CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDIXES

INTRODUCTION

Public attention to white-tailed deer is arguably greater than the interest exhibited for any other species of wildlife in Virginia. As Virginia's most popular game species, implications of white-tailed deer range from welcome public viewing opportunities to serious damage and public safety concerns. The divergent citizen interests associated with white-tailed deer provide unique management challenges for the Virginia Department of Game and Inland Fisheries (VDGIF).

The VDGIF, under the direction of a Governor-appointed Board of Directors, is specifically charged by the General Assembly with the management of the state's wildlife resources. Although many legal mandates of the Board and the Department are expressed throughout the Code of Virginia, the agency's primary functions include management of the wildlife resources (§29.1-103), public education (§29.1-109), law enforcement (§29.1-109), and regulatory powers (§29.1-501). In 1990, the Board of Directors adopted mission statements to help clarify and interpret the role of the VDGIF in managing the wildlife resources of Virginia. They are:

> *To manage Virginia's wildlife and inland fisheries to maintain optimum populations of all species to serve the needs of the Commonwealth;*
>
> *To provide opportunity for all to enjoy wildlife, inland fish, boating, and related outdoor recreation; and*
>
> *To promote safety for persons and property in connection with boating, hunting, and fishing.*

What the Plan Is

In February 1996, the Wildlife Division began to develop a deer management plan to help the VDGIF fulfill its mandate to manage Virginia's deer population(s). Simply put, the deer plan describes the deer management program history, current status (supply and demand) of the deer management program, and the future direction of the deer management program. The plan identifies a framework for the next 6 years of what needs to be done, how it should be done, and when it should be done. By clarifying the management goals and objectives of the VDGIF relating to deer, this plan will assist Board members, VDGIF administrators, VDGIF staff, and the public in addressing deer issues. As the basis for white-tailed deer management budgeting and yearly operational activities, the plan also informs the General Assembly and the public of what the VDGIF intends to accomplish.

How the Plan was Developed

Planning Committees.----Historically, wildlife managers and agencies typically focused on the technical or scientific aspects of resource management. Biologically based principles of deer management played a major role in the successful programs of the past, whereas little emphasis was placed on public values when determining specific management objectives and approaches. Because the VDGIF's mission is

"to serve the needs of the Commonwealth," public values (e.g., economic, sociological, and political) were incorporated into the deer management plan in addition to biological considerations.

This plan was developed to represent the interests of all citizens and not just the visions of any special group (including the VDGIF). It outlines a composite of contributions from citizens, business interests, resource professionals, and recreationists. This plan may represent the first time the public's interests have so thoroughly been incorporated into the planning process from the outset.

To ensure that the plan would represent all citizens and help the VDGIF become a more responsive agency, a Deer Management Planning Committee was created in 1996. The Committee, which met 5 times between January 1996 and August 1997, represented a diverse cross section of Virginia citizens with expertise and an interest in deer management issues. The 19-member Committee (see Appendix I) included representatives from agricultural interests, commercial timber industry, local jurisdictions and governments, sporting groups, wildlife management professionals, animal welfare interests, public land managers, conservation biologists, recreation specialists, and wildlife conservation interests.

With support from the VDGIF technical staff, the Committee assumed responsibility for its own membership and the content of the deer management plan. Dr. Steve McMullin, a planning specialist with the Department of Fisheries & Wildlife Sciences at Virginia Tech, was the planning advisor to the Committee. Dr. McMullin also facilitated the statewide and regional meetings necessary to develop the draft plan.

Because the Committee realized that local input was essential to the development of a meaningful deer management plan, six regional meetings involving 135 participants were conducted throughout the state. The Committee made specific regional participant recommendations and directed VDGIF staff to invite other stakeholders representing a cross-section of local issues. Participants in the regional meetings are listed in Appendixes II - VII. Local meetings were designed to review and revise the suggested deer program goals drafted by the Committee, to determine local deer population management objectives, and to identify locally important deer management issues.

Public Input.----Based on statewide and regional committee input, the draft plan was extensively advertised to solicit public comments during December 1997. Nearly 50,000 copies of a 4-page newspaper version of the draft deer management plan were distributed throughout Virginia. To reach a broad spectrum of Virginia's citizens, these newspapers were mailed to all 1,400 check stations (25 papers to each), all 1,400 hunter safety coordinators, all 500 deer management assistance plan cooperators, all 100 Virginia city/county Boards of Supervisors, the VDGIF's Director's Advisory Committee, and 1,000 Master Gardeners. Newspapers also were mailed to any person who wrote or called requesting a copy. Invited deer management plan programs were presented to the Albemarle and Floyd County Boards of Supervisors.

With few exceptions, an unabridged copy of the draft plan also was sent to every person invited to the regional deer management planning meetings. In all, over 300 copies of the complete draft plan were distributed. Numerous deer management plan articles were published in local newspapers across Virginia. *The Roanoke Times* and *Richmond-Times Dispatch* gave special coverage of the plan.

In response, 110 comments were received. These included letters from three county governments, one petition with 103 signatures and six written comments (the petition was considered one comment), 27 Internet comments, and 73 letters. Everyone who provided comments received a summary of all the public comments and will receive a complete copy of the final plan.

A summary of all the public comments is found in Appendix VIII. These comments generally revisited the same topics already addressed in the draft plan. The major themes found in the public comments involved deer damage (especially from urban/suburban areas), damage control and compensation strategies, hunter access, deer population objectives, population management approaches, quality deer management issues, law enforcement needs, and unethical hunter behavior. The Boards of Supervisors from Accomack and Patrick counties requested that their population management objectives be changed from stabilize to reduce.

Changes to the Draft Plan.----Based on the strong expression of concern from the Boards of Supervisors, the Committee voted to change the deer population objectives in Accomack and Patrick Counties

from stabilize populations to reduce populations. The changes in population objectives for these counties are reflected in the Population Goal section.

Public comments also indicated a need to prioritize the plan's objectives. Objective rankings from the Committee (based on information from the planning meetings and public input) will help guide implementation of the most important aspects of the plan through the annual budgeting process. The Committee's priority guidance is provided in Appendix XI.

The updated draft plan was presented to and endorsed by the Board at their July 1998 meeting.

Format

To clarify deer-related management issues, the deer management plan includes sections on deer program history, deer program status (supply and demand), a technical evaluation of deer management options, and deer program goals. Within the context of the VDGIF mission statement, six goals were drafted. These goals address: populations, habitat, damage, recreation, education, and administration. For each goal, specific objectives have been identified that will help guide attainment of the goal. Preferred strategies then clarify how each objective should be achieved.

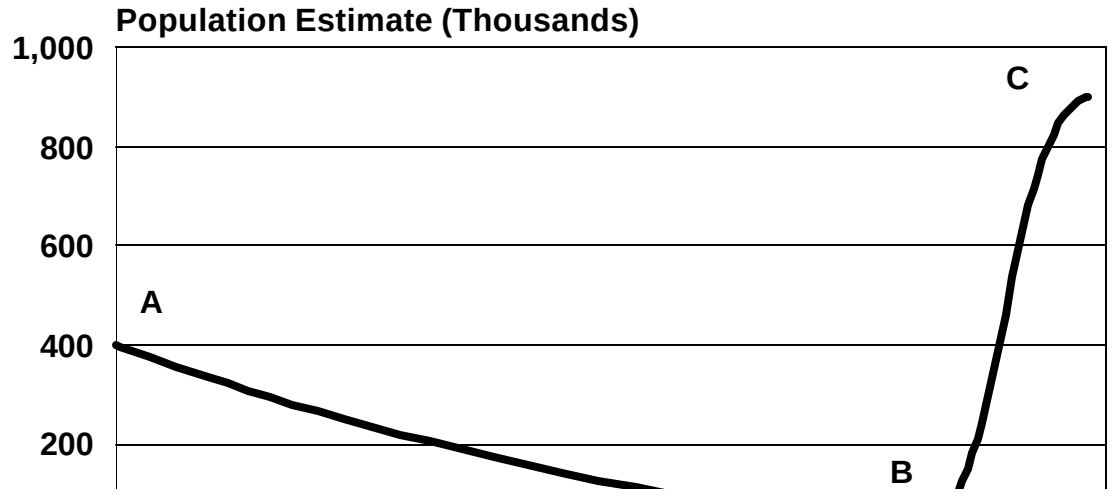
DEER PROGRAM HISTORY

Introduction

White-tailed deer in Virginia have a remarkable and interesting history. Historical changes in deer distribution patterns, population trends, and management practices in Virginia are representative of those in many southeastern states. Deer herds at the time of European settlement around 1600 were plentiful and widespread. Over-exploitation during the next 300 years resulted in near extirpation of deer by the turn of this century.

When the first European settlers arrived in North America in 1607 at Jamestown Island, Virginia, they described an animal in abundance, which would become commonly known as the Virginia white-tailed deer. Early records indicate that white-tailed deer were found statewide with the highest population densities apparently located in the coastal Tidewater physiographic region.

The exact number of deer that inhabited the Commonwealth of Virginia at the time of European settlement is unknown. There are no established estimates of Virginia's precolonial deer herd. However, one of America's foremost naturalists, Ernest Thompson Seton, estimated the deer herd in the eastern United States was 10 deer per square mile at the time of European settlement. Seton's estimate, limited to the land area of Virginia, produces a precolonial population of approximately 400,000 deer (Figure 1; A).



Historical Changes in Distribution and Abundance

Population Decline, 1600-1900. ----Following colonization, Virginia's deer population began to decline. Frequently cited as standard factors causing the decline of white-tailed deer in colonial Virginia are habitat loss due to deforestation and agriculture, over-harvest, and lack of effective law enforcement. Extensive over-harvest may have been most damaging. Although clearing and conversion of forests to agriculture should have benefited Virginia's colonial deer herd, improvements in habitat conditions apparently were negated by continued over-harvest.

In 1699, to address declining deer herds, Virginia was one of the first colonies to set a closed season for hunting deer (from February 1 through July 31). By 1738, separate seasons had been established for bucks and for does and fawns.

The over-harvest of Virginia's deer resource was characterized by several distinct stages. During early European settlement, venison and deer hides were essential staples of everyday colonist life. Nearly every colonial law that was passed to protect deer in Virginia contained an exemption for settlers living on the contemporary western frontier. As evidence of the pioneers' dependence on deer as a source of food and clothing, it was not until 1849 that counties west of the Blue Ridge Mountains established a closed season on deer.

Commercial trade in deer hides, which peaked around 1700, followed subsistence hunting. Between 1698 and 1715, approximately 14,000 hides were exported from Virginia to Europe annually.

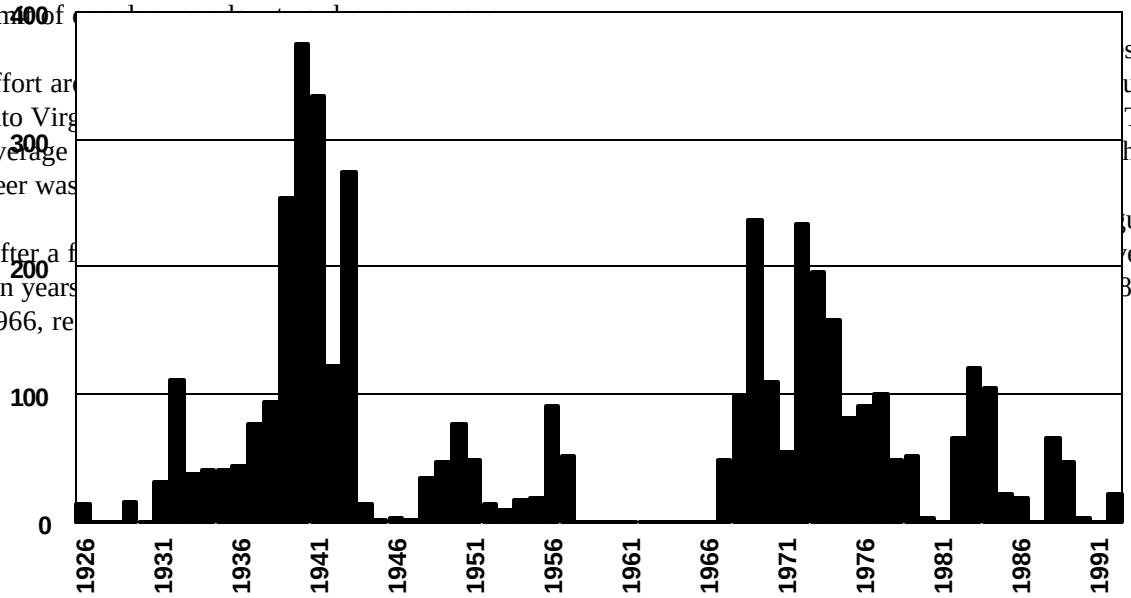
Market hunting followed the commercial trade in deer hides. One market hunter in northwestern Virginia was reported to have killed over 2,700 deer prior to 1860 for an average price of 10 cents per pound. Market hunting effectively ceased with the passage of the federal Lacey Act in 1900 which outlawed the buying and selling of wildlife and gave the federal government control over the interstate transport of wildlife.

