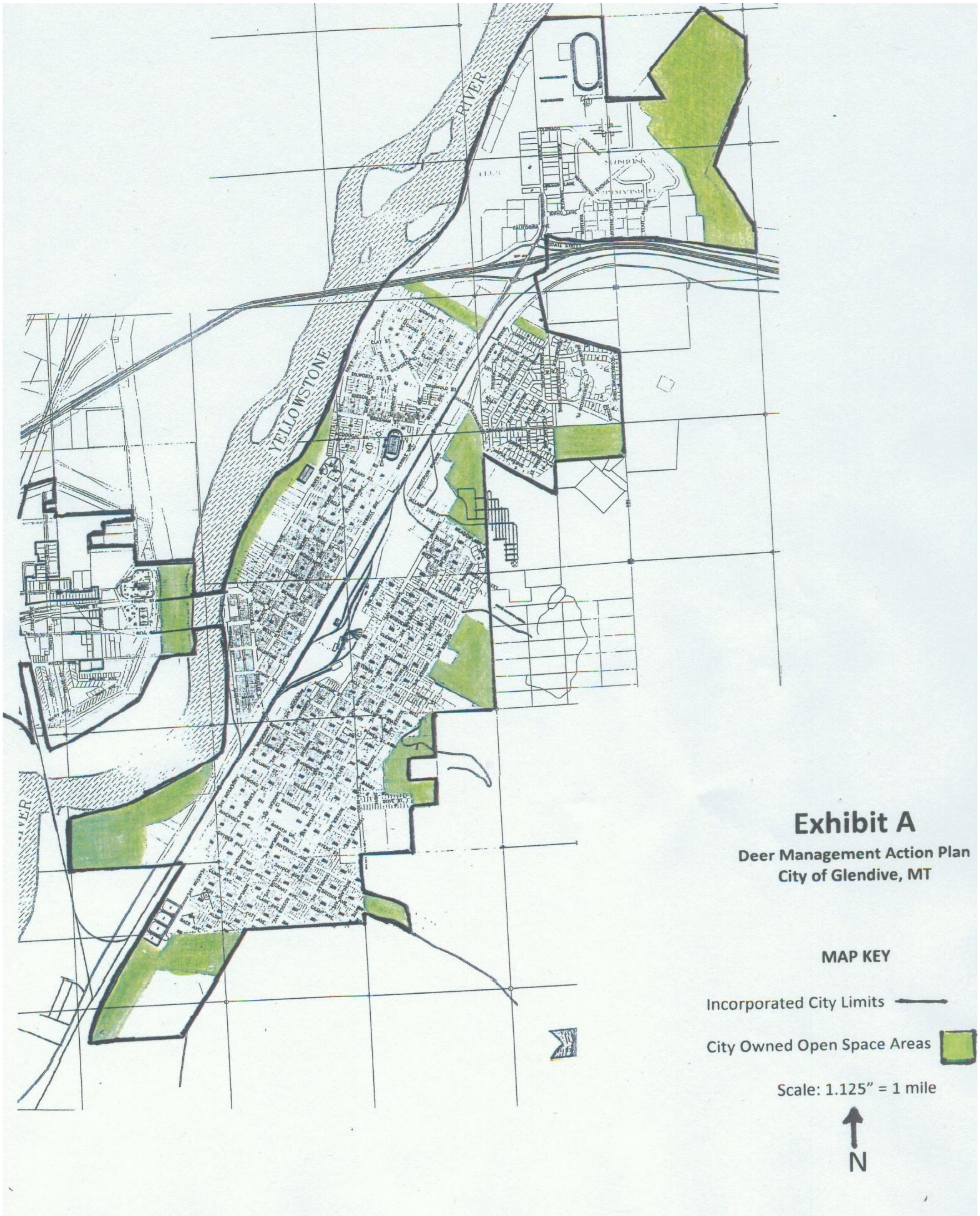
For: The Dawson County Commissioners ____

____

____

For: Dawson County Sheriff's Office ____


RIVER
YELLOWSTONE
Exhibit A
Deer Management Action Plan
City of Glendive, MT
MAP KEY
Incorporated City Limits
City Owned Open Space Areas
Scale: 1.125" = 1 mile
N


RIVER
YELLOWSTONE
Exhibit A
Deer Management Action Plan
City of Glendive, MT
MAP KEY
Incorporated City Limits
City Owned Open Space Areas
Scale: 1.125" = 1 mile
N

FWP.MT.GOV THE OUTSIDE IS IN US ALL.

Mule Deer/White-tailed Deer Management Action Plan for the City of Lewistown, Montana

Overview:

Montana statute recognizes that cities or towns may, on occasion, need to manage wildlife within their boundaries in order to protect residents or their property.

MCA 7-31-4110 reads as follows: *A city or town may adopt a plan to control, remove, and restrict game animals, as defined in 87-2-101, within the boundaries of the city or town limits for public health and safety purposes. Upon adoption of a plan, the city or town shall notify the Department of Fish, Wildlife and Parks of the Plan. If the Department of Fish, Wildlife and Parks approves the plan or approves the plan with conditions, the city or town may implement the plan as approved or as approved with conditions.*

A healthy, wild deer population is important to the people of Lewistown and Montana. Deer hunting and viewing in areas surrounding Lewistown is highly valued by residents and visitors, as well as an important component of the local economy. Minor or occasional property damage caused by wild deer within the city limits is an inevitable but acceptable consequence of the occasional deer roaming through the area. However, high deer densities within the city limits and the behavior of some individual animals can, at times, be problematic. Deer that live all or part of the year in the City of Lewistown may threaten human safety and health, injure pets, and damage property.

History:

A number of Lewistown residents have complained that the risk of human safety and property damage caused by mule- and white-tailed deer living within the city limits has reached unacceptable levels. The City of Lewistown Police Department, Montana Fish, Wildlife & Parks, and city staff regularly respond to incidents of deer acting aggressively towards humans or pets, or damaging residents' homes land landscaping. In September 2021, the Lewistown News Argus printed an article in the paper regarding Urban Deer, and how the high number of deer within the city limits is impacting citizens in a negative way.

In October 2021, the Lewistown Police Department conducted spotlight deer surveys across several patrol areas in Lewistown over a period of nine nights. They observed 321 deer total (across repeat locations) with an average 36 deer observed each night. These were not complete-coverage surveys of Lewistown, and it is unlikely all deer present were observed.

At their October 5, 2021, meeting the Lewistown City Commission discussed what avenues were available to manage the deer population within the city limits. Several Commissioners and a few citizens expressed frustration about the number of deer within the city limits, especially during the winter months.

The complaints covered many different areas including, deer negatively impacting private property, deer becoming aggressive towards pets and the number of deer vs vehicle collisions that occur each year within the city limits.

During this meeting two main options were discussed amongst the City Commission, City Manager and Chief of Police. The first option discussed was the potential of implementing a deer hunt within the city limits by local citizens. This option was discussed thoroughly, including the many pros and cons that may be associated with allowing citizens to harvest deer within the city limits.

The second option discussed was the plan as outlined in this Action Plan. The plan that is in place in White Sulphur Springs Montana was used as an outline for how the City of Lewistown may control the deer population within its own city limits. After a lengthy discussion the City Commission asked the Chief of Police to explore the details of how this Action Plan could be implemented. The Chief of Police worked with Montana FWP Biologist Sonja Andersen to develop the proposed Action Plan as outlined here. This plan was presented to the City Commission's July 18, 2022 meeting and approved. Opportunity for public comment was provided, but no public comment was received.

PURPOSE AND SCOPE OF THE ACTION PLAN:

1) Reduce the negative impacts to people caused by mule- and white-tailed deer within the City of Lewistown, Montana.
2) Provide the City of Lewistown and Lewistown Police Department with the management tools necessary to effectively respond to individual deer-human conflicts and to limit overall deer density within the city limits, as necessary.

GOALS:

1) Euthanize individual deer within city limits which threaten human safety or property.
2) Reduce the potential for human-deer interactions and conflicts by lowering the density of deer resident within the City of Lewistown.

ACTIONS TO MEET GOALS:

1) Mule- or white-tailed deer within the Lewistown city limits which have become habituated to human activity and are behaving aggressively will be dispatched by Lewistown Police Department or Montana Fish, Wildlife & Parks, as soon as possible after verifying the deer's behavior or activities pose a threat to human safety or property. Resident deer threatening the safety of pets confined to yards may also be dispatched. Public complaints need to be first directed to Central Montana Dispatch at (406) 535-1800.
2) The City and Chief of Police may choose to trap and euthanize a number of deer residing within city limits each year between August 15 and February 15 in order to reduce overall deer density. The number of deer removed each year will be limited by the terms of a ***Permit to Destroy Game Animals Causing Damage*** issued to the City of Lewistown by the Fish & Wildlife Commission.
3) All deer removed under this Action Plan must be documented and a record of those removals maintained by the City of Lewistown. An annual report will be provided to Montana Fish, Wildlife & Parks which includes the date and nature of any public complaints, the responding Lewistown Police Department officers, the number, age class, and gender of deer dispatched, the method of removal, and the disposition of the deer removed. Carcasses will be disposed of in accordance with FWP rules and statutes; and venison fit for human consumption will be donated to the Community Cupboard (Montana Food Bank Network) for charitable distribution. Carcasses processed for human consumption will be tested for CWD prior to being distributed. Deer which

have been killed due to vehicle-deer collisions within city limits will be removed by Lewistown Police Department, Lewistown Animal Control, or city maintenance staff, and such will not be included in the permit numbers allowed to be taken. (Salvage of Game Animals: §87-3-145 MCA).

4) All FWP regulations and Montana State Statutes and ARM rules apply, including terms of a ***Permit to Destroy Game Animals Causing Damage*** which may be issued to the City of Lewistown by the Fish & Wildlife Commission.
5) Citizens of Lewistown must refrain from artificially feeding or providing supplemental feed attractants to resident and wild deer pursuant to MCA 87-6-216. Artificial feeding is a misdemeanor and encourages deer to habituate to the urban environment and create human/deer conflict. Wild deer that enter the City limits are less likely to become resident and/or remain in town when artificial feed is contained.

MONITORING RESPONSIBILITY:

The City of Lewistown and Montana Fish, Wildlife & Parks will jointly monitor the implementation and effectiveness of this Action Plan. The Lewistown Police Department will accept, and forward complaint calls and will provide assistance of an officer to respond to complaints about aggressive deer. The Lewistown Police Department, Fergus County Sheriff's Department, or Montana Highway Patrol will continue to respond to deer-vehicle conditions. The number and type of complaints received, as well as the action taken will be recorded and provided to the FWP Region 4 Office in Great Falls in an annual report.

Fish, Wildlife and Parks will assist the City of Lewistown in determining the deer population within the city limits and advising the City in structuring effective management strategies.

PROGRAM LONGEVITY:

The City of Lewistown may modify this Action Plan as needed. However, changes to stipulations regarding the harassment or lethal removal of Game Animals are subject to oversight and permitting by the Fish & Wildlife Commission.

This Action Plan is effective upon authorization by Fish, Wildlife & Parks, the Fish & Wildlife Commission, and the City of Lewistown. It will remain in effect until modified or terminated by any of those named parties.

Agenda #1.

Montana Fish, Wildlife & Parks

Wildlife Division
PO Box 200701
Helena MT 59620-0701
November 14, 2014

Dear Interested Person:

Montana Fish, Wildlife & Parks is requesting public review and comment on a proposed City of Roundup Deer Management Plan. Additional information is below including the deadline for public comment.

City of Roundup Deer Management Plan - Proposed

Background: High deer numbers in and around town have resulted in unacceptable levels of property damage and concern for human safety. During 2013 and 2014 Roundup City Council meetings have had focus on the urban deer problems and complaints from residents about aggressive deer. The Roundup City Council, Mayor and FWP developed a Management Plan to address concerns and provide direction to ameliorate property damage. The Plan's specific goals are to: 1) eliminate individual deer that threaten human safety and 2) reduce the potential for human-deer interactions by lowering deer numbers in and adjacent to the city of Roundup. Public hunting, specifically archery hunting, on property owned by the City of Roundup and Musselshell County will be employed as the chosen method to meet the stated goals. Archery hunting is the only means of take due to safety concerns imposed by the proximity to residential areas and businesses.

Problem/rationale: HD530 where the Roundup Urban Deer Hunt would take place is a permit area for mule deer bucks and there are no antlerless mule deer "B" licenses available in 2014. Thus there are no general-season antlerless harvest opportunities for mule deer in HD530. Current mule deer numbers in and adjacent to Roundup are above the level of public tolerance. The City of Roundup would like the ability to reduce deer numbers and FWP staff believes the addition of 60 either-sex mule deer licenses would serve that end. FWP and the City of Roundup requests 60 either-sex mule deer licenses be made available, up to 3 per hunter valid from the date the Management Plan is approved and valid through the end of the game damage season (February 15, 2015) to reduce the number of deer in and immediately adjacent to town.

Season Details: The urban deer hunt will run from the date the Management Plan is approved to February 15, 2015. In subsequent years the urban deer hunt will run from the beginning of the archery season in September through the end of the game damage season (February 15). The hunt area extends approximately 1 mile west; 1 mile east; 1 mile north and 1 mile south of Roundup MT and is on property owned by the City of Roundup and Musselshell County. The hunt area is legally defined as portions of T8N R25E Sections 11-14, 24; T8N R26E Section 18. Hunters need to obtain permission to hunt at the Roundup City offices (406-323-2804) from 8AM-5PM Monday thru Friday. The Roundup City offices are located at 34 3rd Ave West. Maps detailing the hunt area will be available at the Roundup City offices.

COMMENT PERIOD DEADLINE AND FINAL ADOPTION MEETINGS
The public comment period on proposed City of Roundup Deer Management Plan will extend through 5 p.m., Monday, December 8 with final adoption at the December 11 commission meeting.

TO MAKE COMMENT
For further clarification, you may call the Wildlife Division office at 406-444-2612. To submit comments electronically, this letter with the imbedded links below can be found under "Opportunity for Public Comment" on the Hunting home page at the fwp.mt.gov website. Written comments can be sent to: FWP – Wildlife Division, Attn: Public Comment, POB 200701, Helena MT 59620-0701.

City of Roundup Deer Management Plan – Proposed
The deadline for public comment on this item is 5 p.m., Monday, December 8.
http://fwp.mt.gov/hunting/publicComments/2014/roundupDeerManagementPlanProposed.html

DEER MANAGEMENT ACTION PLAN
CITY OF HAVRE, MONTANA

Overview:

A healthy, wild deer population is important to the people of Havre. Wildlife viewing is an esthetic value that will be preserved. However, high deer numbers and the habits of some individual animals within the City of Havre (City) and the interface between the City and adjacent rural areas can create a situation that threatens human safety, damages property and is not conducive to the long-term health of the deer population or its habitat.

History:

A number of Havre citizens have complained that the risk to human safety and the level of property damage have grown to unacceptable levels.

The Action Plan's PURPOSE and SCOPE are:

1. To reduce the negative impacts to people caused by the deer in and near the City.
2. Provide the City with the management tools necessary to effectively respond to individual deer-human conflicts and to limit overall mule deer density within the City Limits, as necessary.

Note: While the management of deer that inhabit Havre occurs on a larger scale, the restrictions detailed in the PLAN are limited to within the boundaries of the City (Exhibit A, attached). This does not preclude additional coordinated efforts with landowners adjacent to and in near proximity to Havre.

The specific GOALS are:

1. To eliminate individual deer that threaten human safety or property;
2. To reduce the potential for human-deer interactions and conflicts by lowering deer density within the City.

Deer Populations:

The deer comprise two distinct populations. One population is only intermittently present in the city limits and less habituated to human presence and the other resident "City Deer". Non-resident deer generally occupy periphery areas adjacent to Havre but pass through and occasionally use residential or business areas. These deer do not cause as many problems but over time may contribute to growth of the resident population that reside year-round within the City.

ACTIONS needed to achieve the goals:

A. Public hunting will be used as the management tool of choice to reduce deer density in the City and to reduce the habituation of deer to the presence of humans.

B. Aggressive deer that threaten human safety will be dispatched as soon as possible after receiving a complaint. Montana Peace Officers (including but not limited to Fish, Wildlife & Parks Wardens, and Police Officers of the City,) acting in their official capacities, are the only persons authorized to use firearms for the purposes of dispatching animals within the City Limits. All deer issues and complaints within the City should first be directed to the local Havre Police Department Dispatch Center (406-265-4361). If City departments are unavailable to resolve the issue or complaint, or assistance is needed, Montana Fish, Wildlife and Parks (FWP) enforcement or wildlife staff will be the secondary point of contact (406-265-6177).

1. Resident deer threatening the safety of pets confined to yards will be dispatched if necessary, by Havre Police Department. Resident deer causing severe and persistent damage to gardens and ornamental plantings will be addressed by hunting where possible. The intent is to reduce or minimize conflicts where resident deer are causing problems.

C. The people of Havre must refrain from artificial feeding of deer, as it encourages them to stay near or return to the city. Pursuit to MCA 87-3-130, it is a misdemeanor violation to feed deer. It is also a violation of Havre City ordinance 8-5-21. In addition, the diet is unhealthy, and the practice induces the deer to adopt habits that put them in conflict with humans and ultimately means these deer must be destroyed. Wild and wary deer will stay out of trouble but will still be visible to those who enjoy seeing them as they pass through areas occupied by people.

Note 1: Our tradition and state law recognize the importance of Montana's public Wildlife legacy. Minor or occasional property damage caused by wild deer is a by-product of their presence that Montanan's have chosen to accept. This also is in accord with the expressed wishes of the residents of Havre.

Note 2: Citizens who find dead deer in town can dispose of deer. It is recommended that deer carcasses are disposed of in a manner where the carcass will end up in a Class II landfill.

Note 3: Carcasses of deer that must be killed according to above section B, will be given to the local food bank or other suitable charity, organization, or individual when suitable for human consumption. Agency dispatching the deer will be responsible for finding a recipient and donating the deer.

Note 4: Deer that have been killed with a vehicle, within the limits of the City, will be removed by the Havre Police Department, City Public Works or the Montana Department of Transportation depending upon the location of the animal.

Management Process

Using the following strategies will facilitate the reduction of deer within City boundaries:

1. The City may choose to trap and euthanize a number of resident deer within the City Limits each year between August 15 and February 15 in order to reduce overall deer density. The number of deer removed each year will be limited by the terms of a ***Permit to Destroy Game Animals Causing Damage*** issued to the City by Fish Wildlife & Parks Region 6 Supervisor.
2. Implement a public deer hunt within the City with the following rules and regulations:
   a. Hunting will be in accordance with all Montana laws and regulations.
   b. Hunting will be managed with safety as a primary consideration. In some locations assigning and directing hunters to appropriate sites will suffice. In more sensitive locations hunters may be escorted to assure safe and successful harvests.

c. Hunting will be restricted solely to the use of archery equipment in the City as defined by Fish and Wildlife Commission Big Game Regulations.
d. Only open space property owners approved by the City may allow hunting on their properties. A list of approved property owners that are allowing hunting will be kept on hand and updated as needed at the Havre City Hall. Hunters are still required to check-in and obtain approval from a landowner, including the City, before hunting on their property. Additional landowners may be added to the list after being approved by the City.
e. Hunters will be required to bag and remove the deer viscera from City property or any areas where its presence may be offensive or a problem.

    i. **<u>Note:</u>** Hunters, particularly those who might be interested in management hunts but who do not need the meat, may have the option of donating their game. The Havre Food Bank only accepts processed meat. Montana FWP recommends Chronic Waste Disease testing prior to donating deer venison.

f. The range of possible dates for harvest within this plan are from August 15 – February 15.
g. Hunters may be allowed to use existing deer licenses inside the city limits that are valid for HD 600 or 690
h. Additional deer B-licenses (up to 500) that are valid for mule deer, may be available for hunters to purchase if needed. These B-Licenses would be valid within the city limits and may include some properties adjacent to the city, but outside the city boundary.
i. Hunters may purchase up to 5 B-licenses and will not count against their limit of 7 B-licenses.
j. Hunt details (season dates and available licenses/quotas) would need to be approved by the Fish and Wildlife Commission.

Monitoring and Responsibilities:

The City and FWP will jointly monitor the implementation and effectiveness of this Action Plan.

All deer euthanized by the city under this plan will be documented and a record of those removals will be maintained by the City of Havre. An annual report will be provided to FWP to include the number of deer dispatched, the method of removal, and the disposition of the deer removed. After venison is donated, remaining carcass will be disposed of in accordance with FWP rules and statutes.

The Havre Police Department will accept complaint calls and provide the assistance of a police officer, when needed, in response to complaints about aggressive deer. A police officer, or the highway patrol will continue to respond to auto/deer accidents. The number and types of complaints received, as well as the action taken will be tabulated.

FWP will assist the City in determining the deer population within the City Limits and advising the City in structuring effective management strategies.

Approved property owners will manage the hunting on their respective properties.

Measures of Success:

1. Reduced call volume and complaints
2. Reduced vehicle collisions
3. Lower deer density over time
4. General landowner and public satisfaction

Program Longevity:

Consensus of the City and approval of FWP may modify this ACTION PLAN in writing.

This **ACTION PLAN** is effective upon authorization from FWP and the City, and it will remain in effect until modified or terminated by the City or the FWP.

REPRESENTING OFFICIALS:

For Montana Fish, Wildlife & Parks:

Name: Drew Henry Title: Region 6 Supervisor

Signature: [signature] Date: 11-9-2022

For City of Havre:

Name: Douglas A. Kaercher Title: Mayor

Signature: [signature] Date: July 6,2022

Date ACTION PLAN Authorization: July 5, 2022

The following individuals' signatories represent their respective support for the ACTION PLAN.

For: The Hill County Commissioners [signatures]

MULE DEER MANAGEMENT ACTION PLAN FOR THE CITY OF WHITE SULPHUR SPRINGS, MONTANA

OVERVIEW:

Montana statute recognizes that cities or towns may, on occasion, need to manage wildlife within their boundaries in order to protect residents or their property.

MCA 7-31-4110 reads as follows: *A city or town may adopt a plan to control, remove, and restrict game animals, as defined in 87-2-101, within the boundaries of the city or town limits for public health and safety purposes. Upon adoption of a plan, the city or town shall notify the department of fish, wildlife, and parks of the plan. If the department of fish, wildlife, and parks approves the plan or approves the plan with conditions, the city or town may implement the plan as approved or as approved with conditions.*

A healthy, wild deer population is important to the people of White Sulphur Springs. Deer hunting and viewing in areas surrounding White Sulphur Springs is highly valued by residents and visitors, as well as an important component of the local economy. Minor or occasional property damage caused by wild deer within the city limits is an inevitable but acceptable consequence of the occasional deer roaming through the area. However, high deer densities within the city limits and the behavior of some individual animals can, at times, be problematic. Deer that live all or part of the year in the City of White Sulphur Springs may threaten human safety and health, injure pets, and damage property.

HISTORY:

A number of White Sulphur Springs citizens have complained that the risk to human safety and property damage caused by mule deer living within the city limits has reached unacceptable levels. The Meagher County Sheriff's Department, Montana Fish, Wildlife and Parks (FWP), and city staff regularly respond to incidents of deer acting aggressively or damaging residents' homes and landscaping.

In 2017, the White Sulphur Springs City Council asked FWP to assess deer numbers and density within the City. A FWP biologist, warden, and city staff conducted two surveys of mule deer numbers during January and March of 2018 to obtain a census as to the City's deer population. Observers documented 104 and 119 mule deer within the 1.01 mi^2 city limits during those efforts. It is unlikely all the deer present during the surveys were observed.

At their August 5, 2019 meeting, the White Sulphur Springs City Council presented residents with a draft urban Mule Deer Management Action Plan and during their August 5, 2019, meeting took public comment on the proposed Plan. The Public Comment consisted of members of Council relating comments from citizens to the effect a plan was needed to control the deer population in the City limits, although citizens did not wish to declare open season on deer within the City limits. No other comments were made by any citizens in attendance at the meeting.

PURPOSE AND SCOPE of the Action Plan:

1. Reduce the negative impacts to people caused by mule deer within the City of White Sulphur Springs, Montana.
2. Provide the City of White Sulphur Springs and the Meagher County Sheriff's Department with the management tools necessary to effectively respond to individual deer-human conflicts and to limit overall mule deer density within the city limits, as necessary.

GOALS:

1. Euthanize individual deer within city limits which threaten human safety or property.
2. Reduce the potential for human-deer interactions and conflicts by lowering the density of deer resident within the City of White Sulphur Springs.

ACTIONS TO MEET GOALS:

1. Mule deer within the White Sulphur Springs city limits which have become habituated to human activity and are behaving aggressively will be dispatched by the Meagher County Sheriff's Department or their agents as soon as possible after verifying the deer's behavior or activities pose a threat to human safety or property. Resident deer threatening the safety of pets confined to yards may also be dispatched. The Meagher County Sheriff, designated deputies, or their assigned agents are the only persons legally allowed to discharge firearms within the city limits. Public complaints need to be first directed to the Meagher County Dispatch Center (1-406-547-3397).
2. The City and County Sheriff may choose to trap and euthanize a number of deer resident within the city limits each year between 8/15 and 2/15 in order to reduce overall deer density. The number of deer removed each year will be limited by the terms of a ***Permit To Destroy Game Animals Causing Damage*** issued to the County Sheriff by the Fish and Wildlife Commission.
3. All deer removed under this Action Plan must be documented and a record of those removals maintained by the City of White Sulphur Springs. An annual report will be provided to Fish, Wildlife & Parks which includes the date and nature of any public complaints, the responding Meagher County Sheriff/agent(s), the number of deer dispatched, the method of removal, and the disposition of the deer removed. Carcasses will be disposed of in accordance with FWP rules and statutes; and venison fit for human consumption will be donated to the Meagher County Nutritional Coalition for charitable distribution. Deer which have been killed due to vehicle-deer collisions within city limits will be removed by the Meagher County Sheriff's Department, White Sulphur Springs

Animal Control, or city maintenance staff, and such will not be included in the permit numbers allowed to be taken. (salvage of game animals: §87-3-145 MCA)

4. All FWP regulations and Montana State Statutes and ARM rules apply, including terms of a ***Permit To Destroy Game Animals Causing Damage*** which may be issued to the Meagher County Sheriff's Department by the Fish and Wildlife Commission.
5. Citizens of White Sulphur Springs must refrain from artificially feeding or providing supplemental feed attractants to resident and wild deer pursuant to MCA 87-6-216. Artificial feeding is a misdemeanor and encourages deer to habituate to the urban environment and create human/deer conflict. Wild deer that enter the City are less likely to become resident and/or remain in town when artificial feed is contained.

MONITORING RESPONSIBILITY:

The City of White Sulphur Springs and Montana Fish, Wildlife & Parks will jointly monitor the implementation and effectiveness of this Action Plan.

The Meagher County Sheriff's Department will accept and forward complaint calls and will provide the assistance of an officer or an assigned agent to respond to complaints about aggressive deer. The Meagher County Sheriff or the Montana Highway Patrol will continue to respond to vehicle-deer collisions. The number and type of complaints received, as well as the action taken will be recorded and provided to Fish, Wildlife & Parks Regional office in Great Falls in an annual report.

Fish, Wildlife & Parks will assist the City of White Sulphur Springs in determining the deer population within the city limits and advising the City in structuring effective management strategies.

PROGRAM LONGEVITY:

The City of White Sulphur Springs may modify this Action Plan as needed. However, any changes to stipulations regarding the harassment or lethal removal of Game Animals are subject to oversight and permitting by the Fish and Wildlife Commission.