Like most southeastern states, Virginia's deer herd reached its lowest point during the early 1900's. By 1900, the deer herd in nearly all of Virginia's Mountain and Piedmont physiographic regions had been extirpated. In an article that appeared in the predecessor to Virginia Wildlife, Game and Fish Conservationist, the 1931 statewide deer population was estimated to be approximately 25,000 (Figure 1; B).

Population Restoration.-----When exactly deer numbers began to increase significantly in Virginia is unknown. One noted white-tailed deer authority has suggested that, from a North American perspective, deer abundance did not increase significantly until the 1930's. The principal factors that contributed to the significant increase of white-tailed deer in Virginia over the past 60-70 years were reforestation, farm abandonment, protective game laws, effective law enforcement, and restocking. The latter three of these are now the responsibility of the VDGIF.

After the formation of the Virginia Game Commission in 1916, a considerable amount of time and effort was spent on deer management. Initial management efforts to protect remaining deer herds included establishment of shorter seasons and a season bag limit. Annual deer harvests during the 1920's averaged approximately 620 deer for the 33 counties that had open deer seasons. In 1924, the General Assembly

restricted [illegible] deer season between November 15th and December 31st with a bag limit of [illegible]



storation effort ar[illegible] urces into Virg[illegible] The average [illegible] he last deer was [illegible]

gure 2). After a f[illegible] vel for ten years [illegible] 3 to 1966, re[illegible]

Figure 2. Virginia deer restoration, 1926-1992.

Nearly all the 1,980 deer stocked after 1967 came from a single source, the Radford Army Ammunition Plant(s) in Montgomery and Pulaski counties. Restoration efforts conducted in the 1980's and 1990's, which involved about 450 deer, were directed primarily at two far southwestern counties, Buchanan and Dickenson. With the exception of several western Piedmont counties that border the Blue Ridge Mountains, nearly all restocking in Virginia was done west of the Blue Ridge Mountains. In all, more than 4,200 deer were released.

Deer Distribution Maps

1938.----In one of the first maps of deer distribution in Virginia (Figure 3), three distinct areas were described: areas with native deer herds, areas where deer were absent, and 22 locations of isolated deer populations attributed to the restocking effort. At a time when native deer were considered extirpated from nearly all of western Virginia (1920's), Bath and Highland counties were estimated at 500-2,500 deer. By far the largest contiguous area with native deer populations occurred in the coastal Tidewater region and extended into the central Piedmont. Over half of the state, consisting of most of the Mountain region and the northern and southwestern Piedmont, was described as devoid of deer.

Later changes in deer densities and distribution patterns are illustrated in a series of maps produced by the Southeastern Cooperative Wildlife Disease Study, University of Georgia. Over the years, SCWDS has produced a series of maps that depict deer distribution and relative abundance. These maps were prepared from data provided by game and fish biologists, representing conditions in the southeastern United States and the entire United States in 1988.

1950.----The 1950 SCWDS map of Virginia restoration began but gave no indication of relative abundance. By 1950 Virginia had been conducting restoration efforts for nearly 20 years. By the early 1950's, Virginia's statewide deer

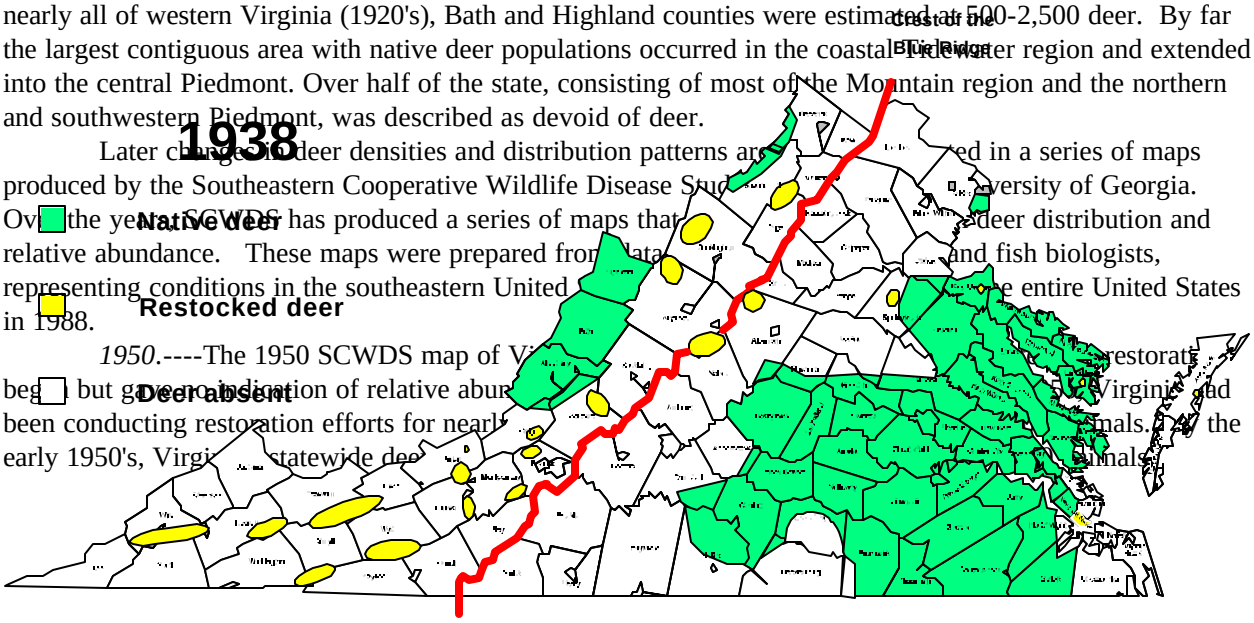


Figure 3. Virginia deer distribution in 1938.

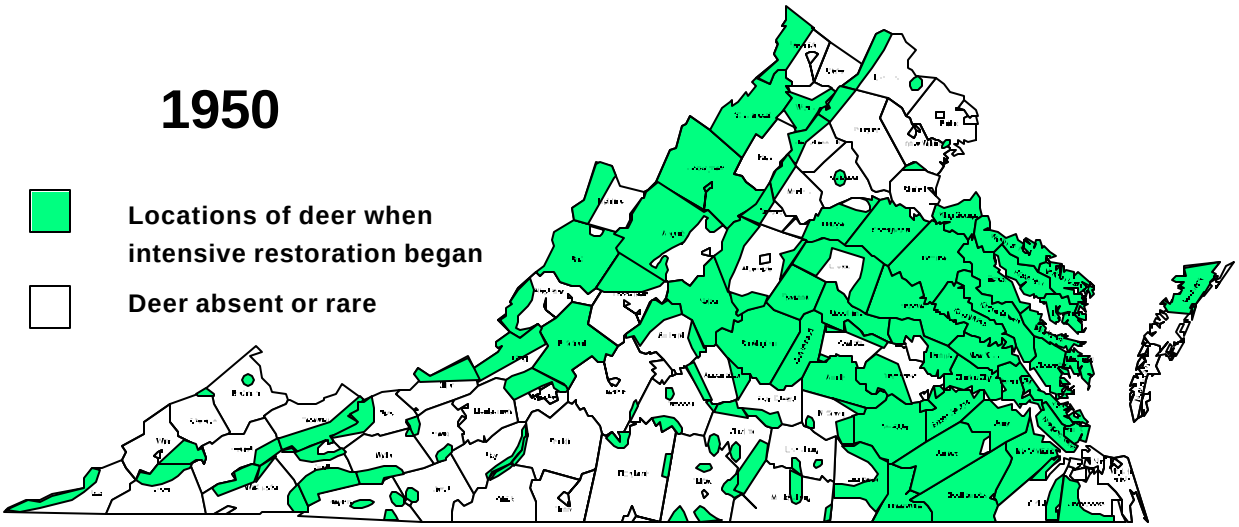


Figure 4. Virginia deer distribution in 1950.

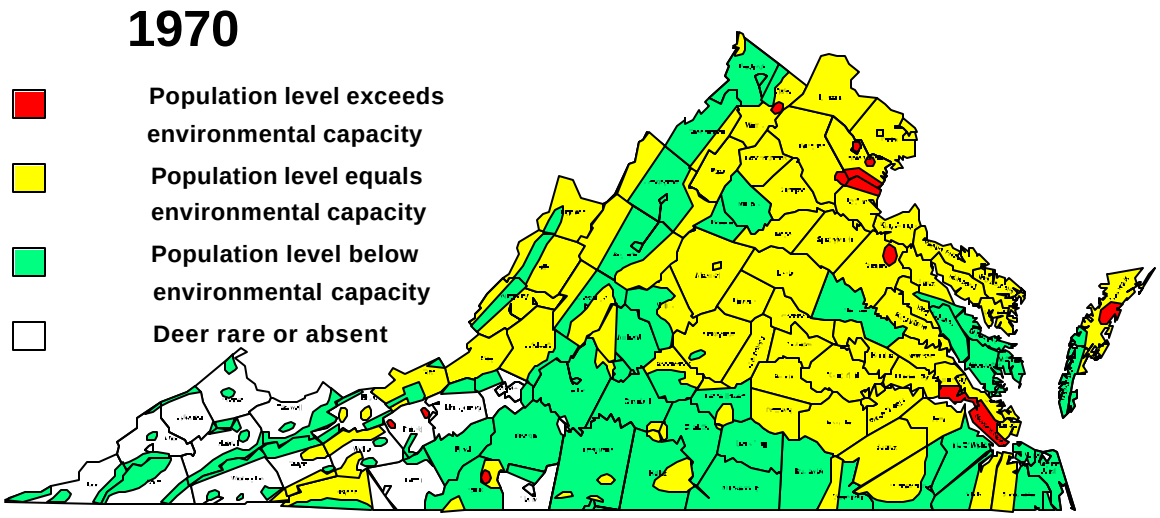


Figure 5. Virginia deer distribution and relative abundance in 1970.

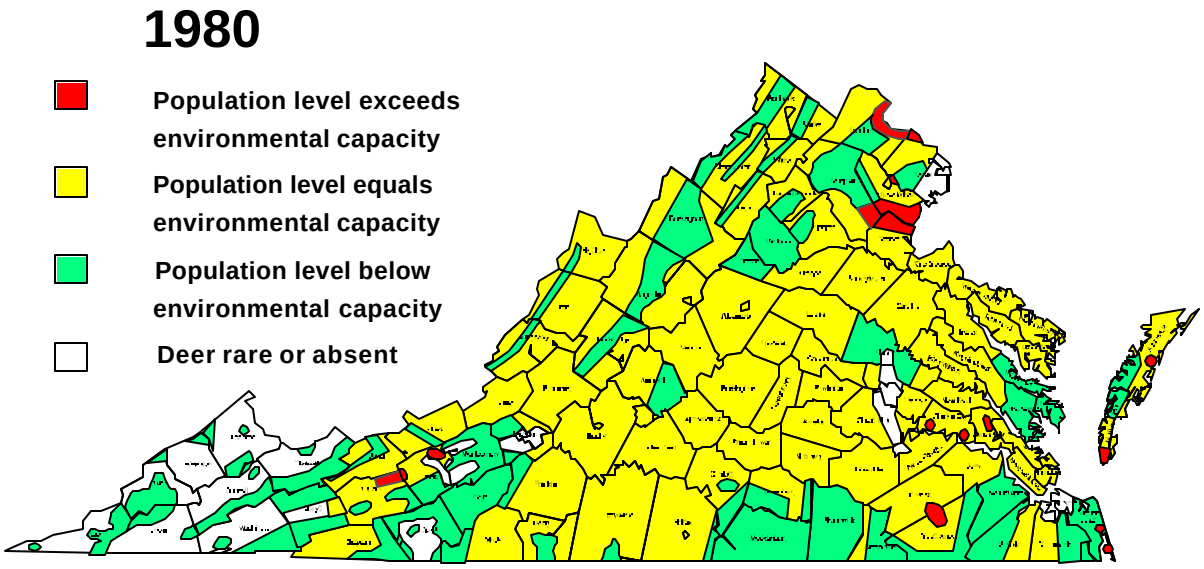


Figure 6. Virginia deer distribution and relative abundance in 1980.

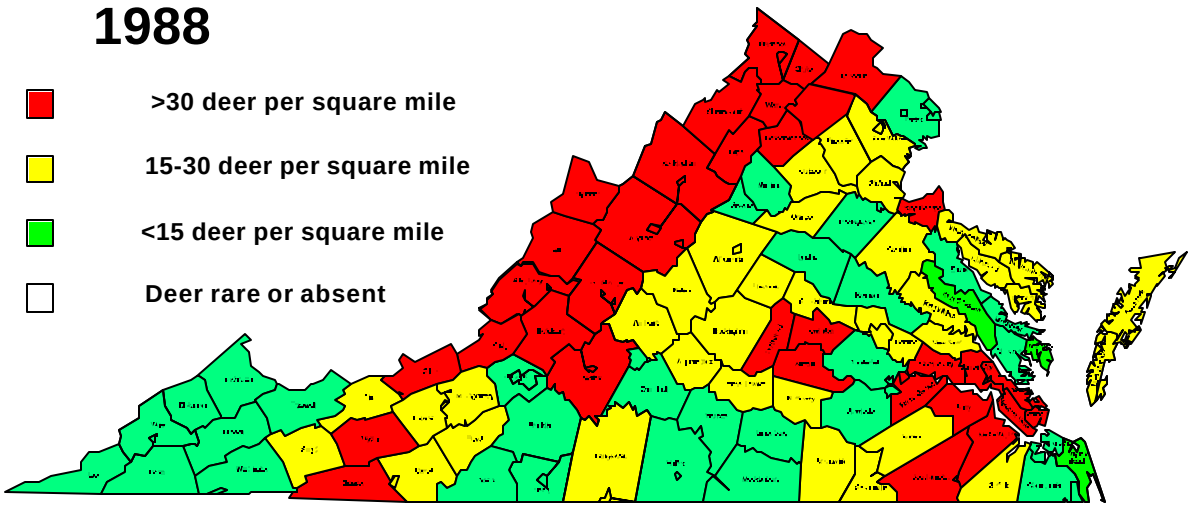


Figure 7. 1988 Virginia deer density estimates by county.

Like the 1938 map, the 1950 SCWDS map indicated that deer occupied a majority of the coastal Tidewater region and the central Piedmont, yet much of the southwestern and northern Piedmont remained unoccupied. Most of the south-central Piedmont lacked deer, with only isolated populations scattered throughout the area. West of the Blue Ridge Mountains, native and restocked deer herds in the northern Mountains had repopulated approximately 75% of the available range. Deer herds in the southern Mountains were depicted as isolated populations with vast areas of unoccupied range.

In 1952, the Virginia Game Commission initiated a statewide program to collect data on deer populations for setting appropriate seasons and bag limits. In 1953, the first full-time deer biologist was employed to direct this program.

1970.----The 1970 SCWDS map depicted a significant increase in the distribution of deer (Figure 5). The northern and southern Piedmont, which lacked deer in 1950, were repopulated by 1970. Deer occupied virtually all-available range east of the Blue Ridge Mountains and in the northern Mountains by 1970.

In addition to significantly expanding its range, Virginia's deer population also continued to grow. By 1970, Virginia's statewide deer population was estimated to be approximately 215,000 animals. Beginning with the 1970 SCWDS map, relative indices of deer population abundance were provided for the first time and included the following: populations exceeding the environmental capacity, populations equal to the environmental capacity, populations below the environmental capacity, and areas where deer were rare or absent.

Environmental carrying capacity, as described for Virginia in 1970 and 1980, represented optimum population levels based on sustained yield management or populations held at or below the "I" carrying capacity (ICC). ICC is the population level yielding maximum sustained yield (MSY). This "optimum density" is equivalent to the term "carrying capacity" as used in range management and represents wildlife population levels where habitat is not limiting and condition and reproductive indices approach the maximum. Environmental carrying capacity as described in Virginia at the time did not represent "K" (or biological) carrying capacity.

Unpublished data from the same period indicate that areas below the environmental capacity typically had deer densities of less than five deer per square mile. Areas described as equal to the environmental capacity ranged from five to 25 deer per square mile, and areas exceeding carrying capacity exceeded 25 deer per square mile.

1980.----Significant increases in the abundance of deer in Virginia occurred between 1970 and 1980 (Figure 6). By 1980, a majority of the Tidewater, Piedmont, and northern Mountains were described as fully occupied at environmental carrying capacity. Populations in the southern Mountains had expanded slightly but were still described as below environmental capacity, with many areas where deer were rare or absent. The 1980 statewide deer population was estimated at 422,000 animals.

1988.----In 1988 SCWDS updated its white-tailed deer distribution map for the entire United States. In contrast to the earlier maps, this map introduced specific density estimates on a county basis (Figure 7). Population estimates used for the 1988 map were based on the highest estimated 1986 or 1987 antlered buck harvest figure per square mile of forested area. Estimated antlered buck harvests by county were calculated from check station data using the equation: estimated antlered males = total male harvest - (total female harvest * 0.3). The total deer population was assumed to be ten times the estimated antlered buck kill per square mile of forest range. Based on this model, the 1987 statewide deer population was estimated to be approximately 575,000 animals.

Deer Management Program

Big Game Check Stations.----The cornerstone of Virginia's deer management program is the big game check station system, which allows the Department to effectively monitor annual deer harvests on a county basis. By law, each successful deer hunter is required to check every harvested deer at a check station to receive an official game tag. Information regarding the animal's sex, date of kill, weapon, and county of kill is recorded. Initiated in 1947, check stations are operated by local volunteers who serve without compensation. An estimate of volunteer services rendered by Virginia's check station operators exceeded $650,000 in 1978.

During the 1994 deer season, there were approximately 1,450 big game check stations distributed throughout the Old Dominion. The check station system is maintained as a joint Wildlife and Law Enforcement Division’s operation. Law Enforcement selects and supervises the check stations while the

Wildlife Division has the responsibility of providing materials and tabulating the annual harvest data. Results of the annual deer harvest are available about one month after the close of the season. In contrast to many states that estimate their annual deer harvest(s), Virginia's deer harvest figures represent an actual known minimum count. The check station system provides harvest figures that the public understands and has confidence in.

Deer Harvest Regulations.----At the state level, deer harvest regulations are evaluated and amended every other year on odd years (e.g., 1993, 1995, etc.). Depending on management goals and the current status of the deer herd, regulation amendments may involve an adjustment in season length(s), bag limit(s), and/or the number of general firearms season either-sex deer hunting day(s) on a county basis.

The process to change regulations typically stretches over six months and represents a major investment of VDGIF staff time and effort. Even before the close of the deer season, Wildlife Division personnel hold meetings to identify regulation issues to be addressed. Following the close of the deer season, a series of regional meetings are held with Law Enforcement and Forest Service personnel and other cooperators to discuss potential changes to regulations and receive additional input. After the regional meetings, recommendations to modify regulations are drafted for review. These draft regulation recommendations are made public when presented to the VDGIF Board of Directors at a public meeting in the early spring. If approved by the Board, revised regulations are officially advertised by the state Registrar and presented to the public in a series of statewide public input meetings.

During spring 1995, eleven public meetings were held around the state to discuss wildlife regulations and over 1,000 persons attended. Following a 60-day public input period, regulations are considered at a second public Board meeting in the late spring at which time the proposals are accepted for passage, amended, or repealed.

Deer Management: Two Traditions.----Deer management in Virginia is characterized by two distinct zones of tradition and regulation, east of the Blue Ridge Mountains and west of the Blue Ridge Mountains.

Deer hunting east of the Blue Ridge Mountains is strongly rooted in a private land hunting club tradition, where use of hounds and a seven-week long general firearms season prevails. Conversely, west of the Blue Ridge Mountains dog hunting is prohibited by state law, hunting clubs are rare, nearly two million acres of public lands are available for hunting, and the general firearms season is twelve days long. Prior to 1964, the western firearms season was six days long. Eight southwestern Piedmont counties (or portions thereof) east of the Blue Ridge Mountains have, over time as deer seasons were opened during the late 1950's and early 1960's, been incorporated into the "western" framework. Historically, bag limits and either-sex deer hunting opportunities west of the Blue Ridge Mountains have been more conservative than those in eastern Virginia.

East of the Blue Ridge Mountains, in the extreme southeastern corner of the state, three counties (Chesapeake, Suffolk (east of the Dismal Swamp line), and Virginia Beach) have an October 1 through November 30 firearms deer season.

Deer Management Paradigm.----The density and health of Virginia's deer herd has been managed by controlling the number of antlerless (i.e., either-sex) deer hunting days. Virginia was one of the first southeastern states to recognize the need for antlerless deer harvests. The first either-sex deer days were held east of the Blue Ridge Mountains in the counties of Caroline, King and Queen, and sections of Southampton and Sussex in 1946-47. West of the Blue Ridge Mountains, the first either-sex deer season was held in Augusta County in 1951. From 1951 to 1967, many different combinations of either-sex deer season approaches were tried. Over time it was noted that heavy harvests of antlerless deer in some counties were followed by a marked reduction in the number of antlered deer harvested. Eventually, the VCGIF Game Division in 1967 adopted a sustained yield management strategy. Management objectives were accomplished by increasing or decreasing the number of either-sex deer hunting days at the end of the general firearms season.

Under this harvest management concept, counties were divided into one of three categories. In counties where the deer herd was considered to be below carrying capacity, the management goal was to allow the population to increase. Regulations ensured that buck harvests made up the majority of the total

harvest, but limited antlerless harvests were permitted. In counties where the deer herd was considered to be at carrying capacity, the goal was to stabilize the population. Either-sex harvest regulations were adopted to provide for 30-40% females in the total harvest. Years of experience had revealed that, when the percentage of does in the total harvest did not exceed 30-40%, total deer harvests in succeeding years either increased or remained stable. In counties where the deer herd was considered to exceed carrying capacity, the management goal was to reduce the population. Sufficient either-sex days were allowed to raise the percent of females in the harvest to 50% or above.

Deer Management Assistance Program (DMAP).----DMAP was implemented by the VDGIF in 1988. DMAP is a site-specific deer management program that increases a landowner's or hunt club's management options by allowing a more liberal harvest of antlerless deer than could be obtained under the current system of county regulations. DMAP tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary goal of DMAP is to allow landowners and hunt clubs to work together on a local level to manage their deer herds. Secondary objectives are to increase the Department's biological database and to improve communication between deer hunters, landowners, and the Department. In 1996, nearly 17,000 DMAP tags were issued to 430+ cooperators on more than 1.13 million acres.

Damage Control Assistance Program (DCAP).----Like DMAP, DCAP was started in 1988. DCAP is a site-specific deer damage management program that increases a landowner's management options by allowing a more liberal harvest of antlerless deer than could be obtained under the existing system of county regulations. DCAP permit tags can only be used to harvest antlerless deer (does and male fawns) and are not valid for antlered bucks. The primary objective of DCAP is to provide site-specific assistance in the control of crop depredation by deer or other property damage. Secondary objectives are to maximize hunter participation in the control effort and to shift closed-season kill permit deer harvest(s) into the open deer season. In 1996, there were over 500 DCAP cooperators.

Kill Permits.----As provided by Virginia State Statue ∋29.1-529. *Killing of deer or bear damaging fruit trees, crops, livestock or personal property or creating a hazard to aircraft*, the VDGIF is mandated to permit owners or lessees of land on whose lands deer are causing damage to kill such deer.

Under the kill permit system, a landowner/lessee sustaining deer damage must report the damage to the local game warden for investigation. If upon the investigation the game warden (or designee of the Director) determines that deer are responsible for the reported damage, he/she is required to authorize in writing that the owner/lessee, or other person(s) designated by the game warden, be allowed to kill deer when they are found upon the property where the damage occurred. In calendar year 1996, 1,324 kill permits were issued for deer and 4,000+ deer were reported killed.