This Action Plan is effective upon authorization by Fish, Wildlife & Parks, the Fish and Wildlife Commission, and the City of White Sulphur Springs. It will remain in effect until modified or terminated by any of those named parties.

SIGNATURE PAGE:

REPRESENTING OFFICIALS:

For Montana Fish, Wildlife & Parks:

Name:________________________ Title: ____________________

Signature:___________________________Date:_______________

For The City of White Sulphur Springs:

Name: Rick Nelson__________ Title: Mayor__________

Signature: [signature]__________Date: 8-6-19______

Date ACTION PLAN Authorized: 8-5-19________

Attachment: [FWP Permit To Destroy Game Animals Causing Damage]

City of Helena
Urban Deer Management Plan

FINDINGS AND RECOMMENDATIONS OF THE HELENA URBAN WILDLIFE TASK FORCE

Final Plan
April 9, 2007

ACKNOWLEDGEMENTS

The Helena Urban Wildlife Task Force acknowledges the following people whose contributions and hard work made the development of this Plan possible:

Helena Urban Wildlife Task Force Members

Matthew Cohn, Co-Chair, representing Helena Citizens' Council
Virginia Niccolucci, Co-Chair, representing community at large
Melissa Broch, representing HOLMAC
Tom DeYoung, representing community at large
Bob Habeck, representing Helena Citizens' Council
Andrews Jakes, representing community at large
Gayle Joslin, representing Fish, Wildlife, and Parks
Mike Maynard, representing Chief of Police (designee)
Sandy Oitzinger, Commissioner, representing Helena City Commission

Helena Parks & Recreation Department

Randy Lilje
Carol Kirkland

Content, Design, and Consulting

Neil Anderson, Montana FWP
Kieth Aune, Montana FWP
John Baldrige, Bureau of Business & Economic Research, University of Montana
Thomas Baumeister, Montana FWP
Tom Carlson, Montana FWP
Kurt Cunningham, Montana FWP
Tim Davis, Montana Smart Growth Coalition
Anthony DeNicola, Wildlife Management Research Group
Tim Feldner, Montana FWP
Dennis Flynn, Valley Farms
Sheila Habeck, Cover Design
Sharon Haugen, City Community Development Department
Gene Hickman, Ecological Assessments
Larry Kline, Independent Record
Mike Ottman, Montana FWP

Helena Citizens

Thank you for your comments!

EXECUTIVE SUMMARY

Over the past decade, the city of Helena has experienced an increase in the urban deer population that has threatened public health and safety, real and personal property, and welfare of the deer. In order to address urban deer issues, the Helena City Commission (Commission) passed a resolution to create the Helena Urban Wildlife Task Force (Task Force). The Task Force was charged with determining whether an urban deer problem exists and with identifying possible management options to be included in an urban deer management program (Program).

The Task Force compiled the *"City of Helena Urban Deer Management Plan - Findings and Recommendations of the Helena Urban Wildlife Task Force"* (Plan) that summarizes the administrative process, technical information, and management options used to recommend specific management and administrative actions to the Commission. The intended use of the Plan is to provide the Commission with a starting point to move forward in adopting and implementing urban deer management actions through a Program.

The Plan summarizes the following about urban deer in Helena:

- They are a natural and permanent part of the Helena community;
- They are currently a public health and safety problem in Helena;
- Lethal and non-lethal management actions are currently necessary;
- The population should be reduced and maintained through management actions;
- Management actions must be (1) safe, (2) humane, and (3) achievable;
- Management actions must build upon city ordinances and work to complement Helena's values and quality of life; and
- Annual evaluation of management actions must include considerations for human health and safety, cost to implement, biological integrity, conflict resolution, and social / political realities.

The Task Force recommends the Commission take the following actions:

- Establish a permanent Urban Wildlife Advisory Committee;
- Create an administrative process to ensure the Plan remains current; and
- Implement immediate management actions to include a combination of: (1) conducting public education / outreach; (2) reviewing zoning / ordinances / laws; (3) promoting landscaping / repellents / barriers; and (4) hiring professional wildlife removers. Other management actions to evaluate over time include (1) fertility / sterility; (2) capture and euthanize; (3) certified public hunting; and (4) deer tracking & aversive conditioning. Future urban deer management actions will be determined following a full review of previous actions taken using the Adaptive Management Strategy.

TABLE OF CONTENTS

Page

1.0 INTRODUCTION

1.1 Background

Over the last ten years, the city of Helena and surrounding area has experienced an increase in numbers of urban deer and associated human-deer conflicts. These issues often result in public safety concerns, property damage, and concerns for the welfare of the deer. As the urban deer population in Helena continues to grow, resident tolerance for deer damage has sharply declined. Unfortunately, some interactions resulted in a negative public perception of urban deer leading to demands for urban deer management actions.

In response to the statewide urban deer issue, the 2003 Legislature enacted HB 249 authorizing local governments, in cooperation with the state Fish, Wildlife, and Parks (FWP), to adopt and implement plans to control, remove, and restrict game animals within local boundaries for public health and safety purposes. It was later amended by SB 410 in the 2005 Legislature. This legislation is codified as 7-31-4110, MCA - Restriction of Wildlife. The statute provides an opportunity for FWP to work with Helena in a cooperative manner to address urban wildlife concerns.

As provided in 7-31-4110 MCA, the Helena City Commission (Commission) pursued the urban deer issue. On February 13, 2006, the Commission passed Resolution #19318 that created the Helena Urban Wildlife Task Force (Task Force). The Commission charged the Task Force with evaluating the current condition of Helena's urban deer population and with recommending urban deer management actions. Resolution #19318, recruitment of Task Force members, membership contact information, and charge to Task Force members are included as Appendix A.

Managing urban deer as a resource, rather than merely pests, requires community collaboration on option selection and implementation. Human-deer issues are primarily characterized as (1) health and safety issues for humans, pets, and deer; and (2) property damage. FWP and City Animal Control customarily respond to urban deer issues by prioritizing health and safety issues and addressing property damage with educational materials. Currently, FWP works cooperatively with City Animal Control to respond to complaints and offers suggestions on how to minimize conflicts.

The Task Force compiled the *"City of Helena Urban Deer Management Plan - Findings and Recommendations of the Helena Urban Wildlife Task Force"* (Plan) that summarizes the process, technical information, and management options the Task Force used to recommend urban deer management and administrative actions to the Commission. The Plan is Helena's first attempt at recommending management actions to address urban deer within Helena. The Plan may be used as guidance when implementing the Program. The success or failure of urban deer management will ultimately depend upon active and conscious public participation in the development and implementation of urban deer management actions.

1.2 Scope and Applicability

The Task Force was charged with determining whether urban wildlife problems exist within the city limits of Helena (City limits). If so, the Task Force was required to recommend actions to manage urban wildlife within City limits, with a primary emphasis on mule deer. From the onset, the Task Force determined urban deer issues were the principal focus of community dialog and the Plan development timeline could not accommodate discussion of other wildlife species. Consequently, the Plan is only applicable to the management of urban deer within City limits. However, the Task Force did consider the effects of urban deer management actions on habitats, species, and residents residing outside City limits.

1.3 Purpose

The purpose of the Plan is to (1) identify the appropriate number of urban deer within City limits that will be tolerated at our community's social acceptance level, and (2) identify urban deer management actions for attaining that balance. The Commission may find it necessary to strike a balance between the aesthetic and sentimental value some residents place on urban deer and the unwelcome interactions and/or costly property damage they cause.

The Task Force recognizes that urban growth and loss of wildlife habitat is the basis for a geographically expanding conflict between the community and deer, as well as other wildlife. This issue requires urban growth planning processes to consider a variety of wildlife issues and deliberate Commission action.

The Task Force believes urban deer populations, left unchecked, will continue to increase as deer readily adapt to our expanding urban habitat. Thus, the growing urban deer population within City limits will continue to result in human-deer conflict. The concept of managing urban deer is based, not solely on the biological carrying capacity, but principally on the social carrying capacity of Helena. Successful implementation of urban deer management actions should maximize the benefits to both residents and deer.

Additionally, the Plan provides the Commission with recommended urban deer management actions that address the roles for the state, city, and residents. The Plan also demonstrates an appropriate level of community involvement necessary for option development and decision-making processes.

2.0 COMMUNITY DEER MANAGEMENT PLANS

Several Montana communities such as Colstrip, Fort Peck, and Missoula have pursued or are currently pursuing urban deer management plans. Rapid City, South Dakota and Iowa City, Iowa also have progressive urban deer management programs. Generally, these communities have organized work groups to investigate the extent of the problem and to determine the number of urban deer their community prefers to sustain. Additionally, these work groups seek to implement urban deer management actions that were determined acceptable by their community.

All community deer management plans have pros and cons. However, communities should understand their own urban environment and allow community participation in identifying sustainable deer population numbers and development of urban deer management options.

The following summarizes several community deer management plans:

2.1 Colstrip

Large deer populations around the Colstrip area was determined to threaten human health and safety, damage property, and were considered not conducive to the long-term health of the herd or their habitat. Residents of Colstrip formed the Colstrip Deer Management Working Group. In April 1997, the Working Group developed the Colstrip Deer Management Action Plan (Colstrip Plan). Following the passage of SB 410 in 2005, the Colstrip Plan was updated and revised to its current form.

The purpose of the Colstrip Plan is to reduce the negative impacts to people caused by the deer in and near the city. The goal of Colstrip Plan is to eliminate individual deer that threaten human health and safety and to reduce damage to property by reducing deer numbers in the city. The Colstrip Plan is included as Appendix B.

2.2 Fort Peck

The City of Fort Peck (Fort Peck) urban deer management plan is a joint effort among Fort Peck, US Army Corp of Engineers (COE) and Montana Fish, Wildlife and Parks (FWP) to cooperatively resolve urban deer management issues within the Fort Peck city limits. Parties review with other law enforcement agencies legal issues and any lethal action which may be taken pursuant to this plan.

Fort Peck discourages feeding activities and may consider making feeding and other attractants illegal in town. Fort Peck contacts FWP when deer issues reach critical levels beyond the capacity of city officials to adequately respond. Fort Peck authorizes hunting in specific areas. Fort Peck develops possible funding sources to minimize expenses. Under extreme conditions, Fort Peck authorizes shotgun, muzzleloader and handguns in approved places. Fort Peck authorizes removal of aggressive deer within COE boundaries with consensus of FWP.

All of the property outside and adjacent to the Fort Peck boundary is controlled by the COE. The COE develops and/or maintains access for hunters to legally harvest deer around the town boundary. COE has allowed some disabled hunters to hunt with restrictions within an adjacent campground.

FWP provides educational materials on deer populations and feeding concerns. FWP verifies Fort Peck complaints of nuisance and/or aggressive deer and develops consensus in resolving the issue. FWP develops a list of hunters to harvest deer if and when necessary and reviews safety concerns and legal issues with hunters. FWP issues “Kill Permits” or “Game Damage” permits within Fort Peck. The animal carcasses are delivered to local meat processors. The County Food Bank sometimes bears the expense of processing these animals. The Fort Peck proposed plan is included as Appendix C.

2.3 Missoula

The Missoula Urban Wildlife Subcommittee (Subcommittee) is composed of City Council members, FWP biologists and game wardens, and citizens from the general public. The Subcommittee has worked to develop an ordinance prohibiting the feeding and attracting of certain wildlife.

The Subcommittee seeks to develop an Urban Wildlife Management Plan in 2007, relying heavily on assistance from FWP. In Fall 2006, the subcommittee conducted a survey of Missoula residents to received comments and suggestions. This information, in part, will be used to develop and implement the wildlife management plan. To date, the subcommittee has not recommended any specific management actions. The Missoula ordinance prohibiting the feeding and attracting of certain wildlife is contained in Appendix D.

2.4 Rapid City, South Dakota

Rapid City, South Dakota (City) began their urban deer management program in 1998 in response to issues caused by urban deer. Since that time, the program has succeeded in its objective of reducing and maintaining the urban deer population. In fact, from 2002 – 2004 when program funding was unavailable, the community witnessed a 25 percent increase in urban deer.

Annual Evaluation of Urban Deer Population

Each year, the City works with the South Dakota Game and Fish agency to conduct an urban deer survey within the City limits. If the annual population survey indicates more deer than in the previous survey, the City notifies the City Council and recommends taking action to reduce deer.

With direction from the City Council, the City applies to the state Game and Fish agency for a number of urban deer licenses. In 2006, the state issued 300 urban deer licenses and in 2005 they issued 200 licenses. The increase in urban deer licenses indicates the urban deer population continues to grow.

How Urban Deer Are Removed

The City does not allow archery shooting due to the liability, but did approve of sharp shooting. Sharp shooting was deemed safe because of the areas of the hunt and the direction of the bullet. Each shooting site has sufficient backdrops, i.e. is located in front of a hill or no houses behind. Contractors are also required to track and account for each bullet.

The City currently contracts with two City employees that have taken a sharp shooting course sponsored by the city police. The contractors charge about $65 / per deer plus expenses which amounts to about $75 / deer. The contractors can harvest about 300 deer in 3 weeks using a city truck with a lift. Harvesting occurs in December and January.

The City has designated safe shooting sites around the City. These shooting sites generally correspond to areas within the City that have the greatest number of urban deer as indicated by the annual survey. The shooting sites are typically located in City parks, golf courses or on private land of more than five acres and use bait to lure the deer into position.

Contractors alert police dispatch when they are in the field. They typically operate between 11:00 p.m. and 5:00 a.m. so as not to conflict with the public. Contractors use a spotlight and most shots are taken within 20 yards using a .22 long rifle.

How the Meat is Distributed

Following a kill, contractors take the carcasses to a remote site for field dressing and then transport them to a City warehouse. State Game and Fish officials remove the heads for testing of chronic wasting disease. The City used to process the meat for distribution. However, that option has been discontinued due to the high cost. Today, the City maintains a public distribution list that involves more that 400 people. Approximately 60-70 percent of these residents are considered low income. Residents may claim a deer following a transfer of hunting license to their name. Most residents take it to a butcher shop and get it packaged or process the meat themselves. Some public assistance organizations claim deer to feed their clients.

Other Program Considerations

The urban deer program is funded by the City Park Department budget and costs approximately $20,000 per year. Most residents are unaware when the program begins or ends except for when to get on the meat distribution waiting list. The City has only had one minor complaint in the last four years. The City considers its liability to be low due to the advance planning and training.

The Rapid City South Dakota 2001 deer herd management program is contained in Appendix E.

2.4 Iowa City, Iowa

Iowa City (City) determined that to prevent irreparable damage to the ecosystems and to prevent significant injury or damage to persons or property, the City Council set the maximum deer population density to be twenty-five (25) per square mile per City-designated management district.

The City conducts urban deer population control through the use of special deer management areas as designated by the City Council. The City is allowed to kill as many deer as the City determines necessary to reach its desired goal. Killing occurs between September 1 and February 28. The City is allowed to utilize sharpshooting with centerfire rifles and rimfire rifles for the lethal removal of deer. Bait may be used to attract deer to the sites. The City must determine the locations, training, and all other conditions for the sharpshooting activities. The City also complies with all applicable state laws.

All deer killed by sharpshooting are processed for human consumption and distributed free of charge. Processing lockers participating in the plan are allowed to keep and utilize the deer hide. No licenses will be required for the City and no fees will be charged. The City uses sharpshooting over bait to reduce the number of deer in each management district to the population limit.

The Iowa City Urban Deer Task Force (Task Force) convenes each spring to review educational material, deer population numbers (current and projected), management options, and to recommend methods to kill urban deer. Any or all legal lethal methods available (including sharpshooting and bow and arrow hunting) may be utilized after the initial reduction plan if the method(s) meet the following criteria: (1) public safety, (2) community acceptance, and (3) effectiveness in maintaining the desired number of deer.

The urban deer management program also includes educational materials that provide residents with information on urban deer habits and guidelines for limiting localized deer damage through the use of screening, alternative plantings, and other techniques. Educational materials are distributed through a variety of methods including public informational meetings, pamphlets, and government television programs.

The City also evaluates the need for additional roadway signage and / or reflectors that may reduce the likelihood of vehicle deer accidents. This strategy is reviewed annually to track effectiveness. Additionally, thoughtful consideration is given to deer migratory paths as transportation improvement projects are approved by the City Council.

To aid in the implementation of the Long Term Deer Management Plan, the Task Force submits an annual plan to be adopted by the City Council following public hearing. Annual plans as approved by the Council are forwarded to the state Department of Natural Resources and, if necessary, the Natural Resources Council for authorization to implement. The Iowa City, Iowa 2005-2006 urban deer annual report is contained in Appendix F.

3.0 STATE AND CITY DEER REGULATIONS AND RESPONSE

The state of Montana has wild animal control and management regulations. These regulations are generally located under Title 87 – Fish and Wildlife and Title 7 – Local Government, MCA. These regulations, in part, allow municipal governments to adopt community wildlife management plans to address wildlife that managed by the state.

The City of Helena (City) also has wild animal regulations as part of city code. These regulations are located under Title 5 – Police Regulations, Chapter 2 – Animal Control; and Chapter 3 – Animals. These regulations, in part, seek to limit the control and feeding of deer within City limits.

Applicable sections of Helena city code are outlined below:

3.1 5-2-21: Wild Animals; Permits and Exceptions

It shall be unlawful for any person to keep or maintain, or cause to be kept or maintained, any wild animal without first applying for and receiving a permit from the animal control officer except that no permit is required to keep or maintain the following wild animals: canaries, parakeets, chinchillas, chipmunks, gophers, finches, guinea pigs, hamsters, marmoset monkeys, parrot-type birds, rabbits, squirrel monkeys, turtles, tropical fish (except caribe), nonpoisonous reptiles (where permitted by state and federal law), white mice and white rats. The provisions of this section shall not prohibit the keeping or maintaining of the following wild animals:

A. Any wild animals which are kept confined in zoos, museums or any other place where they are kept as live specimens for the public to view.

B. Any wild animals which are kept confined and placed on exhibit in a circus, carnival or any other type of exhibit or show.

C. Wild animals in bona fide, licensed veterinary hospitals for treatment. (Ord. 2193, 8-10-1981)

3.2 5-3-6: Feeding of Deer

Except for deer allowed to be kept as wild animals under section 5-2-21 of this title, a person may not purposely or knowingly provide supplemental feed to deer. (Ord. 3046, 12-5-2005)

State code applicable to municipal wildlife management plans is outlined below:

3.3 7-31-4110: Restriction of Wildlife

(1) A city or town may adopt a plan to control, remove, and restrict game animals, as defined in 87-2-101, within the boundaries of the city or town limits for public health and safety purposes. Upon adoption of a plan, the city or town shall notify the department of fish, wildlife, and parks of the plan. If the department of fish, wildlife, and parks approves the plan or approves the plan with conditions, the city or town may implement the plan as approved or as approved with conditions.

(2) The plan may allow the hunting of game animals and provide restrictions on the feeding of game animals. History: En. Sec. 1, Ch. 466, L. 2003; amd. Sec. 3, Ch. 261, L. 2005.

3.4 Current Urban Deer Management Response

Helena and FWP currently respond to urban deer reports. Both agencies use established protocols to evaluate each report prior to taking action. Below are summaries of both Helena and FWP response protocols with a summary of reports to date. Response reports are included as Appendix G.

<u>Helena Police Department:</u>

The Animal Control Officer (ACO) responds to a variety of calls pertaining to wildlife. The majority of wild animal calls consist of deer and skunks, but the ACO also responds to a variety of other wild animal calls due to reports of bites or contact with a rabies vector animal such as a bat, or the animal is injured or dead. Other responses are for calls regarding potentially dangerous animals such as bears and mountain lions and are referred to FWP.

The ACO responds to citizens who report property damage by wildlife. For many of these reports, citizens are referred to the FWP web site for information. When the ACO is not available, a police officer responds to calls of injured animals. Injured deer are only dispatched when they are unable to stand. FWP may be called if police officers are unable to respond.

Police officers also respond to calls of aggressive deer. If there are merits to the complaint, then FWP is called to respond. FWP then makes the determination for the outcome of the incident. Dead deer are removed by the ACO, FWP, or city sanitation and transported to the city transfer station. FWP notifies Helena when they dispatch an animal, within the city, due to injuries or aggressiveness.

A summary of Helena urban deer reports is outlined in Table 1 below:

TABLE 1
SUMMARY OF HELENA URBAN DEER REPORTS[1]

Year	Dead or Injured	Other Problems	Total	Vehicle Accidents[2]
2003	86	17	103	16
2004	77	22	99	30
2005	127	55	182	31
2006	193	48	241	30

1 Includes both Mule and White-tailed deer. If responded, reports may also be accounted for by FWP.

2 These records are not exclusive of "Dead or Injured" and "Other Problems" reports. Therefore, cannot be included in the total.

<u>Montana Fish, Wildlife, and Parks Department:</u>

The Helena Area Resource Office currently responds to public reports involving urban deer. However, public reports also include, but are not limited to a variety of other animal species such as antelope, eagles, owls, bats, bears, beavers, coyotes, crows, dogs, ducks, elk, falcons, geese, herons, fox, snakes, squirrels, hawks, moose, magpies, marmots, muskrats, prairie dogs, pelicans, rabbits, raccoons, turkeys, woodpeckers, and skunks.

Regarding urban deer reports, FWP adheres to an established procedure when receiving public reports. The disposition of every call is tracked. Primarily, FWP staff provides the public with information outlining strategies for how to live with deer and the report is documented in an agency database. If the individual requests specific information or requests a site visit by a warden or biologist, FWP responds accordingly.

When a site visit is deemed necessary, FWP personnel proceed to assess the situation. Deer are evaluated on a number of criteria. Generally, if deer are observed to be in a physical condition that doesn't allow movement, they are dispatched. If animals are ambulatory, even if injured, they are not dispatched. If the animal is determined to be aggressive and a danger to human safety, it is dispatched. If a young fawn (unable to survive on its own) would be orphaned through this action, the fawn is also dispatched. Within City limits, if an animal is reported dead, then it is picked up and delivered to the city landfill.

FWP has also revised existing hunting districts and approaches to address deer populations. In the Helena area, Hunting District (HD) 388 was created to consolidate the greater Helena valley, and thus more appropriately address suburban deer density, reduce deer densities, address the threat of public safety and property damage, and provide the possibility of hunting options within city open space. This re-districting approach has allowed consolidation of the Helena Valley into one smaller hunting district. Previously, the boundaries of four large hunting districts occurred along highways that ran through Helena. Redistricting of hunting districts has resulted in consolidation of areas of higher human density; the hunting methods allowed within

HD 388 reflect human safety concerns. Hunters are restricted in the western portion of HD 388 to taking deer by means of archery, shotgun, handgun, and traditional muzzleloader. The use of high powered rifles is not allowed in the western two-thirds of the more densely populated hunting district. FWP Hunting District 388 proposal that is currently in effect is included as Appendix H.

A summary of FWP urban deer reports is outlined in Table 2 below:

TABLE 2
SUMMARY OF FWP URBAN DEER REPORTS[1]

Year	Dead or Injured	Other Problems	Total
2004	58	15	73
2005	73	76	149
2006	96	66	162

1 Includes both Mule and White-tailed deer. If responded, reports may also be accounted for by the City.

4.0 RESEARCH INFORMATION ON HELENA URBAN DEER

4.1 Resident Telephone Survey

The Task Force was awarded a $7,000 'Living with Wildlife' grant from FWP. This grant was used, in part, to fund a Helena resident telephone survey on urban deer. The total cost of the public telephone survey was $10,000. During the Month of December 2006, the University of Montana Bureau of Business & Economic Research secured over 418 surveys from Helena city residents. The completion rate was 63.1 percent with 110 refusals. Typical Montana polls have approximately 50 percent completion rate. The sampling error was + or – five percent and results were broken down by the seven Helena Citizens' Council (HCC) Districts. A map outlining the seven HCC District boundaries is included as Figure 1.0 (page 49). A map outlining the current city of Helena open lands is included as Figure 2.0 (page 50).

Survey interviewers found that the topic of urban deer was of interest to respondents. Questions generally asked whether respondents found urban deer to be a problem within the city of Helena and to rate their level of tolerance for both lethal and non-lethal deer management control techniques. The survey also asked about deer management program funding mechanisms and the potential for health and safety issues. The survey questions and results are included as Appendix I.

4.2 Urban Deer Inventory

Helena awarded a $6,000 contract to conduct an urban deer inventory. The purpose of the Helena Urban Deer Inventory (Inventory) was to provide the Task Force with an accurate estimate and distribution of the deer population within City limits. Secondly, the Inventory provided sex and age ratios of the estimated urban deer population. Establishing urban deer numbers is a critical prerequisite for the Task Force when determining both the social and biological tolerance for urban deer.

The Inventory employed a method of direct observation of urban deer while driving in a passenger vehicle street-by-street and alley-by-alley. This method is preferred because it may be repeated in future years and the survey data would remain comparable. To ensure survey data accuracy, the city was divided into geographic units that generally follow HCC District boundaries. Each sampling area could be inventoried within 2.5 - 3.0 hours, resulting in approximately 18 to 20 survey events.

Vehicle driving speeds were kept to 25 mph or less. Vehicle stops were made only long enough to verify deer characteristics for recording. A minimum of two observers conducted each survey event. Deer were recorded by street and block. Sex and age of deer were also recorded, i.e. buck, doe, fawn. Survey data was consolidated and reported by the seven HCC Districts.

Survey events were consistently conducted approximately three hours before sunset and/or three hours after sunrise. Each sampling area was inventoried at least twice to further validate the observations. If a sampling area required further validation, a third survey event was conducted. A copy of the Inventory proposal is included as Appendix J.

4.3 1973 Wildlife Study – Helena South Hills Area

The Task Force was provided a 1973 document titled “Wildlife Study” prepared by Karen Zackheim for The Diehl Company. The area studied covered 20 square miles southeast of Helena. The study was concerned with the land located from the south City limits on the upper eastside of Helena, south along I-15 to the Montana City area of Jackson Creek and Clark’s Creek, west to Dry Gulch (Davis Street) back to the City limits bordering the area south of Helena. The area today is considered The South Hills.

This Southeast area was used primarily for sheep grazing prior to 1946 and cattle grazing between 1946 and 1982. At the time of the study, it was still being used from June to October for grazing cattle. Since 1982 there have been no cattle on the land. The area was overgrazed especially during the earlier period. Over 50 species of birds and mammals have been observed. Several species of fish, snakes and amphibians inhabit the area. Among Montana game animals found are mule deer, white-tailed deer, pronghorn antelope, elk and black bear. Several mountain lions also lived in the area.

The wildlife study was undertaken in 1972 to January 1973 by wildlife biologist Forest Tevebaugh of the University of Montana. Field cards were recorded for each wildlife sighting and kept on file at the University of Montana. Tevebaugh made most of the observations but cards were also distributed to area residents and to other personnel working on a land-use capability study.
The results of the study were, in part:

Mule Deer: Mule deer were the most abundant big game species in the study area. According to the report: *“…Fish and Game officials estimate approximately 50 mule deer inhabit the Southeast Helena hills”. “No deer were observed in the northern part of the Southeast Helena Study area within a mile of the city of Helena, probably due to the off-road vehicle use this area receives.”* The deer were observed more in the Clark Gulch-Jackson Creek drainages and the Martinez and Holmes Gulch area.

White-tailed Deer: White-tailed deer were seen regularly along Jackson Creek. No numbers were estimated.

In general the study concluded the increased human activity would cause the wildlife to diminish. The author felt that the pronghorn antelope would be seriously impacted. A copy of the 1973 South Hills area wildlife study is included as Appendix K.

4.4 Town Hall Meetings

The Task force hosted two Town Hall meetings. These meetings were used to gather public comments about the telephone survey and the proposed suite of deer management options. The Town Hall meetings were recorded by the Helena Civic Television and were re-broadcasted. Meeting minutes and the video were used by Task Force members to further evaluate potential control options. A summary of the Town Hall minutes and DVD are included as Appendix L.

4.5 Public Comment

The citizens of Helena offered the Task Force comments regarding the proposed urban deer management actions and draft Plan. A majority of written comments were compiled by the Task Force and used as a reference. However, many public comments were received verbally and could not be included in the Plan. Written public comments are included as Appendix M.

4.6 Task Force Timeline / Meetings / Local Newspaper Articles

The Task Force developed a master planning timeline that outlined meeting dates and activities accomplished. The timeline was also used to forecast future activities and identify deadlines. The timeline was continually revised to reflect the changing schedules and to summarize past meetings and work sessions. Task Force meetings were generally held every two weeks in room 326 of the City-County building, 326 N. Park. Meetings were publicly advertised and members of the public regularly attended. Agendas and minutes were kept by the City Parks and Recreation Department. Public comment was solicited at the end of every meeting.

The master planning timeline and a compendium of agendas and minutes are included as Appendices N and O, respectively. Articles by the Independent Record newspaper regarding Task Force meetings and urban deer are included as Appendix P.

4.7 Helena Citizens' Council Quality of Life Survey

HCC administered a ‘Quality of Life’ (QOL) survey in response to concerns voiced by residents. The QOL committee distributed and collected the surveys from July to September 2006 and received 216 responses back, out of about 2,000 surveys distributed.

HCC made an effort to make the survey accessible through distribution at the Farmers Market, Alive at Five, Library, City-County Building and in both of Helena’s local newspapers. Although HCC received back 216 responses, it believes this reflects the thinking of a larger segment of the population. All areas of town, including outlying areas were included in the responses. Participation was not limited to residents.

The survey asked five open-ended questions such as *"What are your concerns (if any) regarding the quality of life issues in Helena?"* and *"What do you see changing in our community that could jeopardize the quality of life in Helena?"*

The survey cost about $300 to conduct, plus the time and energy of the committee volunteers. Sixteen survey respondents mentioned urban deer. These comments are included as Appendix Q.

4.8 HB 249 & SB 410 – State Legislation

In response to the statewide urban deer issue, the 2003 Legislature enacted HB 249 authorizing local governments, in cooperation with FWP to adopt and implement plans to control, remove, and restrict game animals within local boundaries for public health and safety purposes. It was later amended by SB 410 in the 2005 Legislature. This legislation is codified as 7-31-4110, MCA - Restriction of Wildlife. The statute provides an opportunity for FWP to work with Helena in a cooperative manner to address urban wildlife concerns.

Bill language, public testimony, and HB 249 fiscal note are included as Appendix R.

5.0 FINDINGS ON HELENA URBAN DEER

The Task Force was charged with determining whether urban deer problems exist within City limits. If so, the Task Force was required to recommend actions to managing urban deer within City limits. The purpose of the Plan is to (1) identify the appropriate number of urban deer within Helena that will be tolerated at our community's social acceptance level, and (2) identify urban deer management actions for attaining that balance.

Following a nine-month information gathering process, the Task Force began internal deliberations to answer five core questions: (1) Are the health and/or safety risks to people and urban deer significant enough to be considered a problem, or not? (2) Are urban deer management actions necessary, or not? (3) Has Helena reached its' social carrying capacity of urban deer, or not? (4) Should Helena reduce its urban deer population, or not? and (5) Should Helena establish a permanent Urban Wildlife Advisory Committee, or not?

5.1 Five Core Questions

A planning tool was used to guide Task Force members into answering either "Yes" or "No" to each of the five core questions. Group consensus was achieved to answer each question and references to the appendices were provided. Partial results are outlined below. A summary of full results is included as Appendix S.

Q1. Are the health and / or safety risks to people and urban deer significant enough to be considered a problem, or not?

A1. Group Consensus = YES

Q2. Are urban deer management actions necessary, or not?

A2. Group Consensus = YES

Q3. Has Helena reached its' social carrying capacity for urban deer, or not?

A3. Group Consensus = YES

Q4. Should Helena reduce its urban deer population, or not?

A4. Group Consensus = YES

Q5. Should Helena establish a permanent Urban Wildlife Advisory Committee?

A5. Group Consensus = YES

6.0 URBAN DEER MANAGEMENT OPTIONS FOR HELENA

The Task Force identified the universe of urban deer management options available for immediate and future use within City limits. However, these management options are not necessarily those that may be determined to be the most appropriate. The Task Force advanced these management options for immediate and future consideration with the resulting list being intentionally broad.

The Task Force identified urban deer management options based upon a diverse and extensive evaluation of technical information, literature review, expert testimony, and professional judgment. The Task Force fully examined the economies of scale, effects on deer, budgeting, legality, and logistics of all deer management options. The Task Force recognized certain management actions may be suitable in one situation / location, but impractical in another.

Urban deer management options were categorized as either "lethal" or "non-lethal." When occasional deer damage is a problem, simple, non-lethal management actions should be available to appropriately address the situation. When sheer numbers of deer become a problem, lethal management actions should also be available to appropriately address the situation.

The Task Force favored an integrated approach that would allow management actions to address both minor damage abatement and larger issues of population control. The Task Force determined the Plan must be effective, but flexible enough to allow for lethal, non-lethal, and/or a combination of management options.

The following are general descriptions of each urban deer management option identified for immediate or future use within City limits. Table 3 (page 25) compares each management option by process, cost, advantage, and disadvantage.

6.1 Maintain Current Management Actions

This management option is considered non-lethal and requires no new action to address urban deer. This management option relies on the continued implementation of Helena city codes that prohibit the supplemental feeding of deer and restricts wild animal ownership. This management option also continues the City Animal Control Officers' and FWP representatives' responses to urban deer issues. With no additional control actions in place, the urban deer population is likely to grow. An increase in deer density brings associated risks of disease, vehicle accidents, property damage, and predation.

The direct costs associated with implementing this management option will increase in proportion to deer population growth. However, the indirect costs will include continued property damage repair and increased collective liability / insurance costs.

6.2 Public Education / Outreach

This management option is considered non-lethal and informs residents of the issues involving urban deer. Educational materials would include information on the illegality and adverse consequences of providing supplemental feed and the risk of attracting increased predator populations. This option may also inform residential / commercial property owners regarding non-lethal management options such as repellents, fencing, unpalatable plants, and human behavior modification, among others.

Education / outreach efforts should effectively communicate the goals of managing deer populations, including information on density trends, automobile collision probabilities and costs, property damage, and habitat impacts. If lethal management options are adopted, educational materials should inform residents of designated areas, times, special provisions, and/or any possible weapons restrictions. Public education / outreach may be accomplished through news articles, PSAs, community access television (HCTV), and neighborhood meetings.

The direct costs associated with implementing this management option are considered minimal and include printing brochures, pamphlets, and advertising.

6.3 Landscaping / Repellents / Barriers

This management option is considered non-lethal and allows residents to take individual, direct, albeit sometimes costly and time-consuming, action to mitigate negative effects of urban deer.

Landscaping choices allow residents to select tree, shrub, and flower species proven to be more deer resistant. However, this strategy may result in site-shifting as deer are simply displaced to another area to feed. Local nurseries are prepared to guide residents in selecting plant species that will deter deer-damage to residential landscaping.

Spray repellents are used to discourage foraging when applied directly to specific plants / sites. To be effective, repellents should be applied prior to anticipated periods of deer browsing. Contact repellents are placed directly on the plant and discourage feeding by producing an unpleasant taste. Many repellents must be reapplied after rain showers and periodically as the plants grow. Changing repellents every few years on each site improves repellent effectiveness. The potency of repellents may vary from year to year and from site to site. When deer numbers approach biological carrying capacity, repellents may be ineffective.

Residents may also restrict areas through mechanical devices such as fencing. An effective deer fence may be an eight foot-tall-barrier or a smaller, electric system. Other fencing options include woven plastic netting installed around specific areas. Regular inspection and maintenance of fences increases their effectiveness. As an example, other deterrents to intrusion may include devices such as motion detectors that emit high intensity water jets. Some deer deterrents may be hazardous to humans and other animals.

The direct costs to individual residents associated with implementing this management option is considered moderate to high.

6.4 Zoning / Ordinances / Laws

This management option is considered non-lethal and requires local governments to consider ordinances that restrict land-use and/or personal behavior. Land-use ordinances may require developers to include wildlife corridors through subdivisions and/or limit the type and amount of certain landscaping plants. Land-use ordinances may also include city-sponsored drinking water projects for wildlife on open space.

Personal behavior ordinances may restrict the feeding and sheltering of deer within City limits. Another type of ordinance may modify existing firearm ordinances to allow expanded opportunity for hunting (archery or firearms) within City limits. This may also include expanding hunting districts surrounding Helena or modified hunting seasons.

In the future, Montana communities may seek Legislative solutions to managing urban wildlife. Helena may choose to initiate legislation creating or revising state law to further enable both Helena and FWP to better manage urban deer. Helena may also seek to strengthen the policies to profile aggressive and /or injured urban deer subject to dispatch.

The direct costs associated with implementing this management option are considered minimal. Volunteer and city staff time and minor administrative materials are the primary costs.

6.5 Capture and Transfer

This management option is considered non-lethal, although high incidental losses of subject deer often occur. Deer may be trapped, netted, and/or remotely immobilized with tranquilizers (darted) and relocated to non-urban areas.

While this management option may initially appear to be the least objectionable for reducing urban deer, capturing and transferring deer can be expensive and efforts to capture and transfer urban deer have met with little success.

Deer are always subjected to a great deal of stress during capture and transfer activities. Immobilization drugs inhibit the animal's ability to control body temperature and the animal should only be tranquilized for a short period under certain weather conditions. Even in moderate weather, if the animal is allowed to run for some time before successful darting, hyperthermia may cause body temperatures to rise to dangerous levels and can cause death. Because this option is stressful to deer, this option may result in high deer mortality rates. One study showed only a 15 percent survival rate following relocation.

Information from experiments associated with deer population management in northern Virginia shows capture and transfer leads to high initial mortality (up to 85 percent) in relocated deer. Additionally, the release of deer into other areas will disrupt native wild deer herds, and may increase the incidence of disease in native deer population or initiate / exacerbate other land-use conflicts.

Translocated urban deer are known to gravitate to rural human dwellings and hay stacks or crops, resulting in agricultural game damage. Deer are capable of migrating at least 100 miles. There is no guarantee that transplanted deer will not return to an urban setting. Additionally, FWP is required to respond to incidents of agricultural game damage.

Transplanted deer that have been captured by chemical immobilization cannot be consumed for several months, depending on the immobilization chemical used, so every deer would also have to be ear-tagged to denote that this animal is not suitable for human consumption before a specified date.

The direct costs associated with implementing this management option are considered high. Capture and transfer may be cost-prohibitive. Deer control activity in Wisconsin resulted in capture costs of $412 per deer. Similar work conducted in New York, New Hampshire, and California varied between $431 and $800 per deer. Studies done in the mid-80s and early 1990s also proved very costly, ranging from $261 - $567 per deer. In New Jersey it was found that using portable paddock traps, to trap and transfer deer would cost up to $20,000, not including additional handling fees.

6.6 Capture and Euthanize

This management option is considered lethal because deer are captured and subsequently euthanized. The trap and euthanize option may be most effective in areas where other options cannot feasibly be employed, where deer numbers overwhelm other options, or where individual deer are identified as dangerous. Baited box traps, rocket nets, or drop nets can be used to capture deer, which may then be quickly euthanized using a firearm or bolt gun.

Darting and euthanizing involves authorized professionals with proper equipment. Tranquilizer darts can be fired by air guns and the dart can be tracked electronically. It takes 4-6 minutes for the tranquilizer to take effect, during which time the animal may travel. Deer frequently do not realize that they have been darted and may continue to feed. If the deer moves, it is tracked to where it becomes immobile. The deer is then killed humanely with a captive bolt and then removed.

The meat of a tranquilized animal cannot be consumed and the shooter has little control over where the deer loses consciousness. Additionally, Helena may need to secure permission of a property owner to retrieve a tranquilized animal. As an alternative, urban deer may be lured by bait to a central area where a net is shot over the animals. The immobilized deer may be quickly dispatched using various means.

Meat from non-tranquilized animals may be donated to local food banks. However, this process would require additional coordination to address appropriate field dressing location, carcass transportation, meat / hide processing agreements, food bank storage and distribution, etc.

The direct costs associated with implementing this management option are considered moderate. Total costs for this kind of management option varies from $100 to as much as $600 per deer (including transportation and processing), depending upon the contractor. Capture and euthanize is significantly less costly than capture and transfer (Section 6.5).

6.7 Fertility / Sterilization

This management option is considered non-lethal and reduces the reproductive output of deer consistent with the identified acceptable number of deer and could be considered as a maintenance activity, but it would not measurably reduce population density. Chemical fertility / sterilization control generally requires the need to handle all individual animals and also requires annual treatment to be effective. Fertility, or 'contraceptive' control methods can be categorized as either (1) contraception (i.e., preventing pregnancy) or (2) contragestation (i.e., ending pregnancy). These two contraceptive control methods utilize either supplemental steroid hormones or vaccines and have successfully prevented conception in individually treated deer. Recently, prostaglandin hormones have been used to induce abortions in individually treated deer.

Most fertility control methods available today require two treatments the first year, then annual re-treatment of individual deer every year thereafter, which reduces potential cost effectiveness. Furthermore, the time and effort required to treat a sufficient number of individual deer to achieve control over the population greatly reduces the cost efficiency of fertility control methods.

Current technology enables the successful control of fertility in individually treated animals. However, most of these methods are still experimental and unproven at the population level for use in deer control. To date, fertility control substances have not been approved by the U.S. Food and Drug Administration (FDA). Site-specific "experimental" approval from the FDA is required before fertility control methods can be applied in a deer population. Thus, fertility control methods are not available today for routine, managerial application in deer control programs. These methods have potential for use in deer population control; future research and development may improve their applicability.

Fertility / Sterilization options do not effectively reduce an overpopulation of urban deer, but merely slows the growth of the herd. The direct costs associated with implementing this management option are considered high. Fertility control and/or sterilization may be cost-prohibitive. Actual cost estimates per deer may be as low as $70 per deer per year. Successful fertility control is contingent on repeated annual treatment of virtually every deer.

6.8 Professional Wildlife Removal

This management option is considered lethal because it euthanizes deer through the use of professional experienced wildlife removers (contractors). Contractors are typically insured and bonded and may employ any means to remove deer, but typically use small caliber rifles or bolt-guns. In all situations, contracted urban deer services has been applied safely with little disturbance to residents. Contractors may selectively remove females to more effectively reduce future numbers of urban deer. This option is considered the quickest method for deer reduction.

Typically, contractors will target deer over bait sites or in confined spaces. Attracting deer to bait stations, especially during winter, allows more deer to be removed than if baiting is not used. Bait stations focus contractors to specific sites so that warning signs can be posted and public access closed. To ensure safety, contractors usually orient themselves relative to the bait station so shooting occurs from an elevated position (e.g., a tree stand or other high blind), directing the bullet in a downward trajectory. With a well-aimed shot, death of the deer is instant.

Meat from the animals may be donated to local food banks or to individuals on a registry list. This process would require additional coordination to address appropriate field dressing location, carcass transportation, meat / hide processing agreements, food bank storage and distribution, etc.

The direct costs associated with implementing this management option are considered moderate. Total costs for this kind of management option varies from $100 to as much as $600 per deer (including transportation and processing), depending upon the contractor.

6.9 Certified Urban Hunting

This management option is considered lethal because it allows residents who have completed training and certification to dispatch deer. Certification would include coursework focusing on the safety and methods of removing deer in an urban setting, shooting proficiency, and field training sponsored by FWP. A shooting proficiency test would also be required.

A limited number of certified urban hunters would remove deer according to specifications for location and dates in their permits. Specifications could be restricted or liberalized to influence the effect on urban deer population or to address public safety concerns. The meat from urban deer may be consumed and/or donated to local food banks.

The techniques of urban hunting include the use of bows, shotguns, or muzzleloaders, while traditional hunting typically involves the use of high-power rifles. Archery has the advantage of being safe and non-disruptive, but has the disadvantage of being less efficient at reducing urban deer density than firearm hunting. Therefore, an archery hunt may need to be longer than a firearm hunt.

Some may object to the term “hunting” as used with this management option. However, the term recognizes urban deer removal as a particular form of hunting. The Task Force recognizes the Plan’s primary objective is the reduction of urban deer populations, not the satisfaction of fair chase elements generally associated with a hunting experience in a non-urban environment.

In the vernacular of hunters, killing an animal is a "harvest" because the hunter utilizes the animal (similar to harvesting a renewable crop) -- when contractors are used, the term "cull" is usually used, reflecting the act of removing a specific animal, in a specific place, to meet a specific objective (change the composition of the population, alter numbers to a specified level, etc.). The distinction between the terms “harvesting” and “culling” is important.

Harvesting is designed to take the sustainable harvestable surplus, while culling intimates reduction of a population. Harvesting is a maintenance activity, while culling is a more deliberate effort to reduce numbers when circumstances merit a response.

According to the FWP 2004 Urban Wildlife Working Group, the use of certified urban hunters is both safe and effective when properly managed. Data shows the likelihood of injury or death to humans as a result of urban deer hunting is considerably less than the likelihood of being injured or killed in a car/deer collision. However, there are instances when hunters themselves have occasionally been injured when falling out of tree stands.

Compared to any other sport, hunting is one of the safest activities. Certified Urban Hunting would be especially safe in an urban setting with special class-room and field proficiency training, as well as limitations on equipment, specified hunting locations and timing restrictions. Research from published studies indicate no other method of urban deer population control is as effective, efficient, and acceptable when circumstances merit. There have been no human safety incidents reported in any of the urban deer hunts that have occurred in dozens of U.S. cities, since urban deer hunts have been established.

The direct costs associated with implementing this management option are considered minimal. Costs for conducting controlled removal are primarily administrative and may be offset by requiring special licenses / permits.

6.10 Deer Tracking & Aversive Conditioning

A method to quantify deer movements and at the same time potentially alter behavior of urban deer (induce wariness), would involve a program that would utilize selected, trained individuals from the community to remotely mark urban deer.

This option has three aspects: (1) gathering information on deer movements, (2) potential to induce deer to avoid or become more wary of people, and (3) provide interactive involvement and education to residents.

The Task Force recognizes that this option is a new concept as it is applied to deer and offers it as a way to involve and educate the public while at the same time gathering useful information about deer movements and seasonal use areas within the community.

The “aversive conditioning” aspect of this option is based on the ‘hard-wired’ behavior of prey species such as deer that have evolved with predators. Prey species are acutely sensitive to the act of stalking by predators. Stalking involves slow stealthy movement that brings the predator into close proximity to its prey. It is the Task Force’s belief that this option may induce deer to become less comfortable and thus more wary of humans as they are stalked and then hit and marked with paintballs. But the stalking aspect of this option is secondary to the fact that deer would be marked with a distinctive color of paint in each HCC District.

Applying the concept of stalking by trained and certified individuals who would color-mark deer in each HCC District with a unique color of plaint, could have at least 3 benefits:

(1) Movement of deer between HCC Districts could be tracked using an interactive, on-line database, as people throughout the city enter information about where they are seeing color-marked deer. Movement information would provide a much better understanding about where deer tend to concentrate at different seasons of the year. Better knowledge of seasonal distribution and local concentration areas would lead to customized application of various options of the Plan to local neighborhoods.

(2) Deer may be inclined to change their behavior and may try to avoid people when they associate people with the act of stalking; and

(3) People of the community would become more aware of urban deer, and awareness would lead to active involvement and learning opportunities for the community including: how to successfully live with deer, how to successfully landscape, how to recognize assertive behavior in deer and take proper precautions, and understand the basic biological elements of population change. This could be an effective method to distribute information about the Plan. All Helena citizens would have the opportunity to contribute to the understanding of deer in our community through participation in this program by helping to gather information about the seasonal movements and local

concentrations of deer. Such an understanding of movements and seasonal concentration areas would aid in appropriately customizing management of urban deer for specific neighborhoods.

Because paint will wear off in a matter of weeks or days, deer marking events might occur for a week-long period every month. Regular marking would be necessary to gain timely information about seasonal use areas and movement into other areas of the city. For example, fifty deer marked in July with green paint in HCC District 6 would be entered in the data base, then in late August residents might enter information indicating that they have seen three “green” deer in HCC District 1 where deer were marked in June with yellow paint.

Perhaps several different “colors” of deer are observed in one HCC District during a specific month, thus indicating that this area is a destination location for deer from several areas of the city, during that season. It would also be helpful to determine whether deer are moving in and out of the human population areas and into more rural settings on the fringes of town where lethal methods of control might be more readily implemented. Such information could have practical implications for residents of each city council district as well as consideration for which urban deer management actions might be applicable during different seasons.

Residents who participate in this marking program would have to have had pre-requisite hunter education training as well as urban certification that would include shooting proficiency, and historical perspective about wildlife conservation in North America and why wildlife is a part of our culture and heritage. Certification would involve additional training on safe and responsible use of paintball guns or slingshots in an urban setting, strict rules about asking permission to mark deer on any private property, clean-up of errant water-based paint, recording location, date, time, and number of all deer marked, and submitting all information to a centralized on-line database. Participants would have to be at least a certain minimum age and if a minor, parental approval would be required.

This option is considered non-lethal but with potential to alter deer behavior so they tend to avoid humans and it would have direct practical implications for application of all other deer management options with respect to information that would be gathered about seasonal distribution and concentrations of deer throughout City limits.

TABLE 3

COMPARISON OF URBAN DEER MANAGEMENT OPTIONS

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
Maintain Current Management Actions	• Non-lethal • Maintain compliance with existing city ordinance restricting deer feeding or possession	• Additional costs as deer population increases (for individuals and government actions) • Indirect or future costs include property damage repair to affected residents, potential increase liability / insurance costs to all Helena residents	• Gradual escalation of controversy • Gradual increase in costs	• No reduction in deer population • Property damage increases • Risk of accident / injury, disease, and predation increases • Residents left to deal with deer control on their own • Potential high costs to residents
Public Education / Outreach	• Non-lethal • How-to publications for deer-proofing property • Disseminating statistics regarding deer numbers, costs, other impacts • Issuing notice prior to the use of	• Costs associated with publication, copying, mailing brochures or letters • Costs associated with TV, radio, or newspaper ads	• Does not add to controversy • Minimal cost	• No reduction in deer population • Residents left to deal with deer control on their own

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
	lethal methods			
Landscaping / Repellents / Barriers	• Non-lethal • Planting appropriate yard and garden plants • Erecting fencing • Applying repellents to plants	• Costs of plants and labor • Costs of fencing materials and labor • Costs of repellents	• Gradual increase in controversy • Moderate cost	• No reduction in deer population • Residents left to deal with deer control on their own • High Cost for some • Unsightly • Marginal effectiveness • May cause site-shifting
Zoning / Ordinances / Laws	• Non-lethal: Restricting land-use • Non-lethal: Restricting behavior • Lethal: Authorizing special hunting districts/seasons	• No direct or additional costs	• Hunting would help keep populations from increasing • Minimal Cost	• May Impose additional burden on property owners • Enforcement may be problematic. • Without lethal component, may cause site-shifting effect. • May generate controversy. In some cases, More work for City and FWP, but in long term possibly less work.

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
Fertility / Sterilization	• Non-lethal • Inoculate deer with contraceptive or abortifacient agents using dart guns	• Cost of specialized shooters • Cost of contraceptive or abortifacient agents • Costs of dart guns, other equipment	• Deer birth rate reduced • Popular concept in public mind • Humane method	• High cost • Requires 'experimental' approval from FDA • Requires comprehensive darting of herd • Requires annual maintenance • Urban deer population reduction takes several years
Capture and Transfer	• Considered non-lethal, but losses of subject deer occurs • Net or tranquilize deer • Transfer to non-urban environment	• Cost of specialized shooters • Costs of tranquilizers, guns, traps, other equipment • Cost of pens or trailers • Costs of transportation to transplant site	• Reduction in deer population • May instill more wariness in deer • Popular concept in public mind	• High cost • Least humane option • May shift impacts • May increase incidence of disease in wild deer populations • May disrupt ecosystem or private land use where trans-located • High incidental

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
				losses of subject deer often occur
Capture and Euthanize	• Lethal • Net or tranquilize deer • Euthanize with bolt gun or firearm	• Cost of specialized shooters • Costs of tranquilizers, guns, traps, other equipment • Costs of disposal	• Reduction in deer population • Instill more wariness in deer • Moderate Cost	• May generate controversy • May require property owner permission for capturing or carcass retrieval • Tranquilized deer meat may not be consumed • Legal constraints of seasonality
Professional Wildlife Removal	• Lethal • Sites selected and baited • Deer shot over bait sites by contractors • Use in select districts and times • Contractual oversight to ensure proficiency, public health and safety. • Contractual	• Costs of hiring contractors • Costs of bait • Costs of carcass disposal	• Reduction in deer population • Humane method • Expedient method • Safe method • May instill more wariness in deer • Meat may be consumed • Moderate cost	• May generate controversy • May shift impacts • Legal constraints of seasonality

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
	oversight to ensure proficiency, public health and safety			
Certified Urban Hunting	• Lethal • FWP trains selected residents in the safety and proficiency of urban deer hunting • Special districts and times for deer removal are identified	• Costs of training – to be paid for by participant fees or sponsoring organization	• Reduction in deer population • Expedient method • Safe method • May instill more wariness in deer • Meat may be consumed • Minimal cost – use of participant fees	• May be unpopular concept in public mind • May generate controversy • May not be practical or safe in residential areas • May not be allowed or legal on some properties • May shift impacts • Legal constraints of seasonality
Deer Tracking & Aversive Conditioning	• Non-lethal • Selected residents are trained in safety and proficiency of urban deer marking • Marking of deer would occur using paintball guns	• Costs of training – to be paid for by participant fees or sponsoring organization	• Deer may become wary of people • Information can be gathered on seasonal use areas and movements of deer • Minimal cost – use of participant fees	• May be unpopular to some people • May generate controversy • Some people may not be willing to grant permission to enter property • May shift impacts • Potential legal

OPTION	PROCESS	COST	ADVANTAGES	DISADVANTAGES
	with specified paint color for each Council District, at specified times by a certified team assigned to a specific HCC District		• Increased awareness of both people and deer to each other • May be quite popular among some segments of the population	constraints with respect to paintball gun use

7.0 EVALUATION OF URBAN DEER MANAGEMENT OPTIONS

When evaluating urban deer management options, the Task Force incorporated a process that fully captured Task Force member and public opinion and assured sufficient input into the final recommendation. The Task Force incorporated an “evaluation criteria” tool to assist in comparing and contrasting each management option.

The Task Force defined evaluation criteria as basic questions that should be addressed for each management option. These questions also considered both the immediate and future consequences of each management option.

The Task Force agreed upon five major evaluation criteria with associated questions:

- Social / Political;
- Human Health and Safety;
- Cost to Implement;
- Conflict Reduction; and
- Biological Integrity.

It is acknowledged there is not a criterion representing the perspective of the individual deer. The Task Force discussed this at great length and determined that deer and habitat health are addressed in the “Biological Integrity” section of the evaluation process.