Deer Management Objectives.----Virginia's deer management program has been noted for both its simplicity and its success. Past goals of the deer program have been to provide optimum and sustained numbers of deer for maximum public enjoyment and to provide vigorous, healthy, productive deer herds that are beneficial to man and do not cause economic hardship.

Current objectives of the deer management program are to provide as much recreational hunting opportunity as possible without harming the resource and to apply population control where necessary to maintain herd health and to reduce crop depredation. Today, with the exception of several counties in far southwestern Virginia and on selected National Forest lands in western Virginia, the emphasis of Virginia's deer management program has switched from establishing and expanding deer herds to controlling their growth. This change in management direction has resulted in liberal harvest regulations and an increasing harvest of antlerless deer. During the late 1980's and early 1990's, the total statewide deer harvest and the percent of females in the harvest was increased dramatically through rapid liberalization of deer seasons, bag limits, and the number of general firearms either-sex hunting days.

Consequently, between 1988-1992, the total harvest of deer increased 75% from 114,562 to 200,446, and the percent of females in the harvest increased from 32.9% to 39.6%. Since 1992, the deer harvest has been fairly stable at 200,000-220,000 and approximately 40% female.

Current population estimates, based on computer reconstruction models, indicate that Virginia's deer herd has been fairly stable over the past several years, and a conservative estimate of the statewide prehunt population has been approximately 950,000-1,000,000 animals (Figure 1; C).

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DEER PROGRAM SUPPLY AND DEMAND

Introduction

Change in deer management direction from establishing and allowing deer herd expansion to controlling population growth has been based on the cultural carrying capacity (CCC). CCC is defined as the maximum number of deer that can coexist compatibly with humans. CCC is a function of the tolerance of humans to deer and the effects of deer. CCC can vary widely between and within communities. Development of CCC deer management objectives are subjective and involve a combination of social, economic, political, and biological perspectives. The CCC for deer generally occurs well below the biological carrying capacity (BCC).

Under optimum conditions, deer populations can double in size annually. Lacking an external regulating factor (e.g., predators, hunting, etc.) deer populations will generally expand to the point where food resources are limiting or exhausted. In unmanaged populations, the food supply controls deer numbers. This is the concept of BCC. BCC is the maximum number of deer that can be sustained over time. BCC is a function of the quality and quantity of habitat. It is not a function of deer. A habitat's BCC is not, however, a fixed number. Habitat carrying capacity changes seasonally and annually, with winter being the limiting

season over most of Virginia. Deer herds that expand to the BCC are frequently, but inaccurately, called overpopulated.

Virginia does not currently have many significant widespread "overpopulated" deer herds. Although frequently cited as overpopulated by the press, most of Virginia's deer herds are managed through hunting at moderate to low population densities, in fair to good physical condition, and below the BCC. Control of deer herds through the harvest of antlerless deer by recreational sport hunters is currently the most effective and cost-efficient method to manage deer populations.

Supply

Deer Habitat.----Like most large mammals, white-tailed deer have specific habitat requirements. These requirements include food, water, cover, and space. Of these four generic habitat components, food is the most critical in Virginia. The reason for this is that an average adult white-tailed deer requires 4-6 pounds of food daily per 100 pounds of body weight.

Habitat quality for deer is significantly correlated with soil quality. Soil fertility will directly and powerfully affect the quality of deer habitat. Following soil quality, habitat type, successional stage, and the amount of habitat interspersion or edge have the greatest impact on deer habitat quality. In general, any habitat management practice that improves soil fertility, increases the number of habitat types, reverts habitats to early successional stages, or increases the interspersion of habitat types will result in an increased carrying capacity for deer. Conversely, as a general rule, any habitat management practice that reduces soil fertility, decreases the number of habitat types, results in late successional stages, or decreases the interspersion of habitat types will result in a decreased carrying capacity for deer.

In most habitats in Virginia, deer populations exhibit density dependent population responses with deer condition and reproductive rates inversely related to deer density. As deer population density increases, herd condition and reproductive rates decline. Conversely, as deer population density decreases, herd health and reproductive rates improve.

Deer Habitat Types.----Virginia has approximately 39,682 square miles of land area in five major physiographic regions. These regions include the northern and southern Mountains, northern and southern Piedmont, and the Tidewater or Coastal Plain. Habitat types and forest communities between these regions are diverse. Habitats within the northern Mountains and southern Mountains are characterized by three categories, including Appalachian Plateau, Ridge and Valley, and Blue Ridge. Four major types characterize mountain forest habitats, including mixed mesophysic, northern hardwoods, Appalachian oak, and oak/hickory/pine. Soils in the Appalachian Plateau and Ridge and Valley habitat types are typically shallow and low in fertility
along the narrow ridges and steep slopes. Valley soils are derived from shale and limestone and are relatively fertile. Blue Ridge soils, formed primarily from metamorphic and igneous rocks, tend to be deeper and have better fertility than Ridge and Valley and Appalachian Plateau soils.

Piedmont habitats are characterized by Cecil sandy loam soils with red clay subsoil. Soils are generally acidic and low in organic matter, phosphorus, and nitrogen. Climax Piedmont forest type is oak/hickory.

Tidewater habitats are diverse ranging from coastal marshes, to pine, pine/oak, pine/hardwood, to bottomland hardwood. The most productive forest type for deer in Tidewater is bottomland hardwoods. Coastal plain soils are typically low in fertility.

Deer Habitat Status.----For current deer management purposes, available deer habitat is considered to be the sum of forested and cropland acreage. Deer habitat inventory data are maintained on a county basis from the Virginia Department of Forestry and U.S. Department of Agriculture data. Since 1947, there has been an approximate 7% decrease in available deer habitat statewide. Most of this decline has been due to a 25% decrease in cropland acreage from 9,013 square miles in 1947 to 6,732 square miles in 1994. Forested area has been fairly stable over this period, declining less than 1%. Overall, approximately 31,782 square miles or 80% of the land area in Virginia is considered deer habitat.

A factor that has negatively influenced and will continue to influence deer on public land in western Virginia is deterioration in the quality of deer habitat. The habitat on the National Forest over much of Virginia has progressively grown more mature to the point of becoming less desirable for deer. Deer habitat quality, which is closely related early successional stages and to the interspersion of different habitat types or edge, is lacking on many National Forest lands. Timber harvesting to regenerate mature stands of oaks can provide deer and other wildlife with a lush amount of vegetation for food and cover. However, timber harvests on the National Forest have been reduced significantly during the last 20 years due to national public opinion and budget restrictions in the U.S. Forest Service.

Increased urbanization and development in eastern and central Virginia is expected to have significant effects on the levels and rate of habitat loss in these areas. Many Virginia cities currently are considered to have less than half of their land in deer habitat. These include Virginia Beach (49%), Henrico (44%), Virginia Beach (16%).

Deer Population.---- Virginia's deer herd has increased dramatically over the past six to seven decades (Figure 1). However, liberalized hunting regulations have not appeared to have been successful in controlling herd growth.

Deer Population Status.----Population status is monitored using an antlered buck harvest rate per unit area (e.g., county) index. Antlered buck harvest rates per unit area are routinely used to provide population indices and monitor population trends in deer populations throughout the United States and are based on the fact that, in most habitats, deer populations exhibit density dependent population responses with deer condition and reproductive rates inversely related to deer density

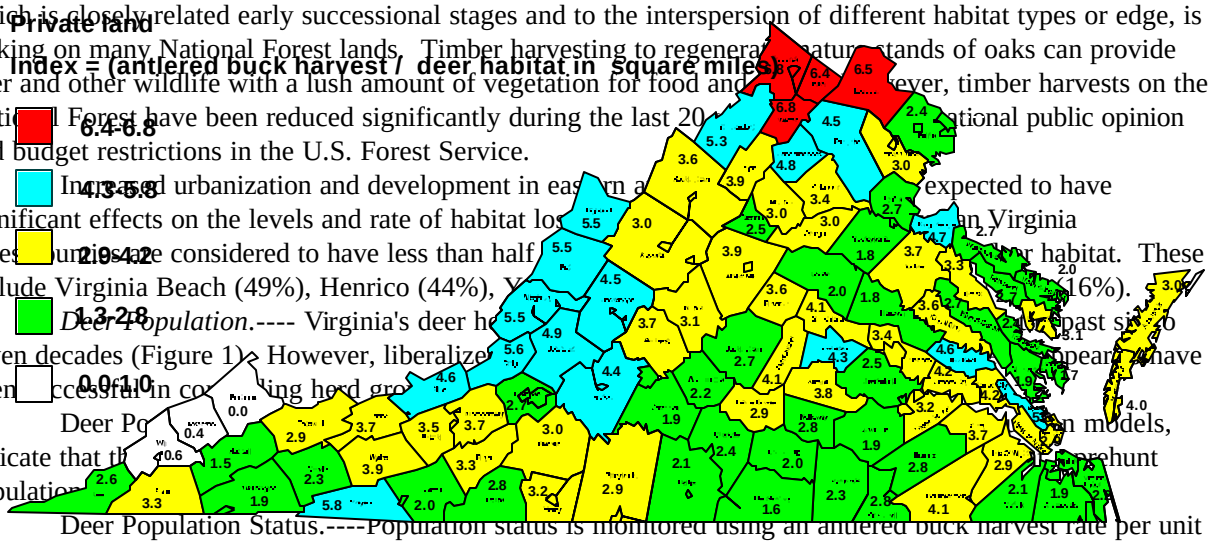


Figure 8. 1995 Virginia private land deer population index by management unit.

This population/habitat relationship results in a distinctive parabola shaped recruitment curve with maximum sustained yield for all deer occurring at a population density of approximately 60% of BCC. Maximum sustained yield for antlered bucks, however, occurs at higher densities, 70-80% of BCC, in populations harvested in a buck-predominated manner. Deer populations at ≥90% of BCC are generally characterized by buck-only hunting regulations. Deer populations at BCC are by definition unhunted.

Virginia has very few deer herds that could be characterized as at, or approaching, the BCC, and most of these could be characterized as isolated refuges. Although frequently viewed as overpopulated by the press, most of Virginia's deer herds are managed through hunting at relatively low population densities, in fair to good physical condition well below the BCC.

Current population indices by management unit, private and public land, are shown in Figures 8 and 9. Data shown are based on a three-year average (1994-96) antlered buck harvest rate per square mile

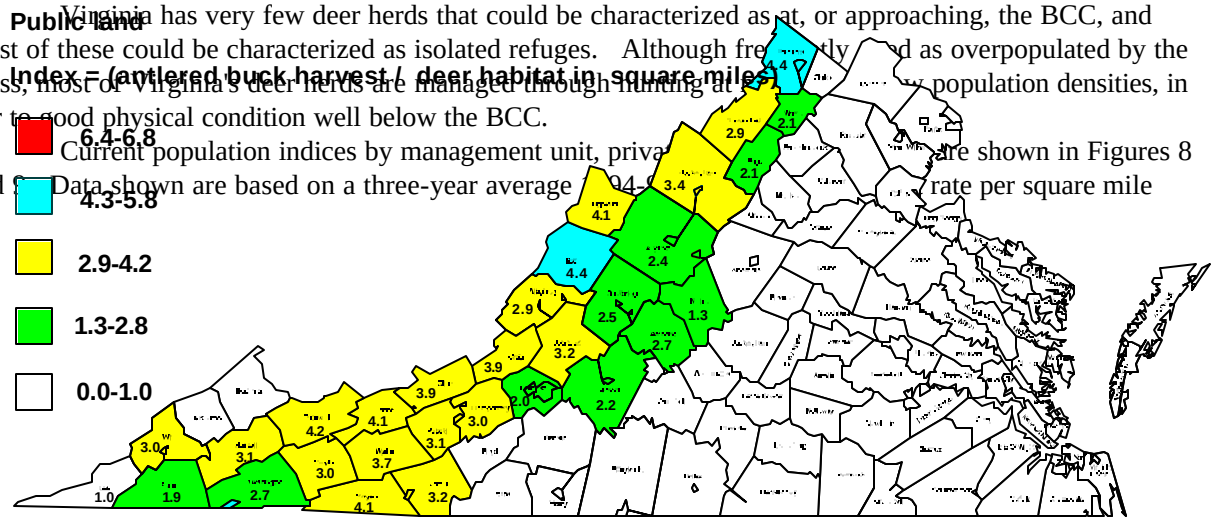


Figure 9. 1995 Virginia public land deer population index by management unit.

of habitat. Antlered buck harvest figures are based on check station data. Habitat is defined on a county basis as the sum of forested and cropland acreage as described by the Virginia Department of Forestry and the U.S. Department of Agriculture. Changes in forested and cropland areas are assumed to be linear over time. County groups were determined by cluster analysis.