The following describes the evaluation criteria used to compare / contrast urban deer management options:

7.1 Social / Political

This evaluation criterion focuses on how Helena residents and elected officials may respond to management options in terms of public sentiment and political or legal obstacles.

<u>Social / political questions include:</u>

1. Is this lethal or non-lethal option socially acceptable?
2. Are there political obstacles to implementing this lethal or non-lethal option?
3. Can this lethal or non-lethal option be immediately implemented without changes in law?
4. Is this option consistent with the public survey?
5. Is this option flexible to address city expansion?
6. Are there immediate and future ramifications?
7. Other questions?

7.2 Human Health and Safety

This evaluation criterion focuses on the general health and safety of Helena residents and management personnel.

Human health and safety questions include:

1. Does this option endanger residents?
2. Is this option dangerous to management personnel?
3. Does this option displace health and safety issues?
4. Does this option impact habitat / residents external to the city?
5. Does this option impact habitat / residents internal to the city?
6. Are there immediate and future ramifications?
7. Other questions?

7.3 Cost to Implement

This evaluation criterion focuses on the cost of implementation along with the associated risks and liabilities.

Cost to implement questions include:

1. Does this option require new public expenditures?
2. Does this option require new personal expenditures?
3. Are there sources of program funding? i.e. grants, mill levy, impact fees, other.
4. Does this option have high personal or public risk / liability?
5. Does the cost justify the benefit of this option?
6. Are there immediate and future ramifications?
7. Other questions?

7.4 Conflict Reduction

This evaluation criterion focuses on the ease of implementation and the level of effort to reduce human/wildlife conflicts.

Conflict reduction questions include:

1. How does this option influence human/wildlife interactions?
2. Is the level of effort commensurate with the outcome?
3. Are there immediate and future ramifications?
4. Other questions?

7.5 Biological Integrity

This evaluation criterion focuses on the well-being of the deer through analysis of the impacts to deer herd and individual health.

Biological integrity questions include:

1. Does this option destroy habitat?
2. Is this option supportive of healthy deer and habitat inside & outside Helena?
3. Does this option support the health of the Helena deer population?
4. Are there immediate and future ramifications?
5. Other questions?

8.0 COMPARISON OF URBAN DEER MANAGEMENT OPTIONS

When attempting to select appropriate urban deer management options, Task Force members understood the need to balance concerns of Helena residents while protecting the welfare of deer. Task Force members openly shared their views with one another during a series of open meetings and public forums and reached consensus where possible. Task Force members sought to recommend urban deer management actions as a group, rather than using a "majority rules" approach.

As outlined in Section 6.0 of the Plan, there are a variety of lethal and non-lethal urban deer management options identified as being available for implementation within City limits. The Task Force believed it was best to first compare each management option in order to recommend only those that are most appropriate for Helena. To this end, each evaluation criterion was assigned a scale by which Task Force members used to compare and contrast management options.

Evaluation Criteria Scaling

In order to understand the importance of a particular management option, Task Force members had to be able to evaluate and convey the intensity of their position relative to each other. It was critical to have an accurate measure of opinion when evaluating management options. This was especially true where the opinions of Task Force members and those of the public diverged.

The Task Force compared and contrasted each management option through a relative scoring system. The management option scoring results are summarized in Table 4 (page 34). The strength of conviction for any given management option was estimated by the difference in the sums of the relative scaling for each evaluation criterion. Management options with high total scores were not automatically considered for recommendation, but simply were identified for further analysis and discussion.

Evaluation criteria scaling is summarized as follows:

8.1 Social / Political

This evaluation criterion focuses on how Helena residents and elected officials may respond to management options both in terms of emotional response and economic reality.

Social / political scaling:

High = 5: Option is not controversial.
Med = 3: Option is somewhat controversial.
Low = 1: Option is controversial.

8.2 Human Health and Safety

This evaluation criterion focuses on the general health and safety of Helena residents and management personnel.

Human health and safety scaling:

High = 5: Option supports health and safety.
Med = 3: Option somewhat supports health and safety.
Low = 1: Option compromises health and safety.

8.3 Cost to Implement

This evaluation criterion focuses on the cost of implementation along with the associated risks and liabilities.

Cost to implement scaling:

High = 5: Option is cost effective.
Med = 3: Option is somewhat cost effective.
Low = 1: Option is not cost effective.

8.4 Conflict Resolution

This evaluation criterion focuses on the ease of implementation and the level of effort to reduce human / wildlife conflicts.
Conflict resolution scaling:

High = 5: Option reduces conflict.
Med = 3: Option partially reduces conflict.
Low = 1: Option does not reduce conflict.

8.5 Biological Integrity

This evaluation criterion focuses on the well-being of the deer through analysis of the impacts to herd and habitat health.

Biological integrity scaling:

High = 5: Option supports healthy deer and habitat.
Med = 3: Option somewhat supports healthy deer and habitat.
Low = 1: Option compromises healthy deer and habitat.

TABLE 4

COMPARISON OF URBAN DEER MANAGEMENT OPTIONS

POTENTIAL DEER MANAGEMENT OPTIONS[1]	EVALUATION CRITERIA[2]					
	SOCIO-POLITICAL	HEALTH & SAFETY	COST	CONFLICT RESOLUTION	BIOLOGICAL INTERGRITY	TOTAL - RANK[3]
1 – Maintain Current Actions	111111311 = **11**	111133133 = **17**	333333313 = **25**	111111113 = **11**	111313113 = **15**	**79 – 10**
2 – Public Ed. / Outreach	553555555 = **43**	533533555 = **37**	553333553 = **35**	331353353 = **29**	333333335 = **29**	**173 - 2**
3 – Land. / Repel. / Barriers	353333533 = **31**	353555333 = **35**	333331355 = **29**	313311333 = **21**	313335313 = **25**	**141 - 6**
4 – Zoning / Ordin. / Laws	333311313 = **21**	553553335 = **37**	553531313 = **29**	333331313 = **23**	335553335 = **35**	**145 - 5**
5 – Capture and Transfer	153111531 = **21**	553113513 = **27**	133111113 = **15**	555133533 = **33**	131113511 = **17**	**113 - 9**
6 – Capture and Euthanize	313131131 = **17**	555133555 = **37**	113133131 = **17**	535353535 = **37**	535353355 = **37**	**145 - 5**
7 – Fertility / Sterilization	331313515 = **25**	313313535 = **27**	111111313 = **13**	333313335 = **27**	513313335 = **27**	**119 - 8**
8 – Prof. Wildlife Removal	333311333 = **23**	555533535 = **39**	555351555 = **39**	555555553 = **43**	555555355 = **43**	**187 - 1**
9 - Certified Urban Hunting	311111131 = **13**	511533135 = **30**	555553155 = **39**	553553353 = **37**	533553355 = **37**	**156 - 3**
10 – Track. / Adver. Condit.	111333355 = **25**	331333335 = **27**	551333155 = **31**	111111133 = **13**	331353135 = **27**	**123 - 7**
TOTAL - RANK	**230 - 5**	**313 - 1**	**272 - 4**	**274 - 3**	**292 - 2**	

[1] Management options determined to be appropriate for Helena.
[2] Evaluation criteria used to compare and contrast management options.
[3] Evaluation criteria scaling is outlined below:

Social / Political

High = 5: Option is not controversial.
Med = 3: Option is somewhat controversial.
Low = 1 Option is controversial.

Human Health and Safety

High = 5: Option supports health / safety.
Med = 3: Option somewhat supports Health / safety.
Low = 1: Option comp's health / safety.

Cost to Implement

High = 5: Option is cost effective.
Med = 3: Option is somewhat cost effective.
Low = 1: Option not cost effective.

Conflict Resolution

High = 5: Option reduces conflict.
Med = 3: Option partially reduces conflict.
Low = 1: Option does not reduce conflict.

Biological Integrity

High = 5: Option supports healthy deer and habitat.
Med = 3: Option somewhat supports healthy deer and habitat.
Low = 1: Option compromises healthy deer and habitat.

9.0 RECOMMENDED URBAN DEER MANAGEMENT ACTIONS

The Task Force proceeded with the understanding that successful implementation of urban deer management actions should maximize benefits to both residents and deer.

The Task Force considered costs associated with implementing immediate and future management actions. Level of effort required to implement each action was also considered. Management actions with a history of success in other communities were not always deemed practical or acceptable for Helena. Ultimately, the Task Force selected management actions that were (1) safe, (2) humane, and (3) achievable.

The Task Force recognized that unless aggressive management actions are immediately implemented, the whole urban deer management program may fail. Urban deer management is historically conducted in two phases: (1) the aggressive initial first-year reduction phase, and (2) the maintenance phase. Although the initial reduction phase is costly, if done effectively, costs in the following years are manageable. The Task Force recommends the Commission vigorously enforce the current ordinances relating to feeding urban deer and add other non-lethal options to a deer management plan.

With that in mind, the Task Force recommended the following urban deer management actions: (1) conducting public education / outreach; (2) reviewing zoning / ordinances / laws; (3) promoting landscaping / repellents / barriers; (4) hiring professional wildlife removers; (5) monitoring the effectiveness of fertility / sterility; (6) monitoring use for capture and euthanize; (7) establishing a deer tracking and aversive conditioning research study; and (8) evaluating certified urban hunting. Future management actions will be determined following a review of previous actions taken using the Adaptive Management Strategy (Section 12.0).

The following is a summary of findings for each urban deer management option:

9.1 Maintain Current Management Actions

The Task Force did NOT recommend this management option.

The Task Force found this option to be inappropriate for Helena. The Task Force determined the population growth rate of urban deer and associated wildlife response calls pose too great of a safety threat to humans and deer. However, it was agreed the City must commit to enforcing current no-feeding ordinances.

Reasonable Cost Estimate: NA
Potential Revenue Sources: NA
Role of Agencies: NA

9.2 Public Education / Outreach

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined that on-going education and outreach was an appropriate means to disseminate information about urban deer management techniques and strategies. The primary form of education and outreach is through brochures, handouts, electronic information, seminars, home visits, etc.

<u>Reasonable Cost Estimate:</u> $3,000 / year.
<u>Potential Revenue Sources:</u> City general fund, FWP Living with Wildlife Grant, Future Legislative Initiatives, etc.
<u>Role of Agencies:</u> Contributing text / editing / existing public information.

9.3 Landscaping / Repellents / Barriers

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined that residents have access to deer-resistant landscaping, repellents, and barriers. The cost of these items to protect private property is solely borne by residents. It is not anticipated the City will need any new landscaping, barriers, or repellents other than what it may currently use. The Task Forced deemed residential costs to be reasonable.

Landscaping, repellents, and barriers are recommended as being the major topic targeted through public education and outreach activities. Cost to City is included in the estimate for public education and outreach listed above.

<u>Reasonable Cost Estimate:</u> $0 Residential purchases.
<u>Potential Revenue Sources:</u> NA
<u>Role of Agencies:</u> Contributing text / editing / existing public information.

9.4 Zoning / Ordinances / Laws

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined that current City subdivision ordinances have the ability to incorporate several provisions that consider urban deer management strategies. This may include provisions for wildlife corridors, cluster development, riparian protection zones, etc. Additionally, the current ordinance addressing the feeding of wildlife may be reviewed and re-evaluated for potential revisions. This also includes City and FWP review of the dispatch criteria policy. Proposed revisions to existing ordinances would result from future work sessions between city planning staff and the Urban Wildlife Advisory Committee. Legislative initiatives may be needed to revise current county planning laws and requirements. Hunting District 388 may be reviewed to expand opportunities to harvest deer in the areas surrounding Helena.

Reasonable Cost Estimate: $0
Potential Revenue Sources: NA
Role of Agencies: Contributing text / editing / existing public information.

9.5 Capture and Transfer

The Task Force did NOT recommend this management option.

The Task Force found this option to be inappropriate for Helena. The Task Force determined the various forms of capture and transfer are very stressful and often result in high mortality rates in the relocated deer. The cost of trapping and transferring deer was also found to be high. Efforts to trap and transfer deer have met with varied success and are labor intensive.

Reasonable Cost Estimate: NA
Potential Revenue Sources: NA
Role of Agencies: NA

9.6 Fertility / Sterilization

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. However, the Task Force determined the processes involved and cost to be prohibitive at this time. The Task Force reaffirms its interest in the progress and results of tests using immunocontraception and recommends the future Urban Wildlife Advisory Committee investigate the feasibility of a pilot project in Helena and seek approval from the Commission and FWP prior to implementation.

Reasonable Cost Estimate: $ unknown
Potential Revenue Sources: Potential public / private grants.
Role of Agencies: Appropriate agency participation.

9.7 Capture and Euthanize

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined the capture and euthanize option to be most effective in areas where other lethal options cannot feasibly be employed or where individual deer are identified as the problem. Capture and euthanize methods generally are considered less humane than sharpshooting or in some instances, hunting. Baited box traps or rocket nets can be used to capture deer, which can then be euthanized by head shots using a firearm or bolt gun.

<u>Reasonable Cost Estimate:</u> Variable - $400 - $800 per deer.
<u>Potential Revenue Sources:</u> City general fund, FWP Living with Wildlife Grant, Future Legislative Initiatives, etc.
<u>Role of Agencies:</u> Appropriate agency participation.

9.8 Professional Wildlife Removal

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined professional wildlife removal to be the quickest way to safely reduce urban deer. This option can be safely used in many residential areas and city parks using bait sites and stationary marksmen. The deer can be then donated to individuals and / or local food banks. Professional wildlife removers may include either national or local companies. Shooting proficiency tests would be required of both national and local contractors. A roster of residential landowners willing to participate with the management option would also be included.

<u>Reasonable Cost Estimate:</u> Variable - $65 - $75 per deer (local business)
$100 - $600 per deer (national business).
<u>Potential Revenue Sources:</u> City general fund, FWP Living with Wildlife Grant, Future Legislative Initiatives, etc.
<u>Role of Agencies:</u> Appropriate agency participation.

9.9 Certified Public Hunting

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. The Task Force determined certified public hunting will effectively reduce urban deer. It is understood this option may be controversial. Therefore, the appropriate coordination with the public and media is an integral part of this option. Safety and proficiency tests will be required before hunters are allowed to participate. Costs for conducting certified public hunting are primarily administrative and could be recuperated through user fees. Recommended areas surrounding Helena would be clearly defined, such as isolated city open spaces. Hunting District 388 regulations would be in effect that limit the use of weapons to shotguns, archery, and muzzleloading. Approval from the Commission and FWP is necessary prior to implementation.

Reasonable Cost Estimate: $0
Potential Revenue Sources: Participant user fees.
Role of Agencies: Appropriate agency participation.

9.10 Deer Tracking & Aversive Conditioning

The Task Force recommended this management option.

The Task Force found this option to be appropriate for Helena. However, the Task Force determined the program must first be fully evaluated for safety and research study design. The Task Force encourages the future Urban Wildlife Advisory Committee to work with FWP to define this option and seek approval from the Commission and FWP prior to implementation.

Reasonable Cost Estimate: $ unknown
Potential Revenue Sources: City and FWP cost share.
Role of Agencies: Appropriate agency and community participation.

10.0 RECOMMENDED URBAN DEER POPULATION OBJECTIVE

Population dynamics for any wildlife species are complex and unique. Most urban deer discussions in North America revolve around white-tailed deer because urban communities are often established in riparian zones along the courses of rivers. In the case of Helena, the city was established in the mountain-foothill ecotone that favors mule deer, although white-tailed deer occur in the north portion of the city where streams and riparian habitat exists. Virtually all concerns voiced about deer within Helena pertain to mule deer. However most of the issues relevant to mule deer also pertain to white-tailed deer, with the exception that mule deer may be more aggressive when in close proximity to humans.

Mule deer population dynamics are distinctly different from white-tailed deer and must be addressed separately. Population parameters provided here (natality, mortality, recruitment rates) represent the mountain-foothill habitat of the Bridger Mountains between Bozeman and Townsend, and about 60 miles southeast of Helena. Data has been compiled on mule deer of the Bridger Mountains for more than 50 years, and represents a long-term data set (*Ecology and Management of Mule Deer and White-tailed Deer in Montana*[1]*)*.

An inventory of mule deer was conducted in Helena from the middle of December 2006 to the middle of January 2007, and provides the ratios of adult females, adult males, and fawns that are used to initiate the growth model that is applied to the Helena urban mule deer population. The results of the Helena urban deer inventory are included as Appendix J.

10.1 Urban Deer Population Estimate Methodology

Determining a population objective for urban deer in Helena will require reliance on four factors and a small amount of professional judgment. The four factors include:

1. Application of established wildlife management methodology;
2. Utilization of population dynamics information from the mountain-foothill habitats of western Montana;
3. A starting population estimate based upon the Helena Urban Deer Inventory study that involves extrapolation to the entirety of each of the seven HCC Districts; and
4. An assumption that mortality rates of urban deer are less than mortality rates in the wild.

The complete methodology that was applied for each of three scenarios to achieve possible mule deer population objectives is included as Appendix S.

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[1] Mackie, Richard, David F. Pac, Kenneth L. Hamlin, and Gary L. Dusek. Montana Fish, Wildlife & Parks Wildlife Division. Helena, MT. Fed. Aid Proj. W-120-R. 180 pp.

Terminology:

Reproductive rate: Means the number of fawns produced per doe at birth.
Mortality rate: Means the number of deer that die within one year in relation to the number of deer present at the beginning of the year.
Recruitment: Means the number of fawns that survive to their first birthday.

Productivity:

The following figures are provided for mule deer in high quality habitats. The female component of the population determines growth of the population. Efficient population management focuses on managing the female component.

Females

- Do not breed as fawns.
- Yearlings breed but at a lower rate than adults – production highly variable.
- Productivity rate of approximately 160 fawns born per 100 adult females for prime age classes (3-9 yrs); less for young/old).
- Ninety percent of females give birth every year.

Males

- Do not breed as fawns.
- Yearlings will breed but at a lower rate than adults.
- A dominant, mature (4 years of age and older) male will breed with dozens of females.

Average Annual Mortality:

- Average annual fawn mortality varied from 60% (Missouri River Breaks) to 73% (Bridger Mountains).
- Adult female = 15% (hunting accounts for less than 1/4 of total mortality).
- Adult male = 55% (hunting accounts for 1/2 to 3/4 of total mortality of adult males and natural causes accounted for the remainder).

Longevity:

- Adult females can live about 12 years and some up to 16 years.
- In most hunted populations, few males live more than 4 years. However, some individuals manage to survive to 7-8 years in light to moderately hunted populations and rarely up to 10-12 years in un-hunted situations.

Early Winter Population Composition:

- In natural populations, adult females generally outnumber adult males by more than 2:1, even where no hunting occurs.
- Long-term average population parameters from the Bridger Mountains were used to provide the basis of population composition in early winter.
- Post season buck:doe ratio = 20:100.
- Fawn:doe ratio (early winter) = 50:100.
- Fawn:adult ratio (early winter) = 41:100.
- This translates into 41 fawns/120 adults = 34% of population are fawns.
- Adult males = 20/120 = 16% of population are males.
- For calculation purposes, the following fawn/male/female percentages are used: 35%, 15% and 50% in early winter.

Home Range:

- Movements and home range size decrease as distances between food, cover, and water sources decrease, as well as with increasing complexity or diversity of habitats.
- Water – free water seldom dictates broad mule deer distribution since they are adapted to live in arid environments; mule deer generally can obtain adequate moisture from succulent vegetation. During severe drought, open water sources may influence local deer distribution when vegetation becomes extremely desiccated.
- On the West Slope of the Bridger Mountains, summer home ranges for adult females with adjacent seasonal ranges varied from 220-395 acres. Winter home ranges for these deer varied from 215-515 acres.
- Home ranges for adult males on the West Slope averaged 595 acres in summer and 615 acres during winter.

Density:

- Density is not uniform across environments.
- Deer densities in the Bridger Mountains varied from 3-15 deer/square mile of year-long habitat during low populations.
- During peak populations, densities varied from 6-22 deer/sq. mile of yearlong habitat in the Bridger Mountains.
- Winter concentrations during peak populations varied from 27 to 117 deer/square mile across the spectrum of occupied habitat.
- Density of Helena urban deer varies widely between HCC Districts, and may vary from 8.9 to 82.1 and may average 31.3 deer/sq. mile during winter.

Observation:

- Under the very best of survey conditions, an observation rate of 80% can be expected. Maximum observation occurs when deer surveys are conducted from a helicopter and when conditions are excellent: light is good, weather is cold, winds are calm. Even from a helicopter, observation can often be as low as 60% if conditions are not optimum.
- A thorough ground survey conducted from a vehicle might be expected to result in an observation rate ranging from 50 to 70%. Only an extremely efficient survey would result in 80% observation.

10.2 <u>Helena Urban Deer Population Extrapolation</u>

These parameters, as applied to the urban setting, are as accurate as current information allows, and are based on established population parameters for mule deer in mountain-foothill habitat and on an inventory of mule deer within City limits.

From the Helena urban Deer Inventory conducted in Helena between mid December 2006 and mid January 2007, the following statements and assumptions can be made:

- The long-term average population composition of mule deer in the mountain-foothill habitat of the Bridger Mountains correlates very well with the first census of mule deer (two replications) that was conducted by vehicle in Helena during the one month period from December 17, 2006 through January 13, 2007.
- The Helena mule deer population approximates a closed system: limited immigration, emigration, and mortality are believed to be occurring.
- Winter population estimates are used in traditional wildlife management to establish harvest objectives.
- The Helena deer inventory was conducted *early* in the winter, therefore the percentage of fawns in the population will be less than indicated, due to over-winter and spring mortality that will occur.
- Actual fawn mortality is unknown but is estimated to be half the mortality that is occurring in the wild, therefore assumed to be approximately 35% (includes vehicle collisions and mortality from natural attrition such as poor health, but does not include predation or hunting season mortality).
- At very high population levels, social regulators within the mule deer population will begin setting a social carrying capacity for the deer themselves, so the population will not continue to grow exponentially. At high numbers, deer will eventually begin to defend their space so some density regulation will occur. But, human social tolerance levels will be met long before deer density dependent factors begin to operate.
- Portions of each HCC District that have roads were surveyed.
- Road coverage of each HCC District ranged from 30% to 100%.
- Ground survey efficiency is generally relatively low at 50% to 70%.

- If we assume a *very high* ground survey efficiency rate of 80%, and extrapolate the number of deer observed to 100% of the area, a more realistic population estimate can be achieved. But an 80% observation rate still provides a conservative population estimate.
- Given: (1) the population parameters that exist for mule deer in the mountain-foothill habitats of the Helena area, (2) a ground observation rate of between 70% and 80%, and (3) extrapolation of deer numbers in surveyed area to non-surveyed area -- existing Helena mule deer population can be estimated to be 500. Five hundred deer provide the basis for projecting population changes over the next three years.

Formula: Estimation for Number of Deer in Each HCC District =

$$(N \times 100 / P) / R$$

Where: N = Number of deer observed during survey;
P = Percent of HCC District that was inventoried; and
R = Observation Rate, in this case 80% or 0.8.

Formula application involves the following two steps:

STEP #1 Extrapolation of deer inventory to entire HCC District = Number of deer observed X 100 / Percentage of HCC District inventoried; and

STEP #2 Dividing by 0.8 expands the 80% observation rate to 100%.

Table 5 outlines the Helena urban deer population estimate based on 2006-07 winter inventory:

TABLE 5
HELENA URBAN DEER POPULATION ESTIMATE BASED ON 2006-2007 WINTER INVENTORY

HCC Dist.	Sq. Mi.	% of HCC District Inventoried by Road (P)	High No. Deer Observed Winter[1] (N)	Extrapolated Inventory to 100% of HCC District	Pop. Level IF 80% Observed (R)	Pop. Level IF 70% Observed	Pop. Level IF 60% Observed	Density - extrap. from 80% observed
1	2.46	30	28	93	116	132	155	47.2
2	1.35	80	23	29	36	41	48	26.6
3	1.75	60	15	25	31	36	42	17.7
4	1.04	75	20	27	34	39	45	32.7
5	5.25	70	27	39	49	56	65	9.3
6	1.35	100	34	34	43	49	57	31.9
7	2.29	70	110	157	196	224	262	85.5
Total	15.49		257	404	505	577	674	32.6
					500 Begin Population Progression			

[1] Winter inventory conducted in December 2006-January 2007.

Population Objective:

At the current average density of more than 32.6 mule deer per square mile, the human social tolerance for urban deer appears to be declining (see Five Core Questions - Appendix S). Based on information from other cities that have established an urban deer density objective, the Task Force concluded that an urban deer density objective should be initially set at 25 deer per square mile. As additional urban deer inventory information is collected, this objective may be revised through the Adaptive Management Approach (Section 12.0). Similar density objectives have been established for urban white-tailed deer in Iowa City, Iowa, and Chicago. In Pennsylvania and Virginia, studies indicate that when deer exceed 15 to 20 per square mile, ecosystems begin to degrade.

At a density of 25 deer per square mile, Helena's urban deer population would remain constant at approximately 380 deer. This current population estimate is considered conservative. If the observation rate of urban deer during the 2006-2007 urban deer inventory was actually less than 80%, or if reproductive rates are greater than 1.6 fawns born to adult females per year; or if mortality rates of females, males or fawns is less than 7.5, 27.5, and 17 percent, respectively, then the population will be growing at a faster rate than what has been calculated. Table 6 outlines Helena urban deer projected population growth rates using different parameters and mortality rates.

TABLE 6
HELENA URBAN DEER PROJECTED POPULATION GROWTH USING DIFFERENT PARAMETERS AND MORTALITY RATES

	SCENARIO A	SCENARIO B	SCENARIO C
	Mountain-Foothill Population Parameters & Mortality Rates (50 yrs of information)	Helena Inventory Population Parameters & Mtn-Foothills Mort. Rate (1 yr of information)	Helena Inventory Population Parameters & Mortality Rates that are 50% of Mortality Rates in the Wild[3]
December 2006	500[1]	500[2]	500[3]
December 2007	647	617	714
December 2008	785	751	990
December 2009	954	908	1,353
December 2010	------------	------------	1,832

[1] Yr 1 - Mountain-Foothill Population Parameters = 50% adult female, 15% adult male, 35% fawns; Mortality Rate used = death rates that occur in the wild of all population segments.
[2] Yr 1 - Helena Population Parameters = 45% adult females, 14% adult male, 41% fawns; Mortality Rate used = death rates that occur in the wild of all population segments.
[3] Yr 1 - Helena Population Parameters = 45% adult females, 14% adult male, 41% fawns; Mortality Rate = one-half the death rate that occurs in the wild of all population segments. This Scenario may best approximate circumstances in the urban setting of Helena.

10.3 Urban Deer Population Density Objective

Helena Urban Deer Population Density Objective = 25 deer per square mile.

Using Scenario C, and depending on when the first year of plan implementation occurs, Table 7 indicates the number of urban deer required to be removed to achieve the 25 deer per square mile density, or a population objective of 380 urban deer.

Once the 25 deer per square mile density objective is reached, annual removal of urban deer to keep the population at the 380 population objective would be 166 deer. Detailed calculations on the annual removal formula is included as Appendix T.

TABLE 7
Total Urban Deer to be Removed to Achieve Density of 25 Deer per Square Mile*

Management Year	Scenario C	Deer to be Removed	Final Deer Population
If Year 1 = Winter 2007-08	714	334	380
If Year 1 = Winter 2008-09	990	610	380
If Year 1 = Winter 2009-10	1,353	973	380
If Year 1 = Winter 2010-11	1,832	1,452	380

* Helena Area = 15.5 sq. miles

11.0 RECOMMENDED ACTIONS BY NEIGHBORHOOD

The Task Force understands that one urban deer management action may be appropriate in one situation / neighborhood, but inappropriate in another. Therefore, the Task Force evaluated each recommended management action from Section 9.0 by each of the seven HCC Districts (neighborhoods). This spatial evaluation of management actions is necessary to ensure success to both urban deer and Helena residents. Figure 1.0 outlines the seven HCC District boundaries (page 49). Figure 2.0 outlines the current city of Helena open lands (page 50).