Demand

Deer Hunter Demands.---- White-tailed deer are the most popular game species in the Commonwealth of Virginia. During the 1995-96 deer season, more than 230,000 deer hunters spent nearly 3.8 million days afield in pursuit of deer. Traditionally, the number of deer hunters and days spent afield hunting have provided the most common measures of demand for deer management programs. Data on these indices are

obtained through license sales and periodic hunter surveys. Initiated in 1968, a hunter survey questionnaire has been conducted every five years using a 2% random sample of resident hunting licenses. Hunter surveys do not include nonresident hunters or nonlicensed hunters (e.g., private landowners). Since the 1993-94 season, hunter surveys have been conducted annually.

Deer Hunter Numbers ---According to the latest hunter survey (1995-96) there were approximately 232,000 r 00 archer, a re than 14,000 be r surveys.

years (Figure 1 crease over the p e in muzzleloa ading season in

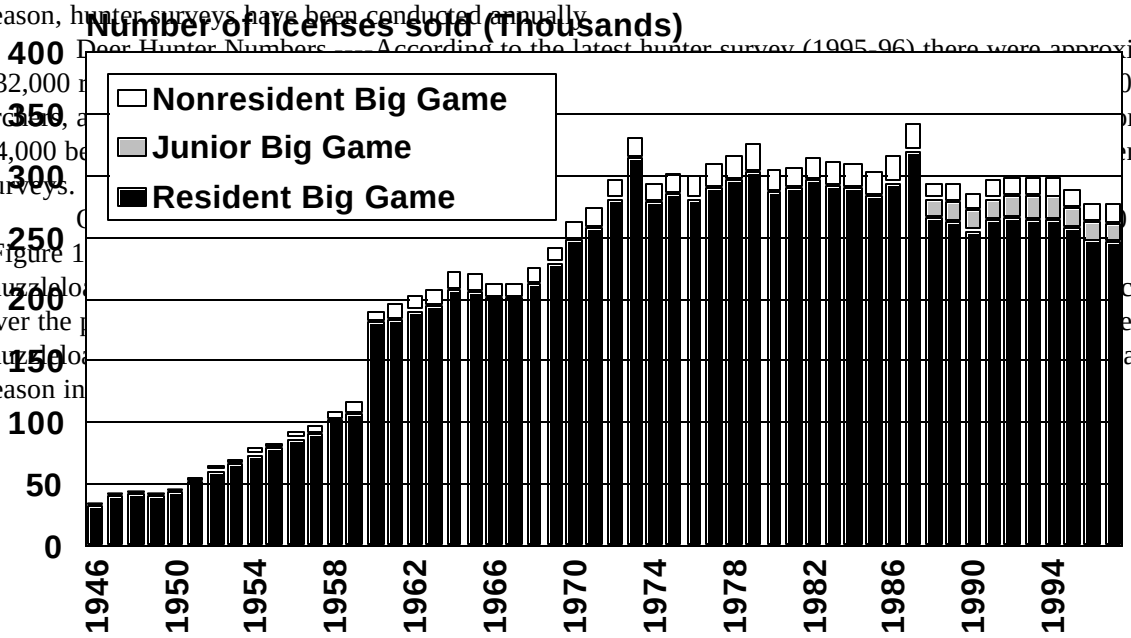


Figure 11. Virginia big game license sales, 1946-1997.

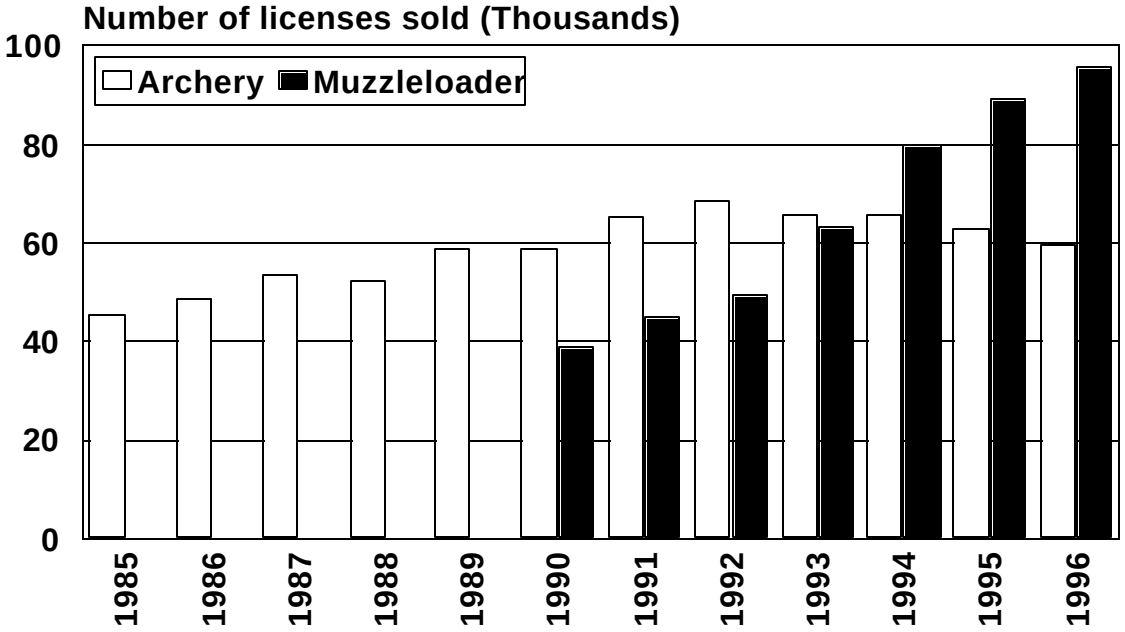


Figure 12. Virginia archery and muzzleloading license sales, 1985-1996.

Similar to hunter survey data, license sales also indicate a recent decrease in total deer hunter numbers (Figure 11). Bear, deer, and turkey (big game) license sales indicate a decline in hunter participation over the past several years. From a fairly stable average of 313,211 total big game licenses sold annually in the 15 years between 1973-87, total big game license sales in the seven years, 1988-94, declined approximately 6%, averaging 294,125. Some of this decline may be attributed to a license price increase in 1988, which resulted in a 30% decline in nonresident big game license sales. The 1981-87 average of 20,017 nonresident licenses sold decreased to a 1988-94 average of 13,929. Correlations between big game license sales and deer hunter numbers are not exact because big game licenses also include bear and turkey hunters.

However, because hunter surveys indicate that over 90% of licensees hunt deer, big game license sales probably indicate deer hunting trends.

A special archery license initiated in 1985 demonstrated steady early growth, peaking at 68,633 in 1992 (Figure 12). Since 1992, archery license sales have declined slightly.

Sales of a special muzzleloading license, initiated in 1990, have demonstrated significant annual increa… …d are contin… …ses. repres… …he number… …he same period… …1994, reside…

Table 1…

Year			
1981	5,430,000	325,653	6.0
1982	5,485,200	328,462	6.0
1983	5,555,900	329,823	5.8
1984	5,635,500	316,452	5.6
1985	5,702,000	310,079	5.4
1986	5,794,700	320,092	5.5
1987	5,915,600	355,248	6.0
1988	6,015,100	285,541	4.7
1989	6,113,319	277,938	4.5
1990	6,189,000	268,895	4.3
1991	6,287,000	265,965	4.2
1992			
1993			
1994			

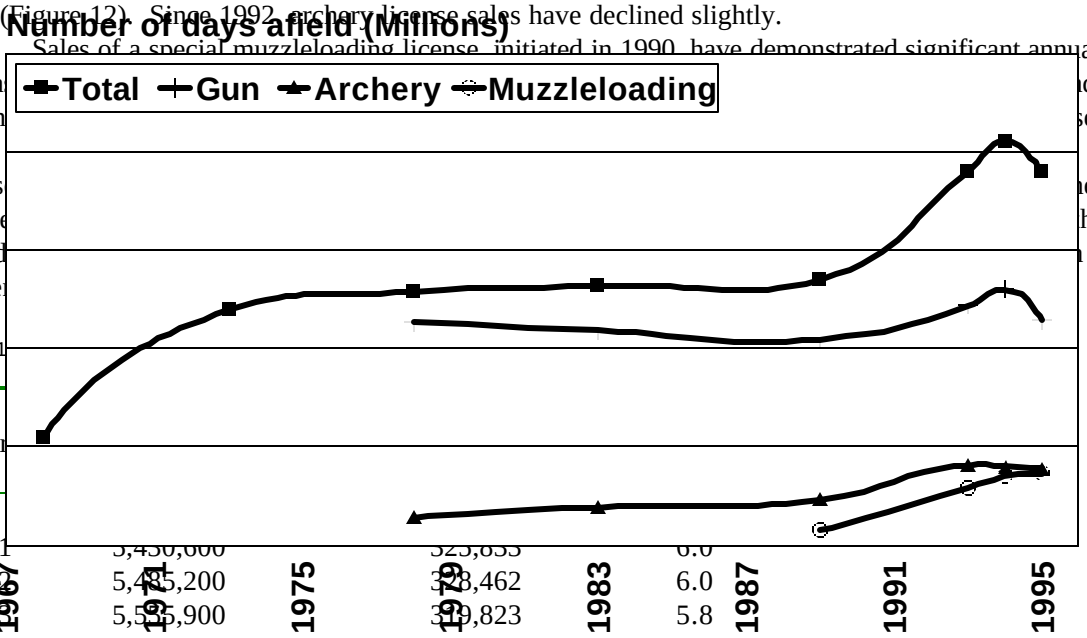
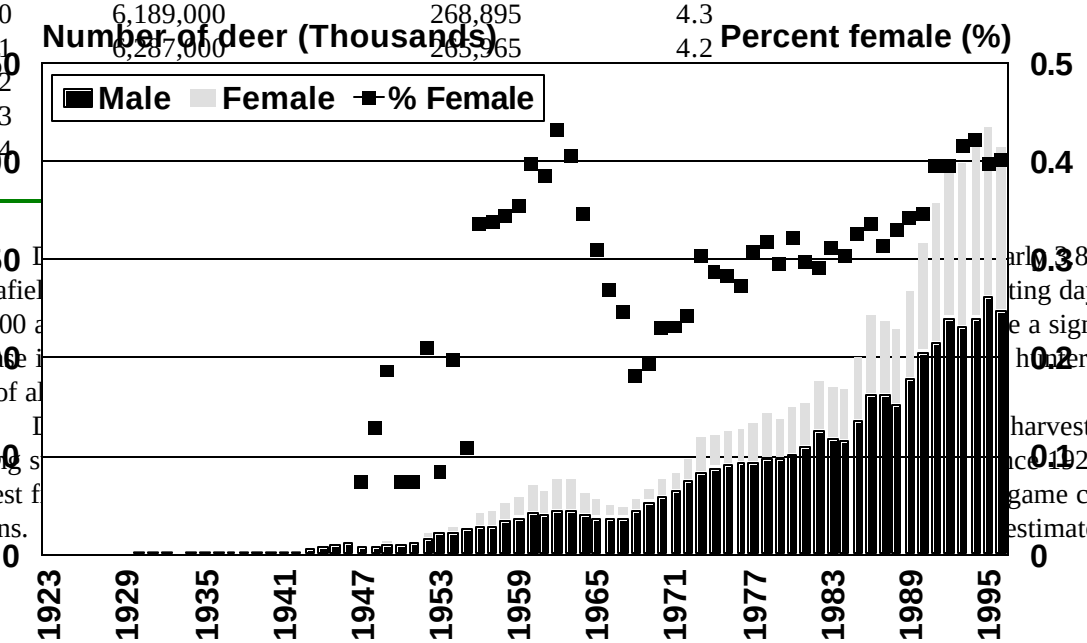


Figure 13. Virginia deer hunter days afield, 1968-1995.