Based upon research information that includes the public telephone survey, urban deer inventory, professional presentations, literature review, Task Force evaluation criteria, Town Hall meetings, and public comment (Section 4.0), the Task Force recommends immediate management actions by neighborhood as outlined in Table 8. The term 'immediate' is defined as those management actions that can be implemented within a one-year timeframe.

The Task Force recommends that management actions be re-evaluated annually by the Urban Wildlife Advisory Committee as directed by the Commission using an Adaptive Management Strategy (Section 12.0). In addition to immediate management actions, Table 9 outlines recommendations for future management actions.

11.1 Management Action Strategy

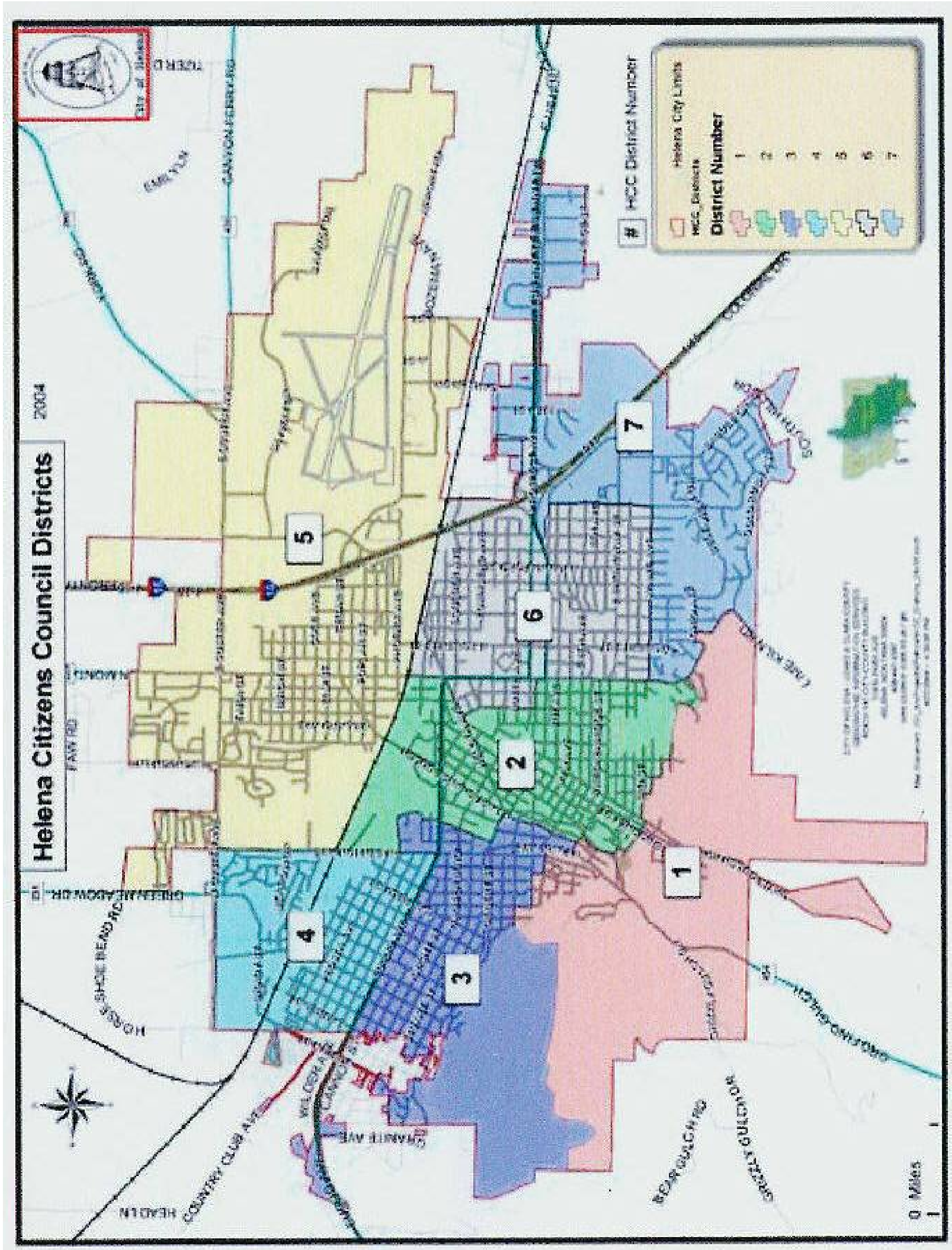
Tables 8 and 9 outline Task Force recommendations for immediate and future management actions. The Task Force believed only those management actions listed in Table 8 were appropriate for immediate implementation. This strategy will ensure urban deer management program success and social acceptability.

Following initial implementation, the future Urban Wildlife Advisory Committee would evaluate the potential use of alternative management actions based upon annual data collection such as an urban deer inventory by neighborhood and measurement of public attitude toward urban deer by neighborhood. A method of gauging social acceptability for the urban deer management program would be to perform an annual water bill survey. Results could then be summarized by HCC District.

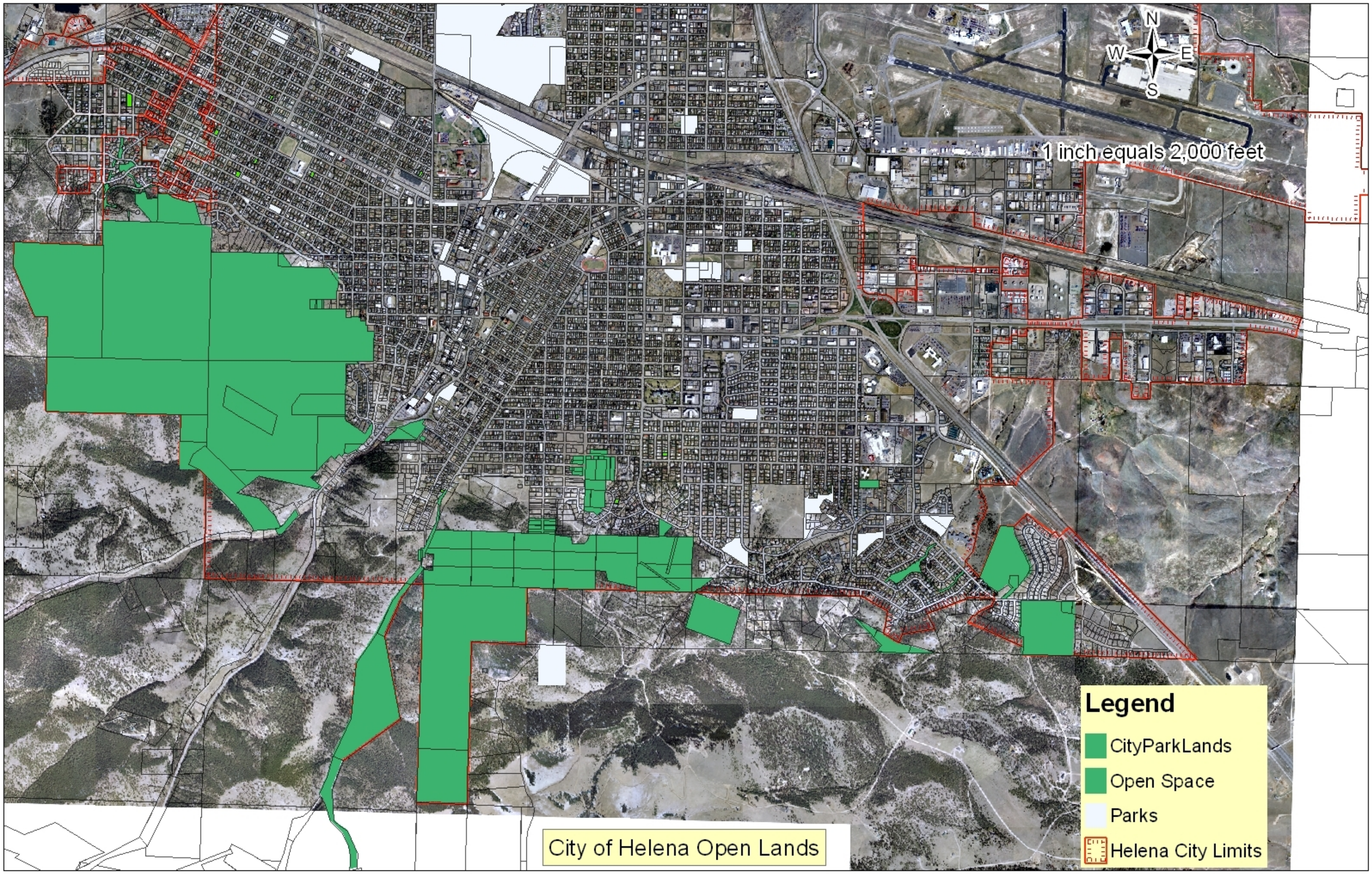
Table 9 illustrates the future inclusion of two additional management actions of Deer Tracking and Adverse Conditioning and Capture / Euthanize. The Task Force agreed the Fertility / Sterility management action should be continually evaluated for its potential use in the future. As outlined in Section 9.0, the Task

Force determined the Maintain Current Actions and Capture & Transfer management actions were not appropriate for Helena and recommend these not be considered for future implementation.

Tables 8 and 9 include an average score of Task Force member evaluation of which management actions are most appropriate by HCC District. Management action average scores of 3.0 or greater are recommended for that neighborhood. As illustrated by Tables 8 and 9, the Task Force recommends that management actions be adaptive and flexible both over time and by neighborhood. For example, the Certified Urban Hunting management action demonstrates how the urban deer management program has the ability to expand or contract over time by using the Adaptive Management Strategy (Section 12.0).



HELENA CITIZENS' COUNCIL DISTRICT BOUNDARIES
FIGURE 1.0



CITY OF HELENA OPEN LANDS
FIGURE 2.0

TABLE 8
YEAR 1: IMMEDIATE URBAN DEER MANAGEMENT ACTIONS BY HCC DISTRICT
"Management Matrix"

HCC District[a]	2006-2007 RESULTS		URBAN DEER MANAGEMENT ACTIONS[d]				
	#Deer / Mile Surveyed[b]	Support Lethal Actions[c]	Education / Outreach	Landscape / Repellents / Barriers	Zoning / Ordinances / Laws	Professional Wildlife Removal	Certified Urban Hunting
1	0.78	67.4%	555555555 = **5.0**	555555555 = **5.0**	555353555 = **4.6**	555353555 = **4.6**	115351531 = **2.8**
2	0.43	53.9%	555555555 = **5.0**	555555555 = **5.0**	315353555 = **3.9**	155153111 = **2.6**	113111111 = **1.2**
3	0.43	50.0%	555555555 = **5.0**	555555555 = **5.0**	335353555 = **4.1**	355353535 = **4.1**	115331511 = **2.3**
4	0.82	62.8%	555555555 = **5.0**	555555555 = **5.0**	335353555 = **4.1**	155353135 = **3.4**	113311111 = **1.4**
5	0.65	51.2%	555555555 = **5.0**	555555555 = **5.0**	335353555 = **4.1**	355351555 = **4.1**	115331311 = **2.1**
6	0.75	44.9%	555555555 = **5.0**	555555555 = **5.0**	335353555 = **4.1**	155151111 = **2.3**	111111111 = **1.0**
7	3.00	59.2%	555555555 = **5.0**	555555555 = **5.0**	355353555 = **4.3**	355353555 = **4.3**	115351531 = **2.8**

[a] Appropriate areas for culling deer include the Helena Open Lands System adjacent to HCC Districts 1, 3, and 7. The Nature Park / Golf Course area may also be appropriate during the winter in HCC District 5.
[b] From Urban Deer Population Inventory, Winter 2006-2007.
[c] From Resident Telephone Survey on Urban Deer in Helena, Fall 2006. Percentages are based from the question "Do you support or oppose using LETHAL actions to manage urban deer". Percentages display public's support in each HCC District for use of lethal action to manage urban deer. Note: Data is not 95% significant when broken into HCC Districts.
[d] Final numbers for each management action within each HCC District are based on the average of total Task Force Member scoring.

High = 5: Strongly support management action in this HCC District.
Med = 3: Support management action in this HCC District.
Low = 1: Do not support management action in this HCC District.

[shaded box] = Average scores of 3.0 or higher are recommended as management actions by HCC District.

TABLE 9
YEAR 2: FUTURE URBAN DEER MANAGEMENT ACTIONS BY HCC DISTRICT
"Management Matrix"

HCC District[a]	2006-2007 RESULTS		URBAN DEER MANAGEMENT ACTIONS[d]						
	#Deer / Mile Surveyed[b]	Support Lethal Actions[c]	Education / Outreach	Landscape / Repellents / Barriers	Zoning / Ordinances / Laws	Behavior Modify	Capture / Euthanize	Profession. Wildlife Removal	Certified Urban Hunting
1	0.78	67.4%	555555555 = **5.0**	555555555 = **5.0**	355535555 = **4.6**	153515555 = **3.9**	311111155 = **2.1**	353535555 = **4.3**	151515551 = **3.2**
2	0.43	53.9%	555555555 = **5.0**	555555555 = **5.0**	355535551 = **4.1**	153515351 = **3.2**	311311351 = **2.1**	155531135 = **3.2**	133111111 = **1.4**
3	0.43	50.0%	555555555 = **5.0**	555555555 = **5.0**	355535553 = **4.3**	153515355 = **3.7**	311111155 = **2.1**	353535555 = **4.3**	151315551 = **3.0**
4	0.82	62.8%	555555555 = **5.0**	555555555 = **5.0**	355535553 = **4.3**	153515355 = **3.7**	311111155 = **2.1**	153531555 = **3.7**	153111511 = **2.1**
5	0.65	51.2%	555555555 = **5.0**	555555555 = **5.0**	355535553 = **4.3**	153515355 = **3.7**	311111155 = **2.1**	353515555 = **4.1**	153313511 = **2.6**
6	0.75	44.9%	555555555 = **5.0**	555555555 = **5.0**	355535553 = **4.3**	153515355 = **3.7**	311311351 = **2.1**	155511135 = **3.0**	113111111 = **1.2**
7	3.00	59.2%	555555555 = **5.0**	555555555 = **5.0**	355535555 = **4.6**	153515555 = **3.9**	311111155 = **2.1**	353535555 = **4.3**	151515551 = **3.2**

[a] Appropriate areas for culling deer include the Helena Open Lands System adjacent to HCC Districts 1, 3, and 7. The Nature Park/Golf Course area may also be appropriate during the winter in HCC District 5.
[b] From Urban Deer Population Inventory, Winter 2006-2007.
[c] From Resident Telephone Survey on Urban Deer in Helena, Fall 2006. Percentages are based from the question "Do you support or oppose using LETHAL actions to manage urban deer". Percentages display public's support in each HCC for use of lethal action to manage urban deer. Note: Data is not 95% significant when broken into HCC Districts.
[d] Final numbers for each management action within each HCC District are based on the average of total Task Force Member's scoring.

High = 5: Strongly support management action in this HCC District
Med = 3: Support management action in this HCC District
Low = 1: Do not support management action in this HCC District

[shaded box] = Average scores of 3.0 or higher are recommended as management actions by HCC District.

12.0 MONITORING AND ADAPTIVE MANAGEMENT STRATEGY

Some management actions are considered complex, on-going activities that require greater technical and / or administrative timeframes. Therefore, future deer management actions are those that require more than one year to implement. These management actions must be reviewed and evaluated for continued implementation. The Urban Wildlife Advisory Committee shall use an Adaptive Management Strategy to annually evaluate effectiveness of existing management actions and to consider future inclusion / exclusion / transition of all appropriate management actions.

12.1 Adaptive Management Strategy

An Adaptive Management Strategy is an approach that adjusts future actions based upon previously learned experience, experimentation, and monitoring. Adaptive management should focus on accelerated learning and through partnerships with city officials, residents and potentially county and state officials, learn together to manage urban deer populations that support both humans and deer.

The primary objective of the Plan is to reduce human-deer conflict, thus increasing public health and safety. Regardless of the management actions implemented, the urban deer management program will require ongoing monitoring to (1) determine whether the Plan is achieving its stated objectives, and (2) evaluate the assumptions for urban deer in Tables 6 and 7.

The urban deer inventory measured the presence of urban deer in winter 2006 – 2007 and provides a beginning snapshot of current conditions prior to initiating management actions. The Task Force recommends an annual urban deer inventory to gain population trend information within City limits. By monitoring population numbers, the acceptable density of urban deer can be established in Helena through social and biological criteria.

The Task Force recommends the urban deer management program establish a conservative urban deer density goal of 25 deer/square mile (Section 10.3). Through biological monitoring and pubic opinion, this number is flexible to meet urban deer management objectives. Plan revisions should be made based on the relative success rates of implemented management actions as demonstrated by the monitoring data.

The Adaptive Management Strategy process for the Urban Wildlife Advisory Committee is established. The process should always involve both the public and current biological information. Evaluation criteria outlined in Section 7.0 should be consulted throughout the process.

12.2 Program Considerations

Annual Collection of Social and Biological Data:

Future Adaptive Management Strategies should rely on the annual collection of social data such as resident complaint reports from urban deer, including type of damage and a description of the urban deer prompting the complaint. Social data may also include the occurrence of deer / automobile collisions. Collecting social data must include City Police and FWP response records or other relevant information that may be compared to baseline information to establish trends.

Collection of biological data primarily involves the urban deer inventory by neighborhood. However, this may also include data collected from the City Police and FWP response records or special research projects such as those established with the Deer Tracking and Aversive Conditioning management action.

Evaluation of Operating Costs:

Operating costs to implement the urban deer management program must also be considered through the Adaptive Management Strategy. Operating costs should also be adaptable and flexible. For example, the HCC may be involved in the annual urban deer inventory. Another consideration includes evaluating the economic benefits to using professional or non-professional wildlife removers.

Distribution of Harvested Meat:

The Urban Wildlife Management Committee must determine a cost-efficient method to distribute the harvested meat. Options may include a public registry based upon an economic means-test. This registry would be implemented to pick up harvested meat. Donation to charitable organizations may also be available. The feasibility and logistics of distributing harvested meat should also use the Adaptive Management Strategy approach.

APPENDICES

APPENDIX A	Task Force Resolution / Recruitment / Membership / Charge
APPENDIX B	Colstrip Deer Management Action Plan
APPENDIX C	Town of Fort Peck – Draft Deer Management Plan
APPENDIX D	Missoula - Prohibition of Feeding Wildlife Ordinance
APPENDIX E	Rapid City South Dakota Deer Herd Management Program
APPENDIX F	Iowa City, Iowa Urban Deer Annual Report
APPENDIX G	Police and FWP Wildlife Calls
APPENDIX H	Hunting District 388
APPENDIX I	Resident Telephone Survey on Urban Deer
APPENDIX J	Urban Deer Population Inventory
APPENDIX K	1973 Wildlife Study – Helena South Hills Area
APPENDIX L	Town Hall Meetings Materials
APPENDIX M	Public Comments
APPENDIX N	Task Force Master Planning Timeline
APPENDIX O	Task Force Meeting Agendas and Approved Minutes
APPENDIX P	Independent Record News Articles
APPENDIX Q	HCC Quality of Life Survey
APPENDIX R	HB 249 & SB 410 – State Legislation
APPENDIX S	Five Core Questions Results
APPENDIX T	Urban Deer Population Objective Scenarios

END OF DOCUMENT

ADDRESSING PUBLIC SAFETY BY STRENGTHENING GFFR'S CODE ENFORCEMENT & FIRE PREVENTION DIVISION

GREAT FALLS FIRE RESCUE

1

OVERVIEW

- GFFR ADMINISTERS THE CITY OF GREAT FALLS SAFETY INSPECTION CERTIFICATE PROGRAM
- GFFR WORKS COLLABORATIVELY WITH PLANNING AND COMMUNITY DEVELOPMENT, AND CITY ENGINEERING IN THE DEVELOPMENT REVIEW PROCESS
- GFFR MUST FOCUS ON ADDRESSING FIRE PREVENTION AND CODE ENFORCEMENT AS THE CURRENT RESPONSE POSTURE CANNOT MEET OPERATIONAL RESPONSE TIMES AND STAFFING REQUIREMENTS
- GFFR INSPECTS MOST ALL PUBLIC SAFETY EVENTS FOR LIFE SAFETY ISSUES, CURRENTLY THERE IS NO FORMAL PROCESS. GFFR IS LOOKING TO ESTABLISH ONE

2

SAFETY INSPECTION CERTIFICATE (SIC)

- FOR YEARS THE CITY HAS USED THE SIC IN PLACE OF A BUSINESS LICENSE
- THE SIC NAME CREATES CONFUSION AMONGST BUSINESSES, SPECIFICALLY OUT OF STATE CORPORATIONS
- WORKING COLLABORATIVELY WITH PCD, FISCAL AND LEGAL, GFFR IS WORKING TO STREAMLINE THE PROCESS TO MAKE IT MORE USER FRIENDLY AND TRANSPARENT
- GFFR AND THE CITY WILL TRANSITION THE SIC PROGRAM INTO A BUSINESS LICENSE PROGRAM

3

GFFR IS LOOKING TO STRENGTHEN FIRE PREVENTION EFFORTS IN THE COMMUNITY BY ADOPTING PROACTIVE FIRE CODE ENFORCEMENT AND PREVENTION BENEFITS:

- GFFR HAS WORKED WITH LEGAL AND PCD ON CITY FIRE CODE REQUIREMENTS AND PROPOSE THE FOLLOWING CHANGES TO THE OFFICIAL CODE OF THE CITY OF GREAT FALLS (OCCGF):
  - TITLE 5 BUSINESS LICENSES, PERMITS, AND SAFETY INSPECTIONS CERTIFICATES
  - TITLE 15 BUILDINGS AND CONSTRUCTION (CHAPTER) 9 FIRE CODE
  - TITLE 9 PUBLIC PEACE, MORALS AND WELFARE (CHAPTER 9) FIREWORKS
- GFFR LOOKING TO ADD OPERATIONAL PERMITS FROM SECTION 105 OF THE IFC
- ADDRESSING CERTAIN CONSTRUCTION PRACTICES THAT HAVE CAUSED PROPERTY LOSS IN THE CITY
- GFFR HAS WORKED WITH THE BUILDING OFFICIAL AND LEGAL ON STEPS TO ADDRESS NUISANCE PROPERTIES

4

DEVELOPMENT REVIEW PROCESS

- INTERNATIONAL FIRE CODE (IFC) IS A MAJOR COMPONENT OF THE DEVELOPMENT REVIEW PROCESS
- IT TAKES MANY CITY DEPARTMENTS WORKING TOGETHER TO CONTINUE TO REFINE AND IMPROVE THE DEVELOPMENT REVIEW PROCESS FOR OUR COMMUNITY
- THIS PROCESS IS A JOINT COLLABORATION BETWEEN GFFR, PCD, ENGINEERING, LEGAL, AND THE CITY MANGERS OFFICE

5

CURRENT CHALLENGES FACING DEVELOPMENT REVIEW

- WITH THE INCREASE OF GROWTH AND DEVELOPMENT IN THE CITY OF GREAT FALLS, THE FIRE PREVENTION DIVISION (FPD) HAS BEEN BURDENED WITH AN INCREASED WORK LOAD
  - THIS HAS RESULTED IN TIMES WHEN FIRE PLANS REVIEWS TAKES A SECONDARY PRIORITY OVER OTHER BUSINESS SUCH AS FIRE INVESTIGATIONS, ALARM SYSTEM TESTING, ETC.
- TO ADDRESS THE INCREASED WORKLOAD, ADDRESS THE DELAYS IN THE DEVELOPMENT REVIEW PROCESS, AND THE LACK OF PUBLIC EDUCATION IN FIRE PREVENTION, GFFR IS LOOKING TO ADD AN ADDITIONAL FTP POSITION.

6

- GFFR WILL ADDRESS THIS NEED THROUGH THE FY 2025 BUDGET PROCESS AND UPDATES TO THE GFFR FEE SCHEDULE FOR SERVICES PROVIDED BY THE FPD
- THE ADDITIONAL FTP POSITION WILL:
  - HAVE AN EMPHASIS IN DEVELOPMENT REVIEW AND KEEP TIMELINES MOVING
  - THIS POSITION, WILL ALSO IMPROVE COMMUNICATION AND EFFICIENCY IN THE REVIEW PROCESS AMONGST OTHER CITY DEPARTMENTS
  - ALLOW FOR FIRE PREVENTION EDUCATION IN OUR SCHOOLS AND PUBLIC EVENTS
  - ASSIST DURING TIMES OF INVESTIGATION OR BUSINESS INSPECTIONS WITH OTHER FPD PERSONNEL

7

GFFR PROPOSED FEE SCHEDULE

- THE LAST TIME GFFR ADJUSTED ITS FEE SCHEDULE WAS 2022 BEFORE THAT, GFFR FEES WERE ADJUSTED ON AVERAGE EVERY 2.87 YEARS
- THE 2022 ADJUSTMENT WAS TO ADD FEES FOR EMS REIMBURSEMENT AND FALSE ALARM VIOLATIONS
- THE REST OF GFFR'S FEES WERE LAST ADJUSTED IN 2019, SIC'S WERE LAST ADJUSTED IN 2017
- FROM 1999 TO 2005 THE MAJORITY OF FEES SAW NO ADJUSTMENT
- GFFR IS PROPOSING FP FEES BASED OFF COMPARISONS OF THE FEES THAT OTHER MONTANA CITIES CURRENTLY CHARGE
- GFFR IS PROPOSING A FEE INCREASE TO EMS REIMBURSEMENT BASED OFF OF MEDICARE AND MEDICADE REIMBURSEMENT RATES
- GFFR IS PROPOSING ALL OTHER FEES INCLUDING BUSINESS LICENSES BE ADJUSTED BASED OFF OF THE CURRENT WESTERN CPI PERCENTAGE

8

CONCLUSION

- TO ADDRESS THE LACK OF OPERATIONAL RESPONSE POSTURE FOR FIRE AND EMERGENCY SERVICES PROTECTION IN THE CITY, GFFR WILL CONTINUE TO STRENGTHEN IT'S FIRE PREVENTION/CODE ENFORCEMENT EFFORTS IN THE COMMUNITY BY:
  - WORKING IN CONJUNCTION WITH PCD, FISCAL AND LEGAL TO MAKE THE CITY BUSINESS LICENSURE PROCESS MORE USER FRIENDLY AND TRANSPARENT
  - WORKING WITH PCD AND ENGINEERING TO CONTINUE TO IMPROVE THE DEVELOPMENT PROCESS WITHIN THE CITY
  - ALLOW FOR PERMITTING OF ALL PUBLIC ASSEMBLY EVENTS

9

Chapter 9 FIRE CODE

Sections:

15.9.010 Fire chief authority.

A. Notwithstanding any other provisions of this chapter and the authority granted in section 2.4.070, the fire chief is authorized to issue a burn ban and may prohibit all fires and burning of combustibles including but not limited to all open burning, fire pits, chimineas, charcoal grills, and fireworks within the city limits. In determining to implement a burn ban the fire chief may consider, among others, current climate conditions including drought, weather forecast, and available fire resources. Any burn ban issued by the fire chief may take immediate effect without further implementing actions and will remain in effect until rescinded by the fire chief.

15.9.0210 International Fire Code—adoption.

A. The City of Great Falls hereby adopts the most current edition of the ly Montana state adopted International Fire Code (IFC) as adopted by the Fire Prevention and Investigation Bureau of the Montana Department of Justice (or its successor)nd appendices, as set out in the Administrative Rules of Montana, and as amended from time to time by the Bureau, are adopted by reference and incorporated in this section as set forth in full, with the additions, amendments, and deletions enumerated within the Administrative Rules, except as may be noted in this section, by future administrative order, or by any regulations not applicable to local government jurisdictions.

B. Any amendments adopted by the Fire Prevention and Investigation Bureau which apply to local government jurisdictions, including the adoption of the latest editions of the IFC or applicable Administrative Rules of Montana shall become effective upon execution of an administrative order of the city manager unless a different effective date is specified in the administrative order.

C. The City of Great Falls and Great Falls Fire Rescue (GFFR) herby adopt the following section of code(s), and annexes not adopted by the Fire Prevention and Investigation Bureau of the Montana Department of Justice.

1. Section 105, Permits

   a. Of Section 105 Permits, only operational permits will be adopted. Construction Permits will not be adopted by the IFC, however will be subject to the permitting requirements of the International Building Code (IBC) and the Municipal Code of the City of Great Falls.

   b. The following operational permits shall be adopted, if the permit is not listed here, it is not adopted.

      i. 105.5.3 Amusement buildings
      ii. 105.5.5 Carnivals and fairs
      iii. 105.5.15 Exhibits and trade shows
      iv. 105.5.16 Explosives
      v. 105.5.32 Mobile food preparation vehicles
      vi. 105.5.34 Open burning (exception: recreational fires)
      vii. 105.5.38 Outdoor assembly event

viii. 105.5.49 Temporary membrane structures and tents

2. Appendix B, Fire Flows

3. Appendix C, Hydrants

4. Appendix D, Fire Apparatus Access Roads

5. Appendix E, Hazard Categories

6. Appendix F, Hazard Rankings

7. Appendix G, Cryogenic Fluids – Weights and Equivalents

8. Appendix I, Fire Protection Systems – Noncompliant Conditions

9. Appendix N, Indoor Trade Shows and Exhibitionsas may be administratively amended by the Great Falls Fire Rescue Department (GFFR).

DB. A copy of the IFC, as may be amended, is available for inspection in the City Clerk's office and the GFFR Fire Marshall's office.

EC. Copies of the IFC may also be obtained from the International Code Council.

(Ord. 3213 , 2020; Ord. 3189, 2018).

15.9.0320 Definitions.

Whenever the following words are used in the IFC, the following definitions shall apply:

A. "Chief of the Bureau of Fire Prevention" means the Great Falls Fire Rescue Department (GFFR) Chief.

B. "Corporation Counsel" means the Great Falls City Attorney.

C. "Jurisdiction" means the incorporated City limits of Great Falls.

D. "Removal" in relation to storage tanks includes vents and fill pipes and all other incidental hardware.

(Ord. 3189, 2018).

15.9.0430 Bureau of Fire Prevention—established—duties.

A. The IFC shall be enforced by the GFFR Bureau of Fire Prevention, under the supervision of the Fire Chief.

B. The GFFR Fire Prevention Bureau may, in the discretion of the Fire Marshall, assess fees for false activation of fire alarm systems as outlined in Title 5 of this code, and -inspections and/or re-inspections of premises for compliance with the IFC, or applicable NFPA standards. Said fees shall be set by Commission resolution.

(Ord. 3213 , 2020; Ord. 3189, 2018).

15.9.040 Pipes thawed with torch prohibited.

A. It is unlawful to use any torch or other flame-producing device for the purpose of thawing out any pipe in or under any house, building, or structure in the incorporated City limits.

B. A violation of this section is a misdemeanor punishable by a term not to exceed six (6) months in jail, a fine not to exceed five hundred dollars ($500.00), or both.

C. Costs incurred by City emergency personal responding to a violation of this section may be assessed as a lien on the subject property by Commission resolution.

(Ord. 3189, 2018).

15.9.050 Preventative Inspections.

A. GFFR Bureau of Fire Prevention shall inspect, or cause to be inspected as often as may be necessary, all premises of the city, except the interior of private dwellings, for the purpose of ascertaining and causing to be corrected, any conditions liable to cause fire, or may be considered a life safety hazard(s).

15.9.0650 Inspection, testing, maintenance and records.

A. All system inspections, tests and maintenance that are required by applicable IFC standards shall be performed by qualified individuals who are licensed to perform work in the City of Great Falls and written reports of such inspections, tests and maintenance shall be kept on the premises for a minimum of three (3) years.

B. All inspection, testing and maintenance reports shall be submitted to the City's online reporting vendor within the following time frame:

1. No deficiencies found: within ten (10) days of the date the inspection, testing or maintenance took place;

2. Deficiencies found: within seven (7) days of the date the inspection, testing or maintenance took place; or

3. Critical issues found: Immediately following the inspection, testing or maintenance, along with immediate notification to the Fire Marshal.

C. Inspections, tests and maintenance that do not comply with the provisions in this Chapter shall result in the inspected or serviced system being deemed non-compliant with the provisions of this Chapter.

D. Non-compliance with this Chapter will be addressed as set forth in 15.9.060 and/or by Title 5, Chapter 2, Safety Inspections.

(Ord. 3237 , 2021).

Ord. 3237 , § 1(Exh. A), adopted Dec. 7, 2021, renumbered the former § 15.9.050 as § 15.9.060 and enacted a new § 15.9.050 as set out herein. The historical notation has been retained with the amended provisions for reference purposes.

15.9.070 Existing fire alarm permit requirements.

B. Fire alarm work to existing fire alarm systems that installs/replaces 5 devices or more will require a permit. This includes like for like replacement.

C. Fire alarm panel replacement will require a permit.

15.9.080 Abatement of fire hazard nuisances caused by structures.

A. Any and all buildings, ruins, chimneys, flues, boilers, walls, remains of burned buildings or other constructions within the city limits which, by reason of their construction or condition, are in danger of being set on fire shall be found to be in violation of Title 16 of the City of Great Falls. The owner or owners of properties that are found to be in violation of Title 16 shall be notified to abate such violations forthwith.

B. In case of a fire resulting directly or indirectly from failure promptly to comply with an order issued under this section, the person so failing to comply with such order shall pay to the city, for the service of GFFR, the actual costs for the time GFFR is engaged in fighting such fire. Such money shall be paid in the general fund of the city.

15.9.090 Knox Box required.

A. From the date of this code forward, any new construction within the city that has a life safety system, fire suppression system or commercial kitchen hood installed, shall have a Knox Box.

B. From the date of this code forward, any existing building that undergoes remodel or alterations that significantly alter or enhance a life safety system, fire suppression system, or commercial kitchen hood, shall have a Knox Box installed if one is not currently present.

15.9.100 Explosives and blasting agents; prohibited.

A. The storage of blasting agents or explosives for construction purposes within the city are prohibited.

B. The use of blasting agents or explosives for construction purposes are prohibited.

15.9.101 Fire sprinkler system tenting prohibited.

A. Given the drastic temperatures that can occur in Great Falls, the practice of tenting fire sprinkler pipe is prohibited.

15.9.102 Pipes thawed with torch prohibited.

A. It is unlawful to use any torch or other flame-producing device for the purpose of thawing out any pipe in or under any house, building, or structure in the incorporated City limits.

B. A violation of this section is a misdemeanor punishable by a term not to exceed six (6) months in jail, a fine not to exceed five hundred dollars ($500.00), or both.

C. Costs incurred by City emergency personal responding to a violation of this section may be assessed as a lien on the subject property by Commission resolution.

(Ord. 3189, 2018).

15.9.103~~060~~ Violation—penalty.

A. Unless otherwise specified in this Chapter, any person who violates or fails to comply with any of the provisions of the IFC as adopted, or any of the provisions of this Chapter, is guilty of a misdemeanor, punishable by a term not to exceed six (6) months in jail, a fine not to exceed five hundred dollars ($500.00), or both.

B. A property that contains a violation of the IFC, or any other violation of this Chapter, is hereby declared a Nuisance as defined by OCCGF Title 8, Chapter 49.

(Ord. 3237 , 2021; Ord. 3189, 2018).

Editor's note(s)—See editor's note following 15.9.050.

15.9.104 Hindering fire service operations prohibited.

A. Any person who willfully interferes or hinders any city fire officer or firefighter in the performance of such officer's or firefighter's duty at, going to, or returning from any fire service call, or while attending to the officer's or firefighter's duties as a member of GFFR, or who willfully or negligently drives any type vehicle across, or along or upon any hose, or who willfully cuts, defaces, destroys or injures any of the property belonging to or connected with GFFR, shall be deemed guilty of a misdemeanor.

9.9.071 Fireworks public display. (needs to go in Title 9)

A. The fire chief and or his/her designee shall review and inspect all supervised public displays of fireworks, including "display fireworks," by the municipality, fair associations, amusement parks, or other organizations or groups of individuals upon completion of the necessary application and submission of appropriate fees as may be established by resolution of the city commission. A visual site inspection shall occur before any permit is issued. Submission of the application does not guarantee issuance of a permit. All applications under this section shall be made to the fire chief.

B. Each display must:
   1. Be handled by a licensed, bonded pyrotechnic operator to be approved of by the fire chief or his/her designee.
   2. Be located, discharged, or fired such that the display, in the opinion of the fire chief or his/her designee, shall not be hazardous to persons or property.
   3. Clearly post a “NO SMOKING” warning within 50 feet of the staging and discharge area established for the display, and no one may smoke within the defined area.

C. The application for permit must be made in writing at least 15 days prior to the date of the display, and must contain, at a minimum:
   1. A map of the proposed display venue, including temporary storage site, the parking and spectator viewing areas if applicable, the fireworks discharge point, location of structures and roads, streets, and alleys within a 1000-yard radius, overhead obstructions or other hazards.
   2. The name of the licensed and bonded pyrotechnic operator along with the operator’s qualifications, training and experience, and the names of any assistants for the event.
   3. The location of all fire hydrants, water spigots or other access points for water, and other fire retardants or extinguishers available at or near the venue.
   4. Proof of general liability insurance specifically including coverage for firework displays in an amount acceptable to the city, and which includes the city as an additional insured.
   5. The name of the association, entity, organization or group and its organizing or supervising board or responsible parties for the event.
   6. A complete list of fireworks intended for use in the display together with their projectile rage, if any.
   7. The location, date and time of the display and written consent from the land owner.
   8. A detailed safety plan for the event.

D. Only upon inspection and issuance of the permit, shall use of fireworks for such display as detailed in the permit be lawful.

E. Following the public display, the organizers and the pyrotechnic operator are responsible for clean-up of the display site, including disposal of all discharged fireworks and non-discharged or “dud” fireworks in a safe manner.

F. No permit issued under this article may be transferred.

G. A permit issued under this article may be revoked by the fire chief or his/her designee at any time when any of the conditions under which the permit was granted change, when a hazardous condition is determined to exist, or when, in the best judgment of the fire chief or his/her designee, such permit must be withdrawn in the interests of public safety. The fire chief or his/her designee may revoke a permit issued under this article for a violation of any rule, regulation or requirement of this article.

9.9.072 General liability insurance required. (Needs to go in Title 9)

A. An individual, firm, partnership, corporation or association planning a public display of fireworks shall, in addition to the permit required in section 9.9.071, provide proof of general liability insurance specifically including coverage for firework displays in an amount acceptable to the city attorney; and which includes the city as an additional insured.

B. Notice to the fire chief or his/her designee must be given ten days prior to any public display if any insurance policy required under this article is cancelled or subject to non-renewal. Notice must be provided by the permittee, the insurance carrier.

C. A copy of the insurance policy and applicable fireworks endorsements for any public display must be filed with the city clerk and must indemnify the city against any damages to private or public property, as well as any injuries to persons, which may be caused by or incident to the public display.

D. Any individual, firm, partnership, corporation or association discharging fireworks without a public display permit shall be deemed to be the responsible party and shall be liable for any damages incurred as the result of such discharge. The individual, firm, partnership, corporation or association insurance policy or policies maintained by the individual or entity discharging the fireworks shall be subject to any claim as a result of such discharge resulting in damage or injury.

9.9.073 Fireworks sale and display violation (Needs to go in Title 9).

A. Sales and public display: Any individual, firm, partnership, corporation or association violating the provisions of this article regarding the sale of fireworks or the requirements for a public display of fireworks shall be guilty of a misdemeanor and, upon conviction, shall be punished by a fine of $500.00. Each sale within the city limits without the require license or permit constitutes a separate offense. In the case of a violation by a firm, partnership, corporation or association, the manager or members of the partnership or responsible officers or agents shall be deemed to be prima facie responsible, individually, and subject to the penalty as provided.

B. Any damages caused or injuries sustained as a result of any violation of this article shall be ordered paid as restitution as a part of any conviction for any violation.

C. The court may order the reimbursement of costs of enforcement, investigation, fire suppression services, and overtime related to a violation upon conviction.

Title 5
BUSINESS LICENSES, PERMITS, AND SAFETY INSPECTION CERTIFICATES[1]

Chapter

Chapter 1 GENERAL BUSINESS LICENSE AND SAFETY INSPECTION CERTIFICATE PROCEDURE

Sections:

5.1.010 Definitions.

The following words and phrases when used in this Title shall have the following meanings:

A. "Buildings or Offices" shall mean all buildings, structures, rooms, offices, or portions thereof which are situated on a permanent structural foundation and permanently connected to City water and sewer service wherein a business or organization is located and which may be accessible to the public, employees, or members or located in such close proximity to other buildings, structures, rooms, offices, or portions thereof so as to constitute a public threat in the event of a Uniform Safety Code violation.

B. “Business, occupation and profession is intended to cover all businesses, associations, occupations, professions, trades, pursuits, vocations, entertainments, social activities, fraternal activities, religious activities located or meeting regularly in buildings or offices, multi-family dwelling units of four (4) or more units with common areas. This includes sole proprietorships, partnerships, corporations, nonprofit corporations, religious organizations, social organizations and fraternal organizations. This does not include “Home Occupation”.

~~"Business" shall mean any occupation, trade, profession, commercial activity, social activity, fraternal activity, or religious activity located or meeting regularly in buildings or offices, including multi-family dwelling units of four (4) or more units, together with all devices, machines, vehicles and appurtenances used therein. This includes sole proprietorships, partnerships, corporations, nonprofit corporations, religious organizations, social organizations and fraternal organizations.~~

C. Unless specifically identified, in this Title, the term, "Business License, Certificate" shall include business licenses~~safety inspection certificates~~, home occupation certificates, or any other certificates

[1]Editor's note(s)—Ord. No. 3168, § 1(Exh. A), adopted Nov. 7, 2017, repealed the former Tit. 5, and enacted a new Tit. 5 as set out herein. The former Tit. 5 pertained to similar subject matter and derived from Ord. 3139, 2016; Ord. 3125, 2014; Ord. 3117, 2014; Ord. 3057, 2010; Ord. 2993, 2008; Ord. 2865, 2003; Ord. 2764, 2000; Ord. 2745, 1998; Ord. 2743, 1998; Ord. 2675, 1995; Ord. 2674, 1995; Ord. 2672, 1995; Ord. 2509, 1988; Ord. 2487, 1987; Ord. 2483, 1987; Ord. 2344, 1983; Ord. 2008, 1977; Ord. 1874, 1975; Prior Codes 5.11.1; 5.11.3; 5.16.1.

or permits issued by the City of Great Falls' Planning and Community Development or Fire Rescue Departments.

D. "Home Occupation" means a lawful business carried on by a resident of a dwelling as an accessory use within the same dwelling or an accessory building, which will not infringe upon the rights of neighboring residents to enjoy the peaceful occupancy of their homes.

E. "Home Occupation Certificate" is a certificate, license, or permit issued by the Planning and Community Development Department under the terms and conditions of 5.2.020—5.2.040.

~~F. "Non-Resident Vendor" is any person engaged or employed in the business of selling to consumers by going from consumer to consumer, either on the streets or to their places of residence or employment, and soliciting, selling, or taking orders for future delivery of any goods, wares, or merchandise.~~

~~1. This definition applies to persons vending food or other merchandise from pushcarts, vehicles, trailers, or other readily mobile sources to customers within the City limits.~~

~~2. This all-inclusive definition applies to vendors coming into Great Falls to provide any type of service (e.g. painters, contractors, tree trimmers, computer technicians, etc.), to residents within the City limits.~~

G. "Nonprofit organization" is any group which does not distribute pecuniary gains, profits or dividends to its members, and/or for which pecuniary gain is not the objective of the organization. For the purposes of this Title, a nonprofit organization need not be recognized as tax exempt by the United States Internal Revenue Service and the Montana Department of Revenue.

H. "Permanent Premises" means any buildings or structures, or any part of any buildings or structures, situated on a permanent structural foundation that meet the engineering requirements in the Uniform Building Code and are permanently connected to City water and sewer service. This definition excludes all accessory structures not intended to be occupied by employees and/or the public.

I. "Person" is meant to include individual natural persons, partnerships, joint ventures, societies, associations, clubs, trustees, trusts, or corporations; or any officers, agents, employees, or representatives thereof, in any capacity, acting either for him or herself, or for any other person, under designation, appointment, or otherwise pursuant to law.

J. "Premises" means any office, property, retail space, structure or portion thereof occupied for business use, the facilities and appurtenances in the structure, and the grounds, areas and facilities held out for the use of business.

K. "~~Safety Inspection Certificate~~Business License" is a license~~certificate~~ for a business, or occupation, at a specific premises acknowledging inspection for Uniform Safety Codes, or other ordinances and regulations, enacted for the purpose of protecting health, safety, and welfare of the public. The license~~certificate~~ is not intended, and shall not be used, to regulate or infringe upon the conduct of a business or profession and is not intended, and shall not be used, to regulate, infringe or prohibit the practice of religion or religious beliefs.

L. "Property Manager" means a "person" who rents or leases rental units, including but not limited to, multi-family dwellings, excluding hotels or motels.

M. "Square footage" is the total number of square feet contained within the exterior walls of a building, suite, office, or premises used in, or available for, the business operation.

N. "Temporary premises" means any buildings, structure, vehicles, or other mobile structures temporarily occupied for business which are without a foundation and permanent connection to City water and sewer service. A temporary ~~premises~~premise can exist for no more than ninety (90) calendar days in any twelve-month period. Temporary premises do not include sales booths, concession stands etc., which are operated in conjunction with a community sponsored event which is authorized by the City.

O. "Non-Resident Merchant" means any person who brings into temporary premises, a stock of goods, wares or articles of merchandise or notions or other articles of trade, and who solicits, sells, offers to sell, or exhibits for sale, such stock of goods, wares, articles of merchandise, notions, or other articles of trade.

P. "Year" for specific Special Business Licensess and Safety Inspection Certificate purposes, means a period of time of twelve (12) months commencing each year on January 1 and ending December 31 of the same year.

Q. "Non-Resident Service Contractor" is any person, not residing within the City limits of Great Falls, engaged or employed in the business of providing services for hire. This includes persons engaged in contract construction, painting and drywall, landscape installation and maintenance, janitorial, and service contractors of all kinds including computer technicians and copier maintenance.

R. "Uniform Safety Codes" as used herein, shall mean the most recent version of the International Building Code, International Fire Code, International Property Maintenance Code, in whole or in part, which have been adopted by the City of Great Falls and referenced in OCCGF Titles 15, 16 and Title 17.

S. "Alarm Agent Business License" is a license issued by Great Falls Fire RescuePlanning and Community Development to a person, business, occupation, or other entity engaged in selling, leasing, maintaining, servicing, repairing, altering, replacing, moving, or installing any alarm system (as defined in 5.3.6.010) or causing to be sold, leased, maintained, serviced, repaired, altered, replaced, moved, or installed any alarm system in, or on, any building, structure, or facility.

((Ord. 3233 , 2021; Ord. 3168, 2017).

5.1.020 Application of regulations.

A. A certificate and special Bbusiness Llicense or certificate shall be obtained in the manner prescribed herein for each branch establishment, including off-site warehouses, distributing plants, multi-family dwellings of four (4) or more units, or any location of the business engaged in, as if each such branch establishment or location were a separate business. However, on-site warehouses and distributing plants used in connection with and incidental to an authorized business shall not be deemed to be separate places of business or branch establishment.

B. No certificate or special license shall be required of any person for any mere delivery in the City of any property purchased or acquired in good faith from such person at the regular place of business outside the City where no intent by such person is shown to exist to evade the provisions of this chapter.

C. All family/group day care facilities and all -day care centers shall obtain a Safety Inspection CertificateBusiness License and shall supply copies of applicable Montana State Licenses to the Great Falls Fire Rescue Department. In home daycares shall obtain a Home Occupation License.

D. All independently owned and operated businesses located within a single building, shall each obtain a Business LicenseSafety Inspection Certificate.

(Ord. 3168, 2017).

5.1.030 Authority and Appeals.

A. Unless otherwise specified in this Title, if an application for a license, certificate, or permit is denied or revised in a way which is unacceptable to the applicant, the applicant may appeal the decision to the City Manager in writing within fifteen (15) calendar days. The City Manager or designee shall review the application and uphold, reverse, or revise the decision on the application. If applicant makes no such appeal, the initial determination shall stand.

B. If the City Manager upholds or revises the determination of the application for a license, certificate, or permit, the applicant may appeal the decision to the City Commission in writing within fifteen (15) calendar days. The Commission shall review the application in a public meeting and uphold, reverse or revise the decision on the application. If applicant makes no such appeal, the City Manager's determination will stand.

C. Unless otherwise specified in this Title, appeals to the City Commission of the denial, revocation or suspension of ~~Safety Inspection Certificates, Special B~~Business Licenses, Home Occupation Certificates, or other licenses or permits under this title shall comply with the provisions of 1.2.040.

(Ord. 3168, 2017).

5.1.040 Procedure for issuance of certificates, permits or special licenses.

A. ~~Safety inspection certificates~~Business Licenses shall be issued by the Great Falls Fire Rescue Department pursuant to the provisions of this Title.

B. Home Occupancy certificates, special licenses and other certificates, permits and licenses shall be issued by the Planning and Community Development Department pursuant to the provisions of this Title.

C. Prior to issuing a certificate, permit, or special B~~b~~usiness L~~l~~icense, the applicant shall:

1. Be in compliance with all Zoning and Uniform Safety Codes and have permanent water and sewer service provided by the City (non-resident licenses exempted);

2. Submit a completed application accompanied by the full amount of the applicable fee;

3. Be current in the payment of all City fees and assessments; and

4. Have no other outstanding obligations to the City.

D. The applicant may change location provided:

1. The applicant complies with all Zoning and Uniform Safety Codes; and

2. The applicant obtains a new certificate, permit, or special business license for the change of location.

E. If a ~~newly established~~ business is determined by GFFR staff to require a Business License~~safety inspection certificate~~, said business shall apply for a Business License ~~safety inspection certificate~~ and complete all the procedures pursuant to this section within 3~~6~~0 days of that determination. Failure to do so shall constitute a violation of Section 5.2.010 of this Title.

(Ord. 3168, 2017).

5.1.050 Certificate, Permit and special business license fees.

A. All certificate, permit or special business license fees shall be defined by resolution adopted by the City Commission. Such fees shall reasonably relate to the cost of issuing the certificate or special license and the additional cost of inspections.

B. New businesses, ~~excluding Non-Resident Merchants,~~ established within the last ninety (90) days of the calendar year shall not pay the initial annual renewal fee.

C. No rebate or refund of any certificate, permit, or special B~~b~~usiness L~~l~~icense fee, or part thereof, shall be made.

D. Offices or buildings that are owned and operated by the United States Government, The State of Montana, or Cascade County may be subject to inspection but are exempt from applicable fees under this Title. However, this exemption does not apply to privately owned businesses operating on exempt property.

(Ord. 3168, 2017).

5.1.060 Certificate, permits and special business license duration — renewal.

A. All certificates, permits or special business licenses issued pursuant to this Title shall expire on December 31 of the year in which such certificate, permit or special business license is issued, unless otherwise specified.

B. Failure to renew a certificate, permit or special business license and to remit all applicable fees within sixty (60) days after expiration shall result in immediate revocation of said certificate, permit, or license.

C. Each day that any violation of this chapter occurs or continues may constitute a separate offense and may be punishable as a separate violation.

(Ord. 3168, 2017).

5.1.070 Late charge.

Failure to renew a ~~the safety inspection certificate or special~~ B~~b~~usiness L~~l~~icense or certificate by December 31 of the year in which such certificate, permit, or special B~~b~~usiness L~~l~~icense is issued, shall result in a delinquent charge as determined by Commission resolution.

(Ord. 3168, 2017).

5.1.080 Duties of license, permit or certificate holder.

A. Every license, permit, or certificate holder under this Title shall permit all reasonable inspections of the business premises by public authorities to carry out the intent of this Title.

B. Every licensee, permit, or certificate holder under this Title shall post the certificate or special license on the premises or carried on the person where an individual license is required.

C. The certificate, permit, or license holder may transfer the certificate, permit or ~~special~~ B~~b~~usiness L~~l~~icense to another business, operating at the same location, in accordance with established City procedures. The new owner shall complete a new business license application and pay the transfer of ownership fee.

(Ord. 3168, 2017).

5.1.090 Certificate, permit or special license — revocation or suspension.

A. The certificate, permit, or special license may be revoked or suspended when the license, permit or certificate holder violates this Title.

B. The following procedure will be followed in revoking or suspending a certificate or license:

1. A written notice shall be mailed or personally delivered to the license, permit, or certificate holder, by the City staff, at least fifteen (15) calendar days prior to revocation or suspension;
2. The notice shall state the reason(s) for the action;
3. Within fifteen (15) calendar days of the date of the written notice, the license, permit, or certificate holder may request a review of the proposed action;
4. When a review is requested, a meeting shall be set between City staff, the City Manager or designee, and the requesting license, permit, or certificate holder; and
5. Following the review, the City Manager or designee will determine, in writing if a suspension or revocation is warranted.

C. If conditions are determined to cause an immediate threat to health or safety, the City Manager or designee shall immediately suspend the certificate or special business license until such condition is remedied.

(Ord. 3168, 2017).

5.1.100 Appeal.

Except as stated in this Title, all appeals of a suspension or revocation of a license, permit or certificate granted, shall be filed in writing by any license, permit, or certificate holder to the City Commission within fifteen (15) calendar days of the date of the written determination to suspend or revoke the certificate, permit or license.

(Ord. 3168, 2017).

5.1.110 Severability.

If any part of this Title is for any reason held to be invalid, or unconstitutional, such decision shall not affect the validity, or constitutionality of the remaining portions thereof.

(Ord. 3168, 2017).

Chapter 2 ~~SAFETY INSPECTION CERTIFICATE~~BUSINESS LICENSE AND HOME OCCUPATION CERTIFICATE

Sections:

5.2.010 Business License~~Safety inspection certificate~~.

A. ~~A.~~ Every business in the jurisdictional limits of the City of Great Falls shall be required to obtain a Business License to ensure that the business and commercial building comply with Uniform Safety Codes and other ordinances and regulations enacted for the purpose of protecting the health, safety, and welfare of the public.

B. If your business is located outside the city limits or you have a Business License from another city and you are conducting business or providing a service within the incorporated City limits, a Business License shall be required. Non-resident service contractors shall comply with requirements established by Planning and Community Development .

C. A Business License fee is authorized.

D. In any multiple business, suite/office structure:

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1. Each independently owned and operated business with a separate business address, within said building or structure, shall be required to obtain a license; and
2. The building owner/agent shall obtain a certificate for indoor commonly accessed areas.