I… …arly 1.8 million days afiel… …ting days, over 778,000 a… …e a significant incre… …hunter survey, 48% of al…

I… …harvest and hunting s… …ce 1923. Harvest f… …game check stations. …estimated 793

Figure 14. Virginia deer harvest, 1923-1996.

deer in 1923 to approximately 200,000-220,000 deer in each of the past five seasons, Virginia's annual deer harvest has, with the exception of a short period during the early to mid 1960's, demonstrated a consistent increase (Figure 14). During the 1996-97 deer season, 208,176 deer were reported harvested in Virginia.

Deer Hunter Success.----Deer management ... success rates. Successfu... hunter surveys. ... (Table 2). Much of ... than doubled b... -sex opportuni...

Table 2. Vi...

Season				
Archery	23.2	26.9	29.9	28.2
Muzzleloader	14.5	32.8	36.6	37.3
General Firearms	47.9	48.4	50.3	59.5
Statewide Avg.	47.8	54.2	57.1	56.6

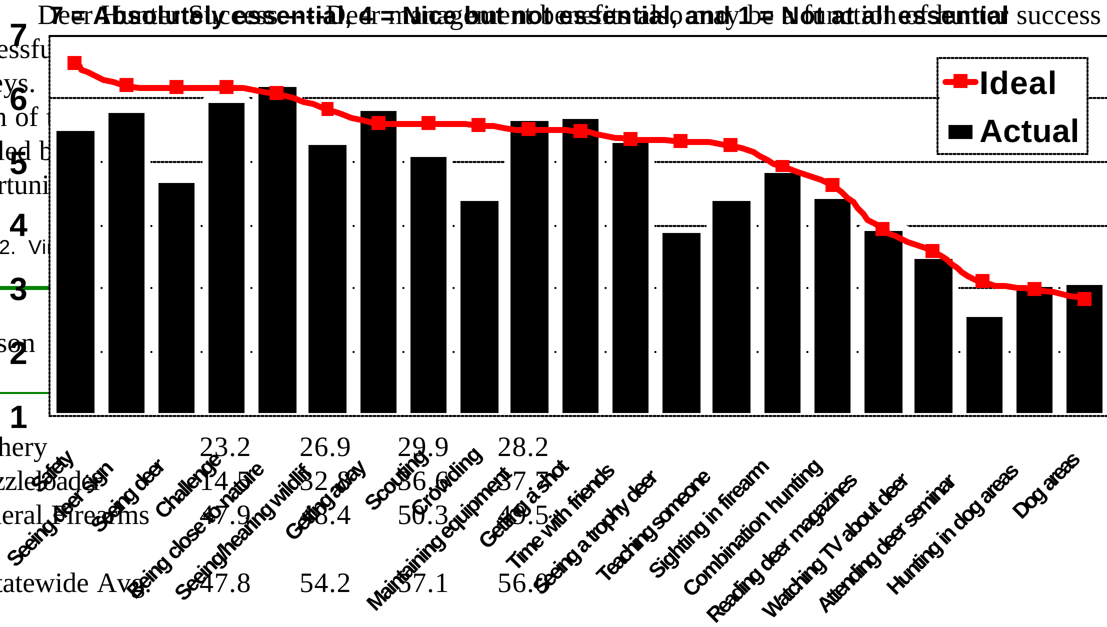


Figure 15. 1994 Virginia gun hunter satisfactions, ideal versus actual.

Deer Hunter Satisfactions.----Over the past several decades, traditional concepts of game-bagged and days afield measures of deer management results have been criticized. Traditional harvest and effort indices assume that maximizing deer harvests and deer hunter days afield increases hunter benefits. Critics of these traditional indices have proposed that the most significant products of wildlife management were hunting experiences, which produce satisfaction of demands and proposed a multiple satisfaction approach to game management. Numerous hunter motivation and satisfaction studies demonstrate that many variables are important in hunter satisfaction.

Table 3. Virginia deer gun hunter satisfaction index.

Physiographic Region	1993	1994	1995
Tidewater	4.83	4.59	4.60
Southern Piedmont	4.32	4.35	4.28
Southern Mountain	3.75	3.91	3.91
Northern Mountain	3.64	3.82	3.66
Northern Piedmont	4.60	4.53	4.67
Statewide Avg.	4.18	4.21	4.18

To measure Virginia's deer hunter satisfaction, a hunter satisfaction index (HSI) (rated on a 7-point Likert scale; 1: poor, 4: adequate, 7: excellent) was introduced in the 1993-94 hunter survey. When asked "*Overall, how do you rate the quality of your deer (gun) hunting?*", statewide respondents rated the 1995-96 season as 4.18. HSI's demonstrated significant physiographic region differences ranging from a high of 4.67 in the northern Piedmont to a low of 3.66 in the northern Mountains (Table 3). Significant differences in satisfaction levels also occurred within regions. For the 1994-95 season, public hunters west of the Blue

Ridge Mountains rated their deer hunting quality as 3.47 (below adequate), while western private land deer hunters rated their deer hunting quality as 4.39 (above adequate).

To determine what satisfaction factors are important to Virginia deer hunters, gun deer hunters were asked to evaluate 21 different hunter satisfaction variables on the 1994-95 survey. Evaluations were based on their relative perception of an ideal hunting season versus the actual season just experienced. In an ideal season, Virginia deer hunters ranked feeling safe in the field as the most important satisfaction component followed by seeing deer signs while hunting, seeing deer while hunting, the challenge of deer hunting, etc. (Figure 15).

The difference between ideal and actual ratings of satisfaction components can be regarded as a measure of hunter satisfaction/dissatisfaction. Four satisfaction components had negative differences between ideal and actual experiences of greater than 1. In order of dissatisfaction these components were seeing deer (-1.45), seeing a trophy deer (-1.39), crowding (-1.16), and safety (-1.00). Deer hunters were most satisfied with the components of deer hunting that involved getting away, getting a shot, maintaining equipment, and being close to nature.

Virginia's 1994-95 results would appear to confirm previous work which noted that perception of deer population size is the single most important satisfaction variable under management control, and deer management programs that maintain populations at low densities ($\leq$MSY) may be destined to produce dissatisfied hunters. Although Virginia gun deer hunters appear to be dissatisfied with opportunities for seeing deer while hunting, the satisfaction level most closely associated with hunter success (i.e., getting a shot) would appear to be meeting hunter expectations.

Deer Damage Demands.----Deer management demands are not only related to hunter recreation. Much of the pressure for the change in deer management direction that took place during the late 1980's can be attributed to the adverse effects of deer. Examples of nonhunter demands commonly associated with Virginia's deer herds include crop depredation, deer-vehicle collisions, urban deer conflicts, and deer ecosystem impacts.

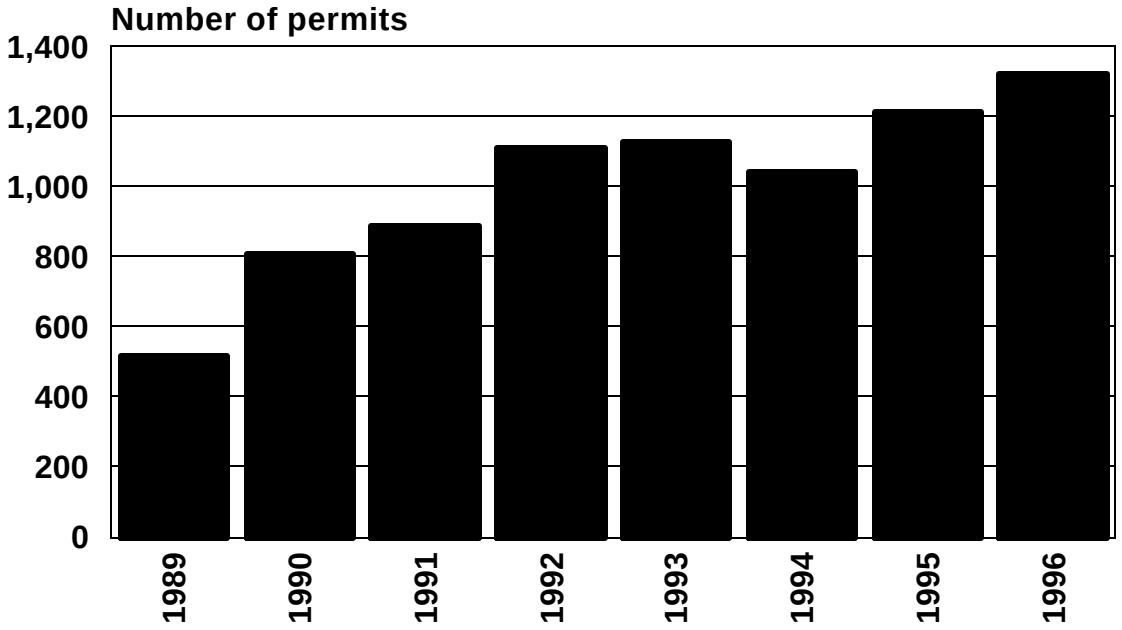


Figure 16. Virginia deer kill permits, 1989-1996.

Deer Crop Damage.----A deer damage committee established by the VDGIF estimated that the amount of agricultural crop damage caused by deer in Virginia in 1992 was approximately $11.4 million. The majority of this damage was to soybeans, peanuts, and orchards at $6.3, $2.0, and $1.9 million, respectively. Deer damage to property in urban/suburban environments (e.g., damage to ornamental plantings, shrubbery, and vegetable gardens) was not estimated.

In fall 1996, a deer damage study funded by the Virginia Deer Hunters Association and conducted by Virginia Polytechnic Institute and State University surveyed 1,506 agricultural producers and homeowners to evaluate their beliefs and opinions about deer and deer damage. Overall, 732 completed questionnaires were returned; 471 were received from producers and 261 were received from homeowners. Among all respondents, 58% reported experiencing deer damage during 1995. Although producers were more likely to report damage than homeowners (71% versus 36% respectively), those producers and homeowners that reported damage also reported similar damage severity. Damage occurrence and severity varied greatly among commodity groups, with soybean, peanut, and tree fruit producers being likely to report greater damage severity whereas forage producers typically reported the least severe damage. Among all respondents, 70% indicated a desire to reduce Virginia's deer population. As expected, the occurrence and severity of damage greatly affected respondents' desire for future population management

Issuance of deer kill permits is used as an index of deer crop damage demands by management unit. As shown in Figure 16, issuance of these permits has demonstrated a significantly increasing trend over the past several years increasing from 515 permits in 1989 to 1,323 in 1996.

Deer Vehicle Collisions.----Deer-vehicle collisions are one of the most critical deer damage demands in Virginia. Although reliable data are not available, it is safe to assume that tens of thousands of deer-vehicle collisions take place in the Commonwealth each year. For example, in Pennsylvania where data on deer-vehicle accidents are monitored, deer-vehicle collisions typically exceed 40,000 annually. If one assumes there are 25,000 deer-vehicle collisions in Virginia annually, with a conservative estimate of $1,000 in

damages per accident, then resulting property damage would be at least 25 million dollars. In the 10 years, 1985-1994, there were twelve fatalities reported as a result of deer-vehicle collisions in Virginia.

Urban Deer Conflicts.----Urban deer conflicts are one of the fastest growing deer management issues in Virginia. Over the past five years, the Department has been officially contacted by numerous city and county governments, landowner associations, and private landowners regarding urban deer issues. Urban deer management circumstances typically involve nonhunted residential areas where deer populations have exhibited significant population increases leading to high levels of damage to ornamentals and property. Several Virginia cities currently have urban deer management programs in place, and several more are being contemplated. Urban deer management issues and their unique deer management situations are expected to increase significantly in the northern Piedmont and Tidewater regions as human populations continue to expand.

Deer Ecosystem Impacts.----Deer-ecosystem impacts are one of the more recent management concerns associated with high-density deer herds in Virginia. The effects of high-density deer herds on forest composition and regeneration, habitat structure, and species diversity are just beginning to be studied and appreciated. The presence of a conspicuous browse line is indicative of the potential impact on habitat caused by deer browsing. Not only do these deer habitat consequences affect deer herd health, they can also displace other wildlife communities (e.g., neotropical migrant songbirds and small mammals) that are dependent upon understory vegetation removed by deer browsing.

Nonconsumptive Deer Demands.----In spite of damage demands, Virginia's white-tailed deer represent a beneficial economic and social resource. The 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation reported that Virginia in-state hunter expenditures (resident and nonresidents) was $84,624,000. This figure includes only direct hunting expenditures and does not utilize an economic multiplier factor. Also, according to the 1991 National Survey, nonconsumptive wildlife activities (which include observing and photographing wildlife) contributed an additional $146 million dollars to Virginia's economy. Unquestionably, the considerable aesthetic and social values of white-tailed deer contribute a significant proportion of Virginia's nonconsumptive wildlife value.