E. For multi-family dwelling units of four (4) or more units, only the indoor commonly accessed areas shall require a license.

F. Any person or business brewing, selling, or dispensing beer, wine, liquor, or other alcoholic beverages must obtain a Business License, there is an additional fee associated with the sale of alcoholic beverages.
1. The fee will based off the type of alcohol license issued. Such as beer only, beer and wine, or all-alcoholic beverages. These additional fees can be found in the GFFR fee schedule.
2. Home brewing for personal consumption does not apply.

G. All cannabis associated businesses shall obtain a Business License, an additional fee is associated with the sale of cannabis. This additional fee can be found in the GFFR fee schedule.

H. Mobile food vendors shall obtain a Business License.
1. This applies to persons vending food from pushcarts, vehicles, trailers, or other readily mobile sources to customers within the City limits.

I. Non-resident merchants shall obtain a Business License in order to stock goods, wares or articles of merchandise or notions or other articles of trade, and to solicits, sell, offers to sell, or exhibits for sale, such stock of goods, wares, articles of merchandise, notions, or other articles of trade.

J. If a business, apartment building of four (4) or more units, or multiple business, suite/office is sold, the new owner shall apply for a license in their name. This includes if the business name is not changing.

K. Businesses operated from the home require a Home Occupation License, which is administered by the City of Great Falls Planning and Community Development Office.

L. It is unlawful for any person to operate a business within the Incorporated City limits without a valid Business License. A violation of this section is punishable by a term not to exceed 6 months in jail, a fine of not more than $500, or both. Additionally, the Court within its discretion, may order the business to cease all operation until it complies with this Title.

M. A business operating within the incorporated City limits without a valid Business Licenses, is hereby declared a Nuisance pursuant to OCCGF Title 8, Chapter 49.

~~Every business, in a building or office, in the jurisdictional limits of the City of Great Falls shall be required to obtain a Safety Inspection Certificate to ensure that the building, store, or office complies with applicable building, fire, or safety codes, and other ordinances and regulations that have been enacted by the City for the purpose of protecting the health, safety, and welfare of the public.~~

~~B. A Safety Inspection Certificate fee is authorized.~~

~~C. In any multiple business, suite/office structure:~~

~~1. Each independently owned and operated business with a separate business address, within said building or structure, shall be required to obtain a certificate; and~~

~~2. The building owner/agent shall obtain a certificate for indoor commonly accessed areas.~~

~~D. For multi-family dwelling units of four (4) or more units, only the indoor commonly accessed areas shall require a certificate.~~

~~E. It is unlawful for any person to operate a business within the incorporated City limits without a valid Safety Inspection Certificate. A violation of this section is punishable by a term not to exceed 6 months in jail, a fine of not more than $500, or both. Additionally, the Court within its discretion, may order the business to cease all operation until it complies with this Title.~~

~~F. A business operating within the incorporated City limits without a valid Safety Inspection Certificate, is hereby declared a Nuisance pursuant to OCCGF Title 8, Chapter 49.~~

~~G. In addition to any penalties listed in this Chapter, the City may refer any outstanding delinquent Safety Inspection Certificate Fees, pursuant to this Chapter, to collections by a collection agency authorized to conduct business in Montana.~~

~~(Ord. 3227 , 2021; Ord. 3168, 2017).~~

5.2.020 Home occupation certificate.

The establishment of a Home Occupation shall require a certificate issued by the City of Great Falls through the Planning and Community Development Department. A Safety Inspection Certificate is not required for the issuance of a Home Occupation Certificate.

(Ord. 3168, 2017).

5.2.030 Issuance — revocation of certificate.

A. Applications for Home Occupation Certificates shall include:

1. A site plan indicating what portion of the dwelling will be used for the business; and
2. A complete description of the type of business to be conducted.

B. The Home Occupation Certificate holder may appeal the denial or revocation of a Home Occupation Certificate to the Great Falls Board of Adjustment pursuant to Title 17 of this Code.

C. Review and/or revocation of the Home Occupation certificate shall occur:

1. Upon receipt of a written request for revocation from any two (2) adjacent property owners, a hearing shall be held by the Board of Adjustment. The finding of the Board of Adjustment shall be presented to the City Commission and, unless a majority of the City Commissioners disagree, shall become binding sixty (60) days after presentation to the City Commission; or
2. Upon verification of any violation of this chapter, the City shall review the certificate in question. Upon the finding that the Home Occupation is no longer compatible with the neighborhood, violates the terms of the Home Occupation Certificate, the said Home Occupation Certificate shall be revoked.

D. It is unlawful for any person to operate a business, in a dwelling, within the incorporated City limits of Great Falls without a valid Home Occupation Certificate. A violation of this section is punishable by a term not to exceed 6 months in jail, a fine of not more than $500, or both.

E. A business operating, within a dwelling, within the incorporated City limits and without a valid Home Occupation Certificate, is hereby declared a Nuisance pursuant to OCCGF Title 8, Chapter 49.

(Ord. 3168, 2017).

5.2.040 Home occupation requirements.

Home Occupations may be permitted wherein the use meets the following requirements and the applicant provides proof of said compliance:

A. **Appearance.** The activity must be conducted in a manner so as not to give an outward appearance, nor manifest any characteristics of, a business in the ordinary meaning of the terms, nor shall it create undue amounts of traffic which would infringe upon the right of neighboring residents to enjoy the peaceful occupancy of their home.

B. **Employees.** That portion of the Home Occupation conducted at the dwelling unit must be carried on by at least one (1) resident of the dwelling unit. In addition, non-resident employees are permitted where the aggregate hours worked by those non-resident employees do not exceed forty (40) hours per week and when no more than two (2) employees are present at one (1) time.

C. **Location.** For Home Occupations in which services are rendered at the customer's location, the use of the dwelling unit shall be limited to the office portion of the business.

D. **Secondary use.** The Home Occupation must be incidental and secondary to the use of the dwelling unit as a residence.

E. **Area.** A maximum of thirty (30) percent of the dwelling may be dedicated to the Home Occupation.

F. **Exterior Use.** No exterior storage of material, equipment, or any variation from the residential character of the principal building shall be permitted.

G. **Noise, etc.** No offensive noise, vibration, smoke, dust, odor, heat or glare shall be produced by the Home Occupation activities permitted by the Certificate.

H. **Delivery.** No material or commodities shall be delivered to or from the residence which are of such bulk or quantity as to create undesirable traffic or congestion.

I. **Weight.** No materials or commodities shall be placed within the building which exceed the allowable floor loading of forty (40) pounds per square foot.

J. **Parking.** No parking of customers' vehicles shall be permitted in a manner of frequency so as to cause a disturbance or inconvenience to neighboring residents or so as to necessitate off-street parking. Business vehicles shall not exceed one (1) ton rated capacity, shall not utilize on-street parking, and shall be parked on the premises identified in the Home Occupation Certificate.

K. **Sign.** No exterior sign or display shall be permitted, except for one (1) non-illuminated name plate, or Home Occupation sign. Signs for Home Occupations allowed in residential homes are allowed one (1) non-illuminated sign, no larger than six (6) square feet in area per face and six (6) feet in height. Signs must be placed a minimum of twelve (12) feet from the back of the curb, and in compliance with 17.32.160.

L. **Garage.** The Home Occupation cannot be conducted upon the area provided to fulfill the off-street parking requirements for the dwelling unit on the lot, including but not limited to garage space.

(Ord. 3168, 2017).

Chapter 3 SPECIAL BUSINESS AND CONSTRUCTION LICENSES, CERTIFICATES, AND PERMITS

Articles:

Article 1 MECHANICALLY-OPERATED DEVICES DEPICTING SEXUAL ACTIVITIES

Sections:

5.3.1.010 Purpose.

The purpose of this article is to recognize the fact that the operation of mechanical amusement devices which depict or display specified sexual activities or specified anatomical areas result in increased enforcement programs for the City, and additional expense to the City, justifying a higher license fee. No license will be issued pursuant to this chapter to any person, organization, or entity that has an outstanding obligation or debt to the City.

(Ord. 3168, 2017).

5.3.1.020 Mechanically-operated devices depicting sexual activities.

Definitions. The following words and phrases when used in this article shall have the following meanings:

A. "Device" shall include any machine which, upon the insertion of payment of consideration, in any form, directly or indirectly depicts, displays, or projects pictures, photographs or other visual images of anatomical areas or specified sexual activities.

B. "Specified Anatomical Areas" include:

   1. Less than completely and opaquely covered: human genitals, pubic region, buttock, or female breast below a point immediately above the top of areola; or

   2. Human male genitals, even if completely and opaquely covered.

C. "Specified Sexual Activities" include:

   1. Human genitals in a state of sexual stimulation or arousal;

   2. Acts of human masturbation, sexual intercourse, sodomy; or,

   3. Fondling of human genitals, pubic region, buttock, or female breast.

D. The license application shall include, but not be limited to, a complete list of the devices owned by the person or business subject to this licensing with an indication thereon of the location of each machine.

(Ord. 3168, 2017).

5.3.1.030 License required.

A. It shall be unlawful for any business to have, or operate, devices depicting sexual activities for which a license or permit is required without such license being first procured and kept in effect at all such times as required by this chapter.

B. Any violation of this section is a misdemeanor punishable by a term of not more than six (6) months in jail, a fine not to exceed $500, or both.

C. The Court, in its discretion may order the destruction of any device depicting sexual activities in violation of this section.

D. Any business that has or operates devices depicting sexual activities in violation of this section, is hereby by declared a Nuisance pursuant to OCCGF Title 8, Chapter 49.

(Ord. 3168, 2017).

Article 2 COMMERCIAL GARBAGE LICENSE

Sections:

5.3.2.010 Commercial garbage license.

A. No person, or business, shall engage in the business of collecting or removing garbage from any business or residence in the City without first obtaining a commercial garbage license.

B. All equipment used by the collector under a City commercial garbage license for collection and hauling of refuse, shall be constructed and maintained to prevent leakage, spillage, or overflow. All portions of the collection vehicle shall be kept clean and sanitary, and shall be clearly identified by assigned equipment number and with the firm and local telephone number affixed thereto.

C. A commercial garbage collector shall have applied for, and received, the proper Montana Public Service Commission (PSC) permit.

D. A current list of all services provided shall be submitted to the City Public Works Department, containing the following information:

1. The names and addresses of each residence served;
2. The names and addresses of each commercial establishment, including multifamily dwellings containing three (3) or more separate dwelling units;
3. The number and size of the containers at each commercial site;
4. The number of times each container is picked up per week; and
5. An estimate of the weekly volume of refuse removed from the site which is outside of regular containers.

D. The City reserves the right to deny, or revoke, a commercial garbage license for just cause, upon written complaint, with regard to the conduct of the service provider, quality of services rendered, or business and/or marketing practices.

(Ord. 3168, 2017).

Article 3 PAWNSHOPS, SECONDHAND STORES AND VALUABLE ARTICLE DEALERS

5.3.3.010 Definitions.

The following words and phrases when used in this article shall have the following meanings:

A. "Customer" means any person or entity who deposits, pledges, sells, trades, barters, consigns, or exchanges personal property, secondhand goods, wares, merchandise, or other valuable things to an operator as set forth in this section.

B. The term "Operator" includes the following:

1. "Pawnbroker" which means any person or entity who loans money on deposit, pledge of personal property or any valuable thing, or who deals in the purchasing of personal property, or valuable things, on condition of selling the same back at a stipulated price, whether he does the same for himself or as an agent of some person or firm or corporation, who by any means, method, or device loans money for personal property when the same is deposited for security or is deposited for any other purpose; and
2. "Secondhand Dealer" or "Valuable Article Dealer" which means any person or entity who, within the City, as a business; engages in the purchase, sale, trade, barter, consignment, recycling, or

exchange of secondhand goods, wares or merchandise; or any person who keeps any store, shop, room, or place where secondhand goods, wares, or merchandise of any kind or description are bought, sold, traded, bartered, consigned, recycled, or exchanged is defined as a secondhand dealer or valuable article dealer within the meaning of this chapter; provided, however, that this chapter shall not apply to bona fide trade or turn-ins of secondhand goods, wares or merchandise or other goods where no cash is transferred or paid by the merchant.

(Ord. 3168, 2017).

5.3.3.020 Register required.

Any operator who engages in the activities set forth in 5.3.3.010 shall keep a legible written register, or record, of all property purchased or taken under that section, along with:

A. A description of each article, including, but not limited to, identification number, serial number, model number, brand name, or other identification marks on such article; and a description by weight and design of precious and semi-precious metals or stones;

B. The customer's name and date of birth;

C. The customer's current address; and

D. The customer's identification from one of the following:

   1. A valid state identification card;

   2. A valid state driver's license;

   3. A military identification card;

   4. A valid passport;

   5. An alien registration card; or

   6. An official identification document lawfully issued by a state or federal government.

E. Records shall be retained for a period of two (2) years from the initial transaction. Such register shall be subject to examination by the Great Falls Police Department (GFPD), or other state or federal law enforcement agency, at any and all times.

F. On a periodic basis, no later than 5:00 p.m. on Friday of each week's transactions, every operator shall file, upload, or record all registers or records of transactions, to an electronic database as designated by the Chief of Police or agent of the GFPD. If the transactions have not been entered into electronic database according to this section, the GFPD shall stop any further transactions by the operator, until the operator is in compliance.

(Ord. 3168, 2017).

5.3.3.030 Duration articles must be held.

For seven (7) days following the electronic filing of the register or record of a transaction into the GFPD database under this section, operators shall not dispose of the property purchased or taken, alter the property from the form in which it was received, or transfer the property to another location.

(Ord. 3168, 2017).

5.3.3.040 Violation; penalty.

A. Subject to subsection (B.) of this section, each operator who violates this chapter shall be fined one hundred dollars ($100.00) for each item received by operator, that the customer illegally obtained, or did not have authority to deposit, pledge, sell, trade, barter, consign, or exchange, or otherwise provide to operator.

B. This fine will be waived if the operator has properly and timely reported the item or items into the police database.

C. All fines collected under this section will be directed to the Police Department for maintenance of the designated database.

(Ord. 3168, 2017).

5.3.3.050 Extensions; exclusions.

The Chief of Police, or designee, may for good cause shown, grant an operator a written extension to the deadlines herein, or an exclusion from these requirements based upon the type or value of property.

(Ord. 3168, 2017).

Article 4 ALCOHOLIC BEVERAGES

Sections:

5.3.4.010 Definitions.

The following words and phrases when used in this article shall have the following meanings:

A. "Alcohol" means ethyl alcohol, also called ethanol, or the hydrated oxide of ethyl.

B. "Alcoholic Beverage" means a compound produced and sold for human consumption as a drink that contains more than one-half of one (0.5) percent of alcohol by volume;

C. "Malt Beverage" means an alcoholic beverage made by the fermentation of an infusion or decoction, or a combination of both, in potable brewing water, of malted barley with or without hops or their parts or their products and with or without other malted cereals and with or without the addition of un-malted or prepared cereals, other carbohydrates, or products prepared from carbohydrates and with or without other wholesome products suitable for human food consumption.

D. "Beer" means:

1. an alcoholic malt beverage containing not more than 8.75% of alcohol by volume; or

2. an alcoholic beverage containing not more than 14% alcohol by volume:

    i. that is made by the alcoholic fermentation of an infusion or decoction, or a combination of both, in potable brewing water, of malted cereal grain; and

    ii. in which the sugars used for fermentation of the alcoholic beverage are at least seventy-five (75) percent derived from malted cereal grain measured as a percentage of the total dry weight of the fermentable ingredients.

E. "License" means a license issued by this City to a qualified person, under which it is lawful either for the licensee to brew, sell or dispense beer or to sell and dispense liquor, respectively, as provided in this chapter.

F. "Premises" means the building or specific portion of any building in which the liquor and/or beer business is conducted and those areas in which the retailer operates a sidewalk café, open-air restaurant or tavern outside of and adjacent to the licensed building and to which patrons are permitted free access from said building. Where a retailer conducts as a single business enterprise two (2) or more bars located on the same premises and which have such intercommunication as will enable patrons to move freely from one (1) bar to another without leaving the premises, the various bars shall be regarded as but one (1) premises for which but one (1) license is required. In all other cases, licenses must be obtained for each bar even though operated in the same building with another bar.

G. "Liquor" means an alcoholic beverage except beer and wine. The term includes a caffeinated or stimulant-enhanced malt beverage.

H. "Retailer" means any person engaged in the sale and distribution of beer, either on draft or in bottles, to the public.

I. "Wine" means any alcoholic beverage made from or containing the normal alcoholic fermentation of the juice of sound, ripe fruit or other agricultural products without addition or abstraction, except as may occur in the usual cellar treatment of clarifying and aging and that contains more than one-half of one (0.5) percent but not more than twenty-four (24) percent of alcohol by volume. Wine may be ameliorated to correct natural deficiencies, sweetened, and fortified in accordance with applicable federal regulations and the customs and practices of the industry. Other alcoholic beverages not defined in this section but made in the manner of wine and labeled and sold as wine in accordance with federal regulations are also wine.

(Ord. 3168, 2017).

5.3.4.020 BusinessAlcoholic beverage Llicense required.

A. Any person or business brewing, selling, or dispensing beer, wine, liquor, or other alcoholic beverage must obtain a City Businessalcoholic beverage Llicense in addition to other permits or licenses which may be required.

B. Such license shall authorize the conduct of business under one of the following specific categories:

1. beer;
2. beer and wine; or
3. all-alcoholic beverages.

C. This section does not pertain to individuals' home brewing for personal consumption.

(Ord. 3168, 2017).

5.3.4.030 Special event alcoholic beverage license required.

A Special Event Alcoholic Beverage License or Permit is required in addition to the State's special permit or license for beer or beer and wine. The Special Alcoholic Beverage License shall be in effect for the period established by the State and will expire at the end of that period.

(Ord. 3168, 2017).

5.3.4.040 Catering license required.

Any person or business providing off-premises food or non-alcoholic beverages to third parties must obtain a City Catering license in addition to other permits or licenses required under this Title. This does not pertain to individuals' home food or non-alcoholic beverage preparation for personal consumption.

(Ord. 3168, 2017).

5.3.4.050 Additional Catering endorsement required.

A. An Alcohol Beverage license, or a Special Event Alcoholic Beverage License, and a Catering License or Endorsement are required for the conduct of off-premise alcoholic beverage catering, in addition to other required permits or licenses;

B. Any alcoholic beverages licensee may obtain an Special Event Alcoholic Beverage License or Permit with a Catering Endorsement, as applicable, for all the catering and/or sale of alcoholic beverages, to persons attending a special event, upon premises within the City not otherwise licensed for the sale of alcoholic beverages;

C. Any Alcoholic Beverages licensee and/or Special Event Alcoholic Beverage licensee, with an Alcoholic Catering Endorsement, shall at least seventy-two (72) hours prior to each special event, submit a license application describing the location of the event, the nature of the event, and the period during which the event is to be held; and

D. Special Event Alcoholic and/or Catering Licensees will indemnify, defend and hold harmless the City from any and all claims, damages, losses and expenses arising from the event. The Licensee shall be required to carry insurance for comprehensive general liability, automobile liability and designated premises in the amount of one million dollars ($1,000,000.00) per occurrence and two million dollars ($2,000,000.00) aggregate, and list the City as an additional named insured under the policy. Documentation of such insurance must be provided to the City at least seventy-two (72) hours prior to the event.

(Ord. 3168, 2017).

5.3.4.060 Teen night license.

A license will be issued by the Planning and Community Development Department, or other authorized designee, to any person for any premises within the City, where beer or liquor is sold, for the purpose of establishing and conducting a teen night where:

A. Any and all Alcoholic Beverages on the premises have been stored away out of sight and shall remain locked and secured for so long as the premises are open as a teen night;

B. All signs advertising or referencing alcohol shall be removed or covered when the premises is open as a teen night;

C. The only patrons permitted on the premises other than the proprietor, his employees, and parents of patrons shall be individuals verifying identification through current high school identification and/or driver's license cards between 6:00 p.m. and thirty (30) minutes prior to curfew and anyone verifying their age over eighteen (18) after curfew on designated days of the week;

D. Registration of the name, age, and address of the licensee's employees (a minimum of four (4)) who shall be responsible for security of the premises including parking lots to be patrolled a minimum of three (3) times per hour while the premises is open as a teen night, and who shall ensure that any and all dangerous drugs as defined by the Montana Criminal Code, Alcoholic Beverages, weapons, or any other dangerous substances are excluded from the premises except Alcoholic Beverages that may have otherwise been locked away and secured thereon.

E. Anyone under the influence of drugs or alcohol shall be excluded from the premises. Where any violations of this Code or laws of the State of Montana are observed, security personnel shall immediately notify the GFPD.

F. For so long as the premises is open as a teen night, smoking of tobacco or vapor products as defined under the Montana Code Annotated, including Mont. Code Ann. §16-11-302, shall be prohibited on the premises, and notice thereof shall be conspicuously posted.

G. If an establishment is unable to abide by these provisions, the City teen night license may be revoked in accordance with licensing procedures.

(Ord. 3168, 2017).

Article 5 NON-RESIDENT VENDOR LICENSE

Sections:

5.3.5.010 Non-resident vendor business licenselicense required.

A. Each individual engaging in Non-Resident Vendor who is based outside the City, who conducts business or commercial enterprise within the City, must first obtain a BusinessNon-Resident Vendor LLicense. The BusinessNon-Resident Vendor LLicense must be obtained prior to soliciting any customer or offering any goods or products for sale.

B. No vendor shall park a vehicle, or any other movable temporary device, on any public street, alley, or private lot for more than four (4) hours in any eight-hour period at one (1) location. The parking of a vehicle, or other moveable device within three hundred (300) feet of the original location is considered one (1) location.

C. The Business Non-resident Vendor LLicense can be obtained from the Great Falls Fire Rescue Planning and Community Development Department during regular working hours.

D. A short-term Non-Resident Vendor Business LLicense may be granted on a short-term basis and shall be good for one (1) week from the date of issuance. A long -term license is good from the issue date through December 31, of the same year, and may be renewed upon its expiration.

E. The City reserves the right to deny or revoke a license, upon receiving written citizen complaints regarding the vendor, merchandise, or practices.

(Ord. 3168, 2017).

5.3.5.020 Non-resident merchant special business license required.

A. Any individual or entity engaged in any business within the City that is defined or administratively determined to be classified Non-Resident Merchant must first obtain a Non-Resident Merchant special BBusiness LLicense from the City of Great Falls Fire Rescue. This special BBusiness LLicense must be obtained prior to soliciting any customer, offering any merchandise or products for sale, or bringing any stock of goods, wares, or other articles of trade to a temporary premise.

B. A Non-Resident Merchant may apply for a Non-Resident Merchant special BBusiness LLicense from the Great Falls Fire RescuePlanning and Community Development Department during normal business hours.

C. The license is valid for a period of six (6) months and may be renewed once thereafter during in any twelve-month period.

D. The City reserves the right to deny or revoke, upon written complaint, a Non-Resident Merchant ~~special~~ business license for just cause with regard to the conduct of the merchant, suitability of any merchandise, or business and/or marketing practices.

(Ord. 3168, 2017).

5.3.5.030 Non-resident service contractor special B~~b~~usiness L~~l~~icense required.

A. Any individual or entity engaged in any business within the City that is defined or administratively determined to be classified Non-Resident Service Contractor, must first obtain a ~~Non-Resident Service Contractor special~~Certificate from Planning and Community Development and must have a business license to operating within the CIty~~ license from the City~~. This~~ special~~ B~~b~~usiness L~~l~~icense must be obtained prior to soliciting any customer, offering or advertising any service, or performing any such service.

B. A Non-Resident Service Contractor may apply for a~~ Non-Resident Service Contractor special~~ B~~b~~usiness L~~l~~icense from the Planning and Community Development Department during normal business hours.

C. This Non-Resident Service Contractor~~ special~~ business license is valid from the date of issuance to December 31 and may be renewed upon its expiration.

D. The City reserves the right to deny, or revoke, a Non-Resident Service Contractor license for just cause, upon written complaint, with regard to the conduct of the service contractor, quality of services rendered, or business and/or marketing practices.

(Ord. 3168, 2017).

Article 6 ALARMS AND ALARM SYSTEMS[2]

Sections:

5.3.6.010 Definitions.

Unless otherwise specified, the following words and phrases when used in this article shall have the following meanings:

A. "Alarm agent" means any person who is directly or indirectly employed by an alarm business, whose duties include any of the following: selling, maintaining, leasing, servicing, repairing, altering, replacing, moving or installing any alarm system on or in any building, structure or facility.

B. "Alarm business" means any individual, partnership, corporation, or other entity engaged in selling, leasing, maintaining, servicing, repairing, altering, replacing, moving, or installing any alarm system or causing to be sold, leased, maintained, serviced, repaired, altered, replaced, moved, or installed any alarm system in, or on, any building, structure, or facility.

C. "Alarm system" means any mechanical or electrical device which is designed, or used for:

[2]Ord. 3233 , § 1(Exh. A), adopted Dec. 7, 2021, amended the title of Art. 6 to read as herein set out. The former Art. 6 title pertained to false alarms.

i. the detection of an unauthorized entry into or fire or hazardous condition within a building, structure, or facility; and/or

ii. alerting others of the commission of an unlawful act within a building, structure, or facility;

and which emits a sound or transmits a signal or message when actuated. Devices that are not designed or used to register alarms that are audible, visible or perceptible outside of the protected building, structure, or facility are not included within this definition, nor are auxiliary devices installed by a telephone or telecommunication company to protect company systems which might be damaged or disrupted by the use of an alarm system. Alarm systems include, but are not limited to:

1. direct dial telephone devices; and

2. audible alarms and proprietor alarms.

D. "Audible alarm" means a device designed for the detection of unauthorized entry, fire or hazardous conditions on premises which generates an audible sound on the premises when it is actuated.

E. "False alarm" means an alarm signal actuated by error, mistake, inadvertence, negligence, or unintentional act necessitating response by the public safety personnel, including but not limited to Great Falls Police Department, Great Falls Fire Rescue, and/or ambulance services, including alarms caused by the malfunction of the alarm system, except the following:

1. alarms caused by repair of telephone or communication equipment or lines;

2. alarms caused by earthquakes, flood, windstorm, thunder, and lightning;

3. alarms caused by an attempted illegal entry or analogous causes of which there is visible evidence; and

4. alarms caused by power outages.

F. "Proprietor alarm" means an alarm which is not serviced by an alarm business.

G. "Subscriber" means any person who purchases, leases, contracts for, or otherwise obtains an alarm system or for the servicing maintenance of an alarm system from an alarm business.

(Ord. 3233 , 2021; Ord. 3168, 2017).

5.3.6.020 Audible alarm requirements.

A. Every person maintaining an audible alarm shall notify the Police Department and/or Great Falls Fire Rescue with names and telephone numbers of the persons to be notified to render repairs of service, and secure the premises, during any hour of the day or night that the alarm is actuated.

B. Whenever any change occurs relating to the required written information, the applicant shall give written notice thereof to the Great Falls Police Department and/or Great Falls Fire Rescue of such change.

(Ord. 3233 , 2021; Ord. 3168, 2017).

5.3.6.030 Alarm Agent business license required.

A. All persons engaged in alarm business to repair, service, alter, replace, remove, design, sell, lease, maintain, or install alarm systems, shall obtain an BusinessAlarm Agent Llicense from Great Falls Fire RescuePlanning and Community Development in accordance with the provisions of this title.