Public Perception of Deer Populations.----At each regional deer management plan meeting, all participants were asked to complete a short two-part survey. First, they were asked their perspective of deer population(s) status (i.e., density) in several different geographical areas within their region. Geographical area clusters were based on subjective evaluations of regional Wildlife Division staff and were based on similar geography, deer density indices, and land use patterns. Statewide there were 19 separate geographical areas differentiated within the Department's five administrative regions (see Figure 17). Opinions of deer herd status were solicited using the question: *In your opinion, how do you perceive the deer herd in each of the following geographical areas?* Answer options by geographical area included: high, moderate, low, and no opinion.

Secondly, all participants were asked what their deer population objective would be. Opinions of deer population management objectives were solicited using the question: *In your opinion, would you increase, decrease, or stabilize the deer herds in each of the following geographical areas?* Answer options by geographical area included: increase, stabilize, decrease, and no opinion.

With the exception of the northern Virginia meeting survey which was conducted by mail several months after the deer management plan meeting, all status/objective surveys were conducted at the start of the meeting. This was done to avoid prejudicing participants' opinion(s) with discussions of deer ecology, management, or current status. West of the Blue Ridge Mountains, meeting participants were surveyed twice to separate opinions between public (National Forest and Department-owned lands) and private lands.

To quantify participants' status and objective surveys, a mean response index was calculated on a 3-point Likert scale. For deer herd status the scale was -1 = low, 0 = moderate, and 1 = high. For deer management objective the scale was -1 = decrease, 0 = stabilize, and 1 = increase.

Participants' views of deer population density and desired population objective varied within regions, between regions, and between public and private lands. Statewide results of the herd status and management objective survey are shown in Tables 4 and 5 respectively.

Overall, the majority of participants' private land deer population management objectives were to stabilize deer populations at current levels (Table 5). Exceptions include a strong desire to increase deer

Table 4. Private/public deer population status by administrative region and geographical area.

	High (+1)	Moderate (0)	Low (-1)	No Opinion	Mean
Private Land					
Region 1					
Eastern Shore	6	14	3	14	0.13
Lower Peninsula	15	9	1	12	0.56
Middle Peninsula	8	15	0	14	0.35
Northern Neck	7	15	0	15	0.32
Southside	24	5	0	8	0.83
Tidewater	3	16	1	7	0.10
Region 2					
South-central Piedmont	4	9	0	4	0.31
Southern Piedmont	3	11	1	2	0.13
Southwest Piedmont/Mountains	2	9	1	5	0.08
West-central Piedmont/Mountains	5	7	1	4	0.31
Region 3					
Blue Ridge	5	9	0	1	0.36
Cumberland Plateau	0	2	9	5	(0.82)
New River Valley	6	7	0	4	0.46
Tennessee River Valley	2	6	2	5	0.00
Region 4					
Alleghany Highlands	6	4	0	3	0.60
Shenandoah Valley	4	7	2	2	0.15
Northern Shenandoah Valley	5	4	0	4	0.56
Region 5					
Central Piedmont	2	7	1	0	0.10
Northern Virginia	16	0	0	0	1.00
	High (+1)	Moderate (0)	Low (-1)	No Opinion	Mean
Public Land					
Region 3					
Blue Ridge	4	6	3	2	0.08
Cumberland Plateau	0	3	8	4	(0.73)
New River Valley	5	8	1	3	0.29
Tennessee River Valley	1	5	3	6	(0.22)
Region 4					
Alleghany Highlands	2	6	2	3	0.00
Shenandoah Valley	2	6	3	2	(0.09)

Northern Shenandoah Valley	1	6	2	4	(0.11)

Table 5. Private/public deer population objective by administrative region and geographical area.

	Increase (+1)	Stabilize (0)	Decrease (-1)	No Opinion	Mean
Private Land					
Region 1					
Eastern Shore	5	15	2	15	0.14
Lower Peninsula	1	13	11	12	(0.40)
Middle Peninsula	1	17	5	14	(0.17)
Northern Neck	3	15	3	16	0.00
Southside	1	10	17	9	(0.57)
Tidewater	0	18	10	9	(0.36)
Region 2					
South-central Piedmont	2	9	2	4	0.00
Southern Piedmont	3	9	2	3	0.07
Southwest Piedmont/Mountains	3	7	1	6	0.18
West-central Piedmont/Mountains	3	6	3	5	0.00
Region 3					
Blue Ridge	0	13	1	1	(0.07)
Cumberland Plateau	9	3	0	4	0.75
New River Valley	0	11	3	3	(0.21)
Tennessee River Valley	3	8	0	4	0.27
Region 4					
Alleghany Highlands	1	4	5	3	(0.40)
Shenandoah Valley	1	8	2	2	(0.09)
Northern Shenandoah Valley	0	8	1	4	(0.11)
Region 5					
Central Piedmont	0	10	0	0	0.00
Northern Virginia	0	3	13	0	(0.81)
	High (+1)	Moderate (0)	Low (-1)	No Opinion	Mean
Public Land					
Region 3					
Blue Ridge	5	7	0	2	0.42
Cumberland Plateau	10	1	0	4	0.91
New River Valley	2	11	1	2	0.07
Tennessee River Valley	6	4	0	4	0.60

Region 4					
Alleghany Highlands	3	6	2	2	0.09
Shenandoah Valley	6	5	1	1	0.12
Northern Shenandoah Valley	3	6	2	4	0.33

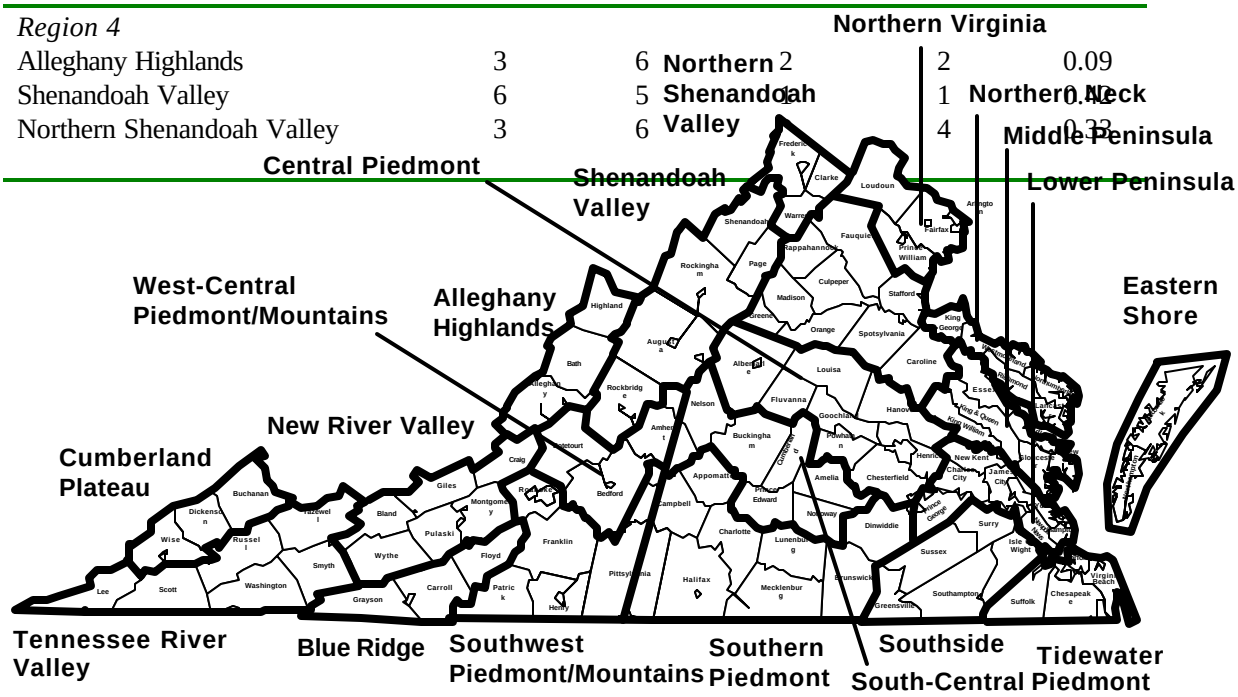


Figure 17. Geographical areas used in regional deer management plan meetings/surveys.

population levels in the Cumberland Plateau counties of Buchanan, Dickenson, and Wise and a strong desire to reduce deer population levels in the northern Virginia counties of Fairfax, Loudoun, and Prince William (Table 5).

On public lands west of the Blue Ridge Mountains, participants' deer population management objectives were varied within and between regions. Public land deer population increases were desired in the Blue Ridge (Carroll and Grayson counties), Cumberland Plateau (Dickenson and Wise counties), Northern Shenandoah Valley (Frederick and Warren counties), Shenandoah Valley (Page, Rockingham, and Shenandoah counties), and Tennessee River Valley (Lee, Russell, Scott, Smyth, Tazewell, and Washington counties). Stabilized deer populations were desired on public lands in the Alleghany Highlands (Alleghany, Bath, and Highland), New River Valley (Bland, Craig, Giles, Montgomery, Pulaski, and Wythe counties), and Shenandoah Valley (Augusta and Rockbridge counties). Stable deer populations were also desired on public and private lands in Botetourt and Roanoke counties.

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AN EVALUATION OF DEER MANAGEMENT OPTIONS

Acknowledgement

An Evaluation of Deer Management Options was co-authored by Mark R. Ellingwood, a Deer Biologist for the Connecticut Department of Environmental Protection, Wildlife Bureau and Suzanne L. Caturano, Public Awareness Biologist for the Connecticut Department of Environmental Protection, Wildlife Bureau. Originally published in 1988 by the Connecticut Department of Environmental Protection, Wildlife Bureau (Publication No. DR-11), the publication was collectively developed by the New England Chapter of The Wildlife Society and the Northeast Deer Technical Committee. The second and third printings were paid for by the U.S. Fish and Wildlife Service Federal Aid Administrative Funds, FY89 and FY96. The text that follows is an abridged version of the latest revision, NH Fish & Game Dep. (1996), printed with the permission of the lead author and the Connecticut Department of Environmental Protection, Wildlife Bureau.

At the request of the deer management planning committee, an additional reference, *Management of urban deer populations with contraceptives: practicality and agency concerns* co-authored by Robert J. Warren and Lisa M. White, was secured regarding fertility control (see Appendix X).

Introduction

The white-tailed deer is the most abundant and best-known large herbivore in the United States. Whitetails are valued and appreciated by large segments of society. State and provincial wildlife agencies are responsible for the management of this invaluable resource.

Considerable confusion and controversy exists concerning white-tailed deer management. The objective of this booklet is to explain the rationale behind deer management and to discuss the utility of various management options.

A Brief History of Deer Management

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

Components of Deer Habitat

White-tailed deer require adequate food, water, cover, and living space in a suitable arrangement in order to ensure their healthy survival. Deer eat a wide variety of herbaceous and woody plants in accordance with their nutritional value and their local and seasonal availability. Water requirements are met through the drinking of water and from the consumption of succulent vegetation. Good habitat provides shelter from extreme temperatures and precipitation, as well as protection and concealment from predators.

Population Growth and the Concept of Carrying Capacity

Deer populations have the potential for rapid growth. Under normal circumstances, does 2 years old or older produce twins annually, while yearling does typically produce single fawns. On excellent range, adult does can produce triplets, yearlings can produce twins, and fawns can be bred and give birth during their first year of life. In the absence of predation or hunting, this kind of reproduction can result in a deer herd doubling its size in one year. This fact was illustrated on the 1,146-acre George Reserve in southern Michigan when the deer herd grew from six to 162 individuals in six years (1928-1933) (McCullough 1979). More recently, the George Reserve herd grew from ten deer in 1975 to 212 deer in 1980 (McCullough 1984).

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

The importance of compatibility between land-use practices and deer populations in urban areas justifies consideration of another aspect of carrying capacity. "Cultural Carrying Capacity" (CCC) can be defined as the maximum number of deer that can coexist compatibly with local human populations (Ellingwood and Spignesi 1986). Cultural carrying capacity is a function of the sensitivity of local human populations to the presence of deer.