B. The Alarm Agent licensee shall have in their possession an BusinessAlarm Agent Llicense while engaged in alarm related business or activities.

(Ord. 3233 , 2021; Ord. 3168, 2017).

5.3.6.040 Exemptions.

A. The provisions of this chapter are not applicable to audible alarms affixed to automobiles.

B. The provisions of this chapter do not include a person who engages in the manufacture for sale of an alarm system from a fixed location, and who neither visits the location where the alarm system is to be installed nor designs the scheme for physical location and installation of the alarm system in a specific location.

(Ord. 3168, 2017).

5.3.6.050 Penalty.

A. Knowingly activating a false alarm when no unauthorized entry, fire or hazardous conditions exist is a violation of the provisions of Mont. Code Ann. 45-7-204, punishable by a fine not to exceed five hundred dollars ($500.00) or imprisonment for a term not to exceed six (6) months, or both.

B. A first or second false alarm during any three hundred sixty-five (365) day period will result in a written notice being provided to the owner, licensee and/or other person responsible for the premises. A third or subsequent false alarm during any three hundred sixty-five (365) day period will result in an assessed administrative fee of one hundred dollars ($250.00100.00) being imposed on the owner, licensee, and/or other person responsible for the premises.

C. Any fee under this article that remains unpaid for thirty (30) days or more is deemed delinquent and may be assessed against the premises as a special charge for current service or, in addition to any penalties listed in this Chapter, the City may refer any outstanding fees, pursuant to this Chapter, to collections by a collection agency authorized to conduct business in Montana.

D. This penalty section shall not be applicable to residential fire alarms in one or two-family dwellings.

(Ord. 3233 , 2021; Ord. 3168, 2017).

Article 7 EMERGENCY MEDICAL SERVICES LICENSES

Sections:

5.3.7.010 Definitions.

Unless otherwise specified, the following words and phrases when used in this article shall have the following meanings:

A. "Ambulance" means a privately or publicly owned motor vehicle, or aircraft that is maintained and used for the transportation of medical patients.

B. "Emergency Medical Services" means a pre-hospital emergency medical transportation or treatment service provided by an ambulance or similar vehicle.

C. "License Certificate" means the City Emergency Medical Services License issued, or renewed, to any person engaging in the ambulance service business. A new Emergency Medical Services license shall be issued only after a favorable determination of public convenience and necessity by the City Commission.

D. "License Year" means a fiscal year from July 1 through June 30 of each calendar year.

E. "Patient" means an individual who is sick, injured, wounded, or otherwise incapacitated. The term does not include a person who is non-ambulatory, and who needs transportation assistance solely because that person is confined to a wheel chair as the person's usual means of mobility.

F. "Person" means an individual, firm, partnership, association, corporation, company, group of individuals acting together for a common purpose, or any other organization of any kind.

G. "Public Convenience and Necessity" means qualified, fit, able, and willing to perform and provide emergency medical service fitting and suited to serve the public need within the City without substantially or significantly adversely impacting the public interest in the overall general provision of the emergency medical service within the City.

(Ord. 3168, 2017).

5.3.7.020 License required.

A. No person shall conduct or operate an emergency medical service within the City without first obtaining an Emergency Medical Services license as provided in this chapter.

B. All Emergency Medical Services licenses shall be valid for a City license year, or for the remainder thereof. An Emergency Medical Services license shall expire at the conclusion of each licensure year, and shall be renewable subject to the ability to meet the standards set by the City and the State Department of Health and Human Services, as to fitness and ability to provide emergency medical services.

C. No Emergency Medical Services license shall be issued under this chapter, to any new applicant, unless the City Commission shall, after conducting a public hearing and review, finds that another ambulance service is in the public interest, for the public convenience and necessity, and that the applicant is fit, willing, and able to perform such public transportation, and to operate in compliance with Montana state law and the provisions of this chapter.

D. If the City Commission finds that another ambulance service would be in the public interest, the City Commission shall authorize the issuance of an Emergency Medical Services License certificate of public convenience and necessity stating the name and address of the applicant, the location of the emergency medical service and the date of the issuance. If the City Commission does not find that public convenience and necessity would benefit from another emergency medical service provider, the application shall be denied. Existing emergency medical services providers may continue to operate within the City, provided they comply with the provisions of this chapter and are in compliance with Montana state law.

E. There must be paid to the City, with each application for, or renewal of, an Emergency Medical Services license, a license fee that shall be set by City Commission resolution.

F. An Emergency Medical Services license is not transferable.

G. An Emergency Medical Services license is non-exclusive.

(Ord. 3168, 2017).

5.3.7.030 Criteria for license.

Any person desiring to obtain an Emergency Medical Services license required by this chapter shall demonstrate the ability to meet the requirements of Title 8, Chapter 9 of this Code.

(Ord. 3168, 2017).

5.3.7.040 Revocation of license.

The City may revoke an Emergency Medical Services license, if it finds that the licensee has:

A. Violated any provision of this chapter or of the rules promulgated by the Montana Department of Health and Human Services or the Board of Medical Examiners, as contained in the Administrative Rules of Montana, or violation of policy, rules and procedure as outlined in the City of Great Falls Emergency Communications Center Policy Manual; and

B. Failed or refused to remedy or correct the violation within the time and in the manner directed by the City.

(Ord. 3168, 2017).

5.3.7.050 Notice and hearing required.

A. The City may deny or revoke an Emergency Medical Services license subject to:

   1. delivery to the applicant or licensee of a written statement of the grounds for denial or revocation of the subject license; and

   2. the opportunity for the applicant or licensee to answer at a hearing before the City Commission to show cause, if any, why the license should not be denied or revoked.

B. Within ten (10) days of the written statement of grounds for denial or revocation, any applicant or licensee desiring a hearing before the City Commission shall make written application to the City Clerk's office requesting a stating the reasons for the applicant or licensee's request.

(Ord. 3168, 2017).

5.3.7.060 Exemptions.

The provisions and requirements of this chapter shall not apply to:

A. The Great Falls Fire Rescue Department, except as provided in Montana state licensing requirements from the State's Board of Medical Examiners and the Department of Health and Environmental Services;

B. Any person providing emergency medical services outside the City, who in the course of providing such services, transports a patient from outside the City into, or through, the City; and

C. Any person providing emergency medical services within the City, who is providing such services at the request of the City, pursuant to a written mutual aid agreement, between the City and the person.

(Ord. 3168, 2017).

Article 8 PLUMBING CONTRACTOR'S LICENSE

Sections:

5.3.8.010 Plumbing contractor licensing.

Any person, firm, corporation, or other entity who engages in the business of installation, alteration, maintenance, or repair of plumbing and drainage systems is required to have a plumbing contractor's license.

(Ord. 3168, 2017).

5.3.8.020 Licensing application.

An applicant for a plumbing contractor's license shall show evidence that the applicant, or at least one (1) member of the firm or corporation, is the holder of a current master plumber's license issued by the State of Montana.

(Ord. 3168, 2017).

5.3.8.030 Insurance and bond.

All applicants for licensing shall file with the Planning and Community Development Department a commercial general liability insurance policy issued by an insurance carrier authorized to do business in the State, with limits established by City Commission resolution. Additionally, a license bond in the amount established by City Commission resolution shall be supplied to guarantee compliance with all laws and regulations applicable relative to the license and permits issued.

(Ord. 3168, 2017).

5.3.8.040 License term.

A. Except as provided in subsection (B.) of this part, all licenses issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31. Renewals or new applicants applying after the expiration date shall pay fees as specified for the full year.

B. Applications after December 1, will receive licenses valid for the remainder of the year plus the next calendar year.

(Ord. 3168, 2017).

5.3.8.050 License fee.

The fee for issuance of a plumbing contractor's license shall be as set by City Commission resolution.

(Ord. 3168, 2017).

Article 9 PLUMBER LICENSING

Sections:

5.3.9.010 Plumber certificate required.

Any person engaged in the trade or calling of journeyman plumber in the City is required to have a plumber's certificate issued by the Planning and Community Development Department. Certificates issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

5.3.9.020 Certificate fee.

A fee as set by City Commission resolution shall be paid for each initial certificate upon evidence of a current journeyman plumber's license issued by the State. The fee for each renewal shall be as set by City Commission resolution.

(Ord. 3168, 2017).

Article 10 MEDICAL GAS SYSTEMS

Sections:

5.3.10.010 Contractor licensing.

Any person, firm, corporation, or other entity who engages in the business of installation, alteration, maintenance or repair of medical gas systems is required to have a medical gas systems contractor's license issued by the Planning and Community Development Department. Medical gas is defined by Title 15 of this Code. Licenses issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

5.3.10.020 Application.

An applicant for a medical gas systems contractor's license shall show evidence that the applicant, or at least one (1) member of the firm or corporation, is the holder of a current medical gas certificate.

(Ord. 3168, 2017).

5.3.10.030 Insurance and bond.

An applicant for a medical gas systems contractor's license shall meet the requirements of 5.3.8.030.

(Ord. 3168, 2017).

5.3.10.040 Medical gas contractor license fee.

The fee for issuance of a medical gas systems contractor's license shall be as set by City Commission resolution.

(Ord. 3168, 2017).

5.3.10.050 Medical gas systems certificate required.

Any person engaged in the installation, alteration, maintenance or repair of medical gas systems in the City is required to have a medical gas certificate.

(Ord. 3168, 2017).

5.3.10.060 Medical gas contractor certificate fee.

A fee as set by City Commission resolution shall be paid for each initial certificate upon evidence of a current medical gas endorsement issued by the State. The fee for each renewal shall be as set by City Commission resolution. Certificates issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

Article 11 FUEL GAS PIPING SYSTEMS

Sections:

5.3.11.010 Gas fitting contractor licensing.

Any person, firm, corporation, or any other entity who engages in the business of installation, alteration, maintenance, or repair of gas piping systems is required to have a gas fitting contractor's license issued by the Planning and Community Development Department. Licenses issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

5.3.11.020 License application.

An applicant for a gas fitting contractor's license shall show evidence that the applicant, or at least one (1) member of the firm, corporation, or entity is the holder of a current gas fitters certificate.

(Ord. 3168, 2017).

5.3.11.030 Insurance and bond.

An applicant for a gas fitting contractor's license shall meet the requirements of 5.3.8.030.

(Ord. 3168, 2017).

5.3.11.040 Gas fitting contractor's license fee.

The fee for issuance of a gas fitting contractor's license shall be as set by City Commission resolution.

(Ord. 3168, 2017).

5.3.11.050 Gas fitter's certificate.

Any person engaged in the trade or calling of gas fitter in the City is required to have a gas fitter's certificate. Certificates issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

5.3.11.060 Certificate application.

A. A person or entity desiring a gas fitting license shall make application to the Building Official to schedule a time and place for an appropriate examination to determine the qualifications of the applicant.

B. A fee of twenty dollars ($20.00) shall be paid for each examination.

C. The examination shall be administered by the person responsible for gas installation inspections, who will certify the results to the Building Official.

D. Examination is required for each initial application and is not required for renewal of the license, unless the license has been expired for more than thirty (30) calendar days. Adequate proof of experience in the field of gas fitting or related trades shall be submitted prior to the date of examination.

E. Proof of experience shall include affidavits from previous employers themselves in the business of plumbing, pipe fitting or gas fitting totaling a minimum of two (2) years.

(Ord. 3168, 2017).

5.3.11.070 Gas fitting certificate fee.

Upon successful completion of the examination, an initial certificate shall be issued. The fee shall be as set by City Commission resolution for each renewal.

(Ord. 3168, 2017).

Article 12 ELECTRICAL CONTRACTING

Sections:

5.3.12.010 Electrical contractor's license.

Any person, firm, corporation, or other entity engaging in the business or installation, alteration, maintenance or repair of electrical equipment in the City is required to have a City Electrical Contractor's License issued by the Planning and Community Development Department. This does not apply to the installation, alteration, or repair of electrical signal or communications equipment owned or operated by a public utility or the City. Licenses and

Certificates issued under the provisions of this article shall be for the calendar year beginning January 1, and expiring on December 31.

(Ord. 3168, 2017).

5.3.12.020 Electrical contractor's license application.

A. An applicant for an electrical contractor's license shall apply to the Building Official, and shall show evidence that:

1. all work is under the direction, control, and supervision of a licensed master electrician; or
2. under the direction, control and supervision of a journeyman electrician for residential construction consisting of less than five (5) living units in a single structure. Journeyman, master, and residential electricians are as defined and licensed under authority of the Mont Code Annotated and hold a current contractor's license issued by the State.

B. The applicant shall also file an insurance policy or certificate as required by Section 5.3.12.030.

(Ord. 3168, 2017).

5.3.12.030 Insurance and bond.

A. All applicants for licensing shall file with the Planning and Community Development Department a commercial general liability insurance policy or certificate of same, issued by an insurance carrier authorized to do business in the State, with limits established by City Commission resolution. Such limits shall be minimums and shall be in force through the term of the license.

B. All new electrical contractors will be required to post a license bond in an amount established by City Commission resolution to guarantee compliance with all laws and regulations relative to the license and permits issued for the first two (2) years of business. If performance under the bond is satisfactory, the City may release the contractor from further posting of the bond.

C. Additionally, if an electrical contractor is not performing satisfactory work and has no license bond, the Board of Adjustment shall conduct a hearing to determine if a license bond shall be required to be posted and determine the period of the posting.

(Ord. 3168, 2017).

5.3.12.040 Electrical contractor's license fee.

The fee for issuance of an electrical contractor's license shall be set by City Commission resolution.

(Ord. 3168, 2017).

5.3.12.050 Individual wiring certificate.

Any person who is, or in the future may become, engaged in the trade or calling of a journeyman or residential electrician in the City is required to have an individual wiring certificate issued by the Planning and Community Development Department.

(Ord. 3168, 2017).

5.3.12.060 Individual wiring certificate application.

An applicant for an individual wiring certificate shall submit evidence to the Building Official that such person is the holder of a current license issued by the State to engage in the trade or calling of residential electrician, journeyman electrician, or master electrician, as defined by Mont. Code Ann. Title 37.

(Ord. 3168, 2017).

5.3.12.070 Individual wiring certificate fee.

The fee shall be established by resolution of the City Commission.

(Ord. 3168, 2017).

Chapter 16 CATV REGULATIONS

Repealed.

(Ord. 3168, 2017).

Chapter 20 RESERVED

Editor's note(s)—Ord. No. 3115, § 2, adopted Dec. 17, 2013, repealed Tit. 5, Chapter 20, which pertained to establishing and operating an electric utility and derived from Ord. 2861, 2003; and Ord. 2925, 2005.

(Ord. 3168, 2017).

RESOLUTION 10444

A RESOLUTION BY THE CITY COMMISSION OF THE CITY OF GREAT FALLS, MONTANA, REVISING THE FEE SCHEDULE FOR GREAT FALLS FIRE RESCUE (GFFR) AND SUPERSEDING RESOLUTION 10436

WHEREAS, GFFR presented at the June 15, 2021 work session and the Commission subsequently adopted Ordinances pertaining to Safety Inspection Certificates and False Alarms; and

WHEREAS, the Great Falls City Commission adopted Resolution 10436 on January 18, 2022, setting forth fees for services provided by Great Falls Fire Rescue (GFFR), inclusive of the annual Safety Inspection Certificate (SIC) program re-inspection fees on deficient life safety systems and repeated false activation of fire alarm systems; and

WHEREAS, providing ancillary services or special circumstances are beyond the scope of those services covered by typical emergency work; and

WHEREAS, subsequent to GFFR's presentation of the Fire Rescue Ambulance Transport Cost Recovery at the January 18, 2022 work session, it was the consensus of the Commission for GFFR to pursue an agreement with a billing service with expertise and knowledge in Medicare, Medicaid and Insurance billing, for cost recovery of GFFR's increased ambulance transport role for the community.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COMMISSION OF THE CITY OF GREAT FALLS, MONTANA, that:

1) Resolution 10436 is superseded by these terms.

2) Great Falls Fire Rescue service fees are set forth as follows:

Great Fall Fire Rescue (GFFR) Fee Schedule

REPORTS:

Incident Reports	$15~~1~~.00
Fire Investigation Report & Photos – BY SUBPOENA ONLY	$100.00
Single page copies	$0.25/page

BUSINESS LICENSE:

New Issuance

Tier 1 (0-2000 sq ft) $170 + $130 (Zoning) = $300.00
Tier 2 (2001-10,000 sq ft) $220 + $130 (Zoning) = $350.00
Tier 3 (10,001-25,000 sq ft) $295 + $130 (Zoning) = $425.00
Tier 4 (25,001-50,000 sq ft) $380 + $130 (Zoning) = $510.00
Tier 5 (50,001-100,000 sq ft) $565 + $130 (Zoning) = $695.00
Tier 6 over 100,000 sq ft $765 + $130 (Zoning) = $895.00
Churches $170 + $130 (Zoning) = $300.00

Renewal
Tier 1 (0-2000 sq ft) $80.00
Tier 2 (2001-10,000 sq ft) $125.00
Tier 3 (10,001-25,000 sq ft) $185.00
Tier 4 (25,001-50,000 sq ft) $265.00
Tier 5 (50,001-100,000 sq ft) $440.00
Tier 6 over 100,000 sq ft $640.00
Churches $170 + $130 (Zoning) = $80.00

Transfer of ownership = $40.00 (staff recommends increase to $50.00)
Renewal late fee = $40.00 (staff recommends increase to $50.00)

FIRE INSPECTION FEES:

First Inspection	Covered by SIC
1st Re-Inspection (2nd- Inspection)	$100.00 ~~Covered by SIC~~
2nd Re-Inspection (3rd – Inspection)	$200.00
3rd Re-Inspection (4th – Inspection)	$300.00
4th Re-Inspection (5th – Inspection)	see ~~see~~ OCCGF § 15.9.050

FIRE PLANS REVIEW FEES:
Life Safety plans reviewed in house, $150 per hour, and $75 inspection fee.

FIRE PERMIT FEES:
$100.00 permit review, and inspection fee. Minimum 1 inspection per permitted Event. $75 inspection fee over 1 inspection (Amusement buildings, Carnivals/Fairs, Exhibits/Trade shows, Outdoor assembly event, Tent/Membrane structure)
$75.00 Open burning permit review and inspection fee. Minimum 1 inspection

FIRE SPRINKLER ACCEPTANCE:
$75 fee per inspection 100 heads or less. Min 3 inspections. Inspection increases by 1 for every 99 heads over 100 heads.

FIRE ALARM ACCEPTANCE:
$75 fee per inspection. Min 2 inspections for 25,000 square feet or less. Inspection increases by 1 at 25,001 square feet, then every 25,000 square feet after that. Prices increases $75 per added inspection.

HOOD ACCEPTANCE:
$75 fee per inspection, minimum 1 inspection per project.

FIRE SUPPRESSION SYSTEM ACCEPTANCE:
$75 fee per inspection, minimum 1 inspection per project.

FIRE PUMP ACCEPTANCE:
$75 fee per inspection, minimum 3 inspections per project.

STANDPIPE ACCEPTANCE:
$75 fee per inspection, minimum 2 inspections per project.

SPECIAL INSPECTION:
$75 per hour, minimum 1 hour.

AFTER HOURS INSPCTION:
$75 per hour, minimum 1 hour.

CONTRACTOR NOT READY FOR ACCEPTANCE:
$200 per instance

OPEN BURNING VIOLATION:
$50

FALSE ALARM FEE:

3rd False Activation in a 365-day time period	$~~100.00~~250.00

FACILITIES (daily rates):

Training Center classroom (*includes audio/visual equip*)	$1~~21~~40 per day
Training Center facility ~~*(includes Tower, Roof /Burn Props)**~~	$~~286~~335 per day
**Note: Burn prop requires GFFR supervision*	

APPARATUS (hourly rates – personnel costs not included):

1 ALS Rescue Engine	$2~~24~~50 per hour
1 Fire Engine	$~~188~~220 per hour
1 Aerial Apparatus 100 foot Pierce Platform	$3~~35~~90 per hour
1 Command Vehicle	$1~~20~~40 per hour
1 Rescue Vehicle	$1~~20~~40 per hour
1 Hazmat Trailer w/equip	$1~~42~~85 per hour
Hazmat supplies/tools	cost + 20%

SERVICES OTHER:

CPR Training Class	$75 ~~35~~ per student
Fire Water Line Flush, under 100' of hose used $100. Over 100' of hose used, $50 per every 25'over a 100'~~h~~	~~$100 each~~

PERSONNEL (regular hourly rates at **cost to City):** Current

1 Management	Current salary plus benefits
1 Command Officer	Current salary plus benefits
1 Company Officer	Current salary plus benefits
1 Firefighter	Current salary plus benefits

**Overtime hours will be calculated at the rate of 1.5 times regular rate*

EQUIPMENT:

Ladder testing (per ladder)	$9077
Hose repair (per length)	$2519
Repair parts	cost + 20%

CASCADE SYSTEM – BREATHING AIR:

30 / 60 min bottle filleding with NFPA certified Air	$3024 per cylinder
60 min bottle filled with NFPA certified Air	$50 per cylinder

PATIENT TRANSPORT COST RECOVERY

Advanced Life Support (ALS):

ALS Emergency	$1,150 1,050
ALS 2 Emergency	$1,250
ALS Treatment w/o Transport	$ 150
Oxygen	$ 65
I.V. Supplies	$ 75 68
ALS Routine Supplies	$ 100 95
Intubation Supplies	$ 125 98
Defibrillation Supplies	$ 120 85
EKG Supplies	$ 20 14
Mileage (per Loaded Miles)	$ 22 17.50

Basic Life Support (BLS):

BLS Emergency	$900 850
BLS Routine Supplies	$ 75 72
BLS Transport (per Loaded Miles)	$ 17.50

Note: All rates are invoiced at a minimum of 1 hour and rounded to the nearest half hour.

BE IT FURTHER RESOLVED BY THE CITY COMMISSION OF THE CITY OF GREAT FALLS, MONTANA that these fees shall become effective upon adoption. Great Falls Fire Rescue shall post the fee schedule on the GFFR webpage of the City's website.

PASSED AND ADOPTED by the City Commission of the City of Great Falls, Montana, this 1st day of March, 2022.

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Bob Kelly, Mayor

ATTEST:

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Lisa Kunz, City Clerk

(CITY SEAL)

APPROVED FOR LEGAL CONTENT:

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Jeffrey M. Hindoien, City Attorney

Year	Percent Increase
2023	3.6
2022	6.2
2021	7.1
2020	1.5
2019	2.8
2018	3.1
2017	3.1
2016	2.5
2015	1.8
2014	1.3
2013	1.8
2012	1.7
2011	2.7
2010	1.3
2009	2.2

		2024		3/1/2022	1/182022	2019	2014	2011	2005	2003	2001	1999
Resolution				10444	10436	10311	10070	9946	9465	9315	9185	
OPERATIONS												
Reports												
	Incident	*15*	*14*	$11	$11	$11	$11	$10	$6	$5	$5	$2
	Investigation	*x*		$100	$100	$100	$100	$55	$10	$5	x	x
	copies	*0.25*	*0.5*	$0.25	$0.25	$0.25	$0.25	$0.25	x	x	x	x
Equipment												
	Ladder Testing		*90*	$77	$77	$77	$70	$63	$50	$45	$45	x
	Hose Repair		*21*	$19	$19	$19	$17	$15	$11	$10	$10	$10
	Parts			cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%
Breathing Air			*29*	$24.00	$24.00	$24.00	$22	$20	$15	$15	$12	$10
Facilities	TC classroom		*143*	$121	$121	$121	$110	$100	$80	$60	$60	$60
daily	TC Facility		*334*	$286	$286	$286	$260	$234	$195	$150	$150	$150
Apparatus	ALS Engine		*250*	$224	$224	$224	$195	$175	$135	$100	$100	$100
hourly	Engine		*221*	$188	$188	$188	$171	$155	$120	$100	$100	$100
	Aerial		*393*	$335	$335	$335	$305	$275	$180	$150	$150	$100
	Command		*139*	$120	$120	$120	$110	$97	$75	$50	$50	$50
	Rescue		*139*	$120	$120	$120	$110	$97	$75	$75	$50	$50
	Hazmat		*184*	$142	$142	$142	$142	$129	$100	x	x	x
	Haz supplies			cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	cost + 20%	x	x	x
Personnel	Salary + Benefits			S+B	S+B	S+B	S+B	S+B	S+B	S+B	S+B	S+B
EMS												
CPR		*$75*		$35	$35	$35	x	x	x	x	$15	$15
EMS Patient Recovery												
ALS Transport	ALS	*$1,150*		$1,050	x	x	x	x	x	x	x	x
	ALS 2	*$1,250*		$1,250	x	x	x	x	x	x	x	x
	ALS w/o	*$150*		$150	x	x	x	x	x	x	x	x
ALS Supplies	Oxygen	*$65*		$65	x	x	x	x	x	x	x	x
	IV	*$75*		$68	x	x	x	x	x	x	x	x
	ALS supplies	*$100*		$95	x	x	x	x	x	x	x	x
	Intubation	*$125*		$98	x	x	x	x	x	x	x	x
	Defib	*$120*		$85	x	x	x	x	x	x	x	x
	EKG	*$20*		$14	x	x	x	x	x	x	x	x
	Mileage	*$22*		$17.50	x	x	x	x	x	x	x	x
BLS Transport	Emergency	*$900*		$850	x	x	x	x	x	x	x	x
	Supplies	*$75*		$72	x	x	x	x	x	x	x	x
	Mileage	*$18*		$17.50	x	x	x	x	x	x	x	x

FIRE PREVENTION

Fire Inspections											
	Initial	*sic includes*	sic includes	sic includes	x	x	x	x	x	x	x
	1st Reinspect	*$100*	sic includes	sic includes	x	x	x	x	x	x	x
	2nd Reinspect	*$200*	$200	$200	x	x	x	x	x	x	x
	3rd Reinspect	*$300*	$300	$300	x	x	x	x	x	x	x
	4th Reinspect										
False Alarm											
	3rd		$100	$100	x	x	x	x	x	x	x
Fire Line Flush			$100	$100	x	x	x	x	x	x	x
Fire Plans Review		*$75/$150hr*	x	x	x	x	x	x	x	x	x
Fire Permit Fees		*$75/$150*	x	x	x	x	x	x	x	x	x
Inspection Acceptance	Sprinkler System	*$75*	x	x	x	x	x	x	x	x	x
	Alarm System	*$75*	x	x	x	x	x	x	x	x	x
	Hood System	*$75*	x	x	x	x	x	x	x	x	x
	Suppression Systen	*$75*	x	x	x	x	x	x	x	x	x
	Fire Pump	*$75*	x	x	x	x	x	x	x	x	x
	Standpipe	*$75*	x	x	x	x	x	x	x	x	x
Special Inspection		*75*	x	x	x	x	x	x	x	x	x
After Hours		*75*	x	x	x	x	x	x	x	x	x
Contractor Not Ready		*200*									
Open Burning Violation		*50*	x	x	x	x	x	x	x	x	x

		2017	2007	2003
Resolution		10207	9711	9344
New Issuance				
Zoning		$100	$25	$25
Tier	1	$132	$115	$95
	2	$173	$150	$125
	3	$230	$200	$165
	4	$299	$260	$215
	5	$443	$385	$320
	6	$600	x	x
	Church	$132	$115	$95
Renewal				
Tier	1	$63	$55	$45
	2	$98	$85	$70
	3	$144	$125	$105
	4	$207	$180	$150
	5	$345	$300	$250
	6	$500	x	x
	Church	$63	$55	$45
Transfer Fee		$30	$30	$30
Late Fee		$30	$15	$15