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

Consequences of Deer Overpopulation

As previously indicated, deer populations have the ability to grow beyond BCC. When BCC is exceeded, competition for limited food resources results in overbrowsing (Dasmann 1971, Dasmann 1981).

Severe overbrowsing alters plant species composition, distribution, and abundance, and reduces understory structural diversity (due to the inability of seedlings to establish themselves). These changes may have a deleterious impact on local animal communities which depend on healthy vegetative systems for food and cover. In time, overbrowsing results in reduced habitat quality and a long-term reduction in BCC. Coincident with overbrowsing is a decline in herd health. This decline is manifest in decreased body weights, lowered reproductive rates, lowered winter survival, increased parasitism, and increased disease prevalence (Eve 1981). In the absence of a marked herd reduction, neither herd health nor habitat quality will improve, as each constrains the other. Such circumstances enhance the likelihood of die-offs due to disease and starvation.

Deer overabundance often leads to a high frequency of deer/vehicle collisions, as well as excessive damage to commercial forests, agricultural crops, nursery stock and landscape plantings (Marquis and Brenneman 1981, Matschke et al 1984). In addition, studies suggest that a correlation exists between high deer densities and the incidence of Lyme disease, an arthritic disease that can be contracted by humans (Anderson et al 1987).

A Justification for Deer Population Management

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

Deer Management Options

Option 1 – Use Regulated Hunting as a Deer Management Tool.----Regulated hunting has been proven to be an effective deer population management tool (Hesselton et al 1965, McCullough 1979). In addition, it has been shown to be the most efficient and least expensive technique for removing deer (Palmer et al 1980). Wildlife management agencies recognize deer hunting as the only effective, practical and flexible method available for regional deer population management and, therefore, rely on it as their primary management tool. Through the use of regulated hunting, biologists strive to maintain deer populations at desirable levels or to adjust them in accordance with local biological and/or social needs. They do this by manipulating the size and sex composition of the harvest, season type, season timing, season length, number of permits and land-access policies.

Values associated with white-tailed deer management are diverse and extensive (Langenau et al 1984). Ecological benefits derived from regulated hunting include protection of our environment from overbrowsing (Arnold and Verme 1963, Behrend et al 1976), protection of flora and fauna that may be negatively affected by deer overpopulation and the maintenance of healthy, viable deer populations (Hesselton et al 1965, McCullough 1979) for our benefit and that of future generations. Social benefits which result from regulated hunting include: increased land-use compatibility stemming from fewer land-use/deer conflicts, human safety benefits resulting from reduced deer/vehicle incidents, diverse educational and recreational opportunities, and emotional benefits associated with a continued presence of healthy deer herds. Regulated hunting provides economic benefits in the form of hunting-related expenditures. Researchers estimated nationwide deer hunter expenditures during 1991 at $4.5 billion. Estimated values received by hunters and non-hunters was $12.3 billion and $18.1 billion, respectively (U. S. Fish and Wildlife Service 1992). An economic evaluation of regulated deer hunting should also include costs that would be incurred in the absence of

population management. As an example, the cost of agricultural commodities, forest products, and automobile insurance would likely increase if deer populations were left unchecked.

Option 2 – Allow Nature to Take Its Course.----In the absence of regulated hunting, deer herds would grow until they reached the upper limit at which they could be sustained by local habitat. Herds at this "upper density limit" consist of deer in relatively poor health (Dasmann 1981). High density herds such as these are prone to cyclic population fluctuations and catastrophic losses (McCullough 1979). Such herds would be incompatible with local human interests and land-use practices. Disease and starvation problems in the Great Swamp National Wildlife Refuge, New Jersey (Rue 1979); damage to ornamentals on Block Island, Rhode Island; vegetation destruction at Crane Beach, Massachusetts; roadkill problems in Princeton, New Jersey; and forest regeneration difficulties on Connecticut's Yale Forest are but a few examples of the deleterious impacts of a "hands off" deer management policy. Allowing nature to take its course could result in a significant negative effect on other plant and animal species as well as local deer herds. In extreme cases, the balance achieved by "hands off" management may be local herd extinction (Smith 1986). It is important to note that humans have had a dramatic effect on the ecology of North America. Among other things, they have altered landscapes, changed and manipulated plant communities, displaced large predators, eliminated a variety of native species, and introduced numerous exotics. Natural systems and regulatory processes have changed as a result of these effects. Adopting a "hands off" policy will not restore North American ecosystems to a pristine state.

Deer evolved under intense predation and hunting pressure. In precolonial times many Native American tribes hunted deer year-round and depended on them as their primary food source (McCabe and McCabe 1984). Mountain lions, wolves, bobcats, and bears all utilized the precolonial deer resource. The high reproductive capability of present-day herds likely reflects intense predation and hunting in the past. As a consequence, it would seem inaccurate to describe a deer herd in today's environment, with few if any predators and no hunters, as "natural." In fact, active management in the form of regulated hunting seems to be a more natural option than the "hands off" approach. Active deer population management offers distinct ecological, social, and economic benefits to society. Few such claims can be made for the "hands off" option. In fact, there are significant costs associated with the "hands off" approach to deer management.

Option 3 – Trap and Transfer Excess Deer to Other Locations.----This option would include the use of trapping, netting and/or immobilization for the purpose of capturing and relocating deer. Trap-and-transfer efforts have proven to be labor intensive and prohibitively expensive. Research conducted with an urban deer herd in Wisconsin (Ishmael and Rongstad 1984) resulted in capture costs ranging from $113 to $570 per deer ($412 per deer for all capture methods combined). Similar work conducted on Long Island, New Hampshire, and Angel Island, California (O'Bryan and McCullough 1985) resulted in costs of $800 and $431 per deer, respectively.

Aside from problems of cost and logistics, large scale trap-and-transfer programs would require release sites capable of absorbing large numbers of relocated deer. Such areas are often lacking. The potential negative effect that translocated deer could have on local BCC and/or CCC is an additional concern. Land-use conflicts and disease concerns caused by translocated deer could lead to questions of liability.

Deer are susceptible to traumatic injury during handling. Trauma losses average approximately four percent during trap-and-transfer efforts. Capture myopathy, a stress-related disease that results in delayed mortality of captured deer, is thought to be an important (and often overlooked) mortality factor. Delayed mortality as high as 26 percent has been reported (Rongstad and McCabe 1984).

Survival rates of relocated deer are frequently low. Trap-and-transfer efforts in California, New Mexico and Florida resulted in losses of 85, 55 and 58 percent, respectively, from four to 15 months following relocation (O'Bryan and McCullough 1985).

The poor physical condition of deer from an overpopulated range and the behavior of some deer from overpopulated urban settings predispose them to starvation, accidents and dog predation following relocation into new surroundings.

An additional concern associated with relocation of deer, especially from an overpopulated range, is the potential for spreading disease. The presence of Lyme disease in some areas of North America makes this a timely consideration.

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

Option 4 – Use Fencing and Repellents to Manage Conflicts with Deer Populations.----To the extent that fencing and repellents are practicable, wildlife agencies regularly recommend them to address site-specific problems. Application of repellents and/or fencing can only be justified economically when the financial gain yielded by protection is equal to or greater than the cost of implementation. Research conducted in New York's Hudson Valley revealed that it costs approximately $70/acre/year to implement an orchard repellent spray program (Ellingwood et al 1983). Similar work conducted in Connecticut nurseries indicated that repellent costs (equipment and labor excluded) ranged from $10 to $396 per acre for a single application (Conover 1984). In New York, it was determined that it cost approximately $18/acre/year (when pro-rated over a 10-year period) to protect a 25-acre parcel with a moderately priced, high-tensile electric fence. Under the same circumstances, it would cost $60/acre/year to use an eight-foot woven-wire fence (Ellingwood and McAninch 1984). Economic, personal, and aesthetic considerations typically restrict the use of these techniques to cost effective applications.

There are constraints that limit the applicability of various damage abatement techniques. High-tensile electric fencing requires regular maintenance and is best suited to areas of good soil depth and moderate terrain. Electric fences suffer from seasonal problems associated with poor grounding due to heavy snows and dry soil conditions. In addition, electric fences are inappropriate for use in areas where frequent human contact is likely.

Effective repellent programs require frequent applications because rapidly growing shoots quickly outgrow protection and repellents weather rapidly. Spray repellents can only be applied effectively during mild weather, so their value during winter months is restricted. Additional limits on repellent use stem from plant damage concerns, labeling restrictions, equipment problems (heavy binding agents and repellent slurries clog equipment), and difficulties resulting from noxious and/or unaesthetic product residues.

Repellent performance is highly variable and seems to be negatively correlated with deer density. Work conducted in New York and Connecticut indicates that repellent performance is highly variable. This seems to result from the fact that repellents are behavior modifiers; they perform well under moderate pressure but may be ignored when alternative deer foods are scarce. Electric fence performance is variable as well, apparently due to differences in deer pressure and fence quality.

There are distinct limitations on the applicability of fencing and repellent options. As an example, neither technique has value in addressing concerns relating to wide-scale deer impacts on plant and animal communities. These techniques were designed to supplement, not replace, deer population management. As a consequence, they are best employed within the context of a comprehensive deer management program. In the absence of population regulation, deer damage will increase in severity and the efficacy of abatement techniques will decline.

Option 5 – Use Fertility Control Agents to Regulate Deer Populations.----Steroidal fertility control agents (i.e., synthetic progestins and estrogens) have been evaluated for use in deer reproduction control. Research conducted on a captive deer herd in Ohio indicated that oral and intramuscular doses of diethystilbestrol (DES) significantly reduced deer productivity. However, the reduction was insufficient to contain local herd growth (Harder and Peterle 1974). In Kentucky, oral doses of microencapsulated DES

successfully interrupted deer pregnancies; but high dose requirements, aversion to treated bait, and post-treatment breeding precluded effective herd control (Matschke 1977). Additional research revealed that oral doses of melengestrol acetate (MGA) effectively inhibited deer reproduction, but daily treatment requirements made the technique impractical for use on free-ranging deer herds (Roughton 1979).

Concerns pertaining to oral contraception in deer include: cost and logistics of bait distribution, dosage control, and ingestion of bait by non-target wildlife. Based on these concerns and past research, oral contraception programs, to date, would be impractical and ill-advised.

Several studies have shown subcutaneous implants of some fertility control agents to be effective in preventing deer pregnancies (Matschke 1977, Matschke 1980). Recent advances in the delivery and efficacy of implants allows for the remote delivery of intramuscular treatments using biodegradable projectiles, with one year of effective treatment. Remote delivery reduces the probability of direct consumption of fertility control agents by nontarget species. Nonetheless, the limited life expectancy of implants, the expense involved in treatment, and the difficulty of treating an adequate portion of the herd, suggest that large-scale implant programs would be impractical. However, this technique may have value in controlling small insular herds. Unresolved questions relating to the use of implants include the effect of long-term steroid exposure on deer and the effect of steroid treated carcasses on consumers in the food chain.

Recent advances in wildlife contraception have facilitated remote delivery of antifertility agents to feral horses via dart guns (Turner and Kirkpatrick 1988). More recently, immunofertility agents have been successfully employed to control deer reproduction in penned applications. Field research in areas where deer are habituated to humans has also resulted in various degrees of successful reproductive inhibition. Advances in delivery systems, coupled with improvement in the efficacy of antifertility vaccines, improve the prospect for limited applications of wildlife contraception in the future. The cost of manpower and materials

and the practicality of treating an adequate number of deer will likely limit the use of immunocontraceptives to small insular herds habituated to humans.

Since fertility control has no short-term effect on population size, pre-treatment culling will be an essential part of the timely resolution of deer problems with fertility control agents. In addition, questions regarding the potential negative effects of fertility control agents on deer energetics and genetics remain largely unresolved.

In conclusion, fertility control in deer is a rapidly advancing technology that continues to require additional research. Fertility control may have value for use on small insular deer populations under carefully regulated conditions, but will not provide an alternative to hunting for the control of free-ranging herds (Kirkpatrick and Turner 1988). While effective fertility control agents have been identified, their use on free-ranging herds would be impractical

Option 6 – Provide Supplemental Food to Alleviate Conflicts with BCC and CCC.----Implementation of a supplemental feeding program would be counterproductive to control efforts directed at free-ranging herds because it would encourage additional population growth (Dasmann 1971). In addition, supplemental feeding on a regionwide basis would be logistically and economically impractical. Work conducted in Michigan and Colorado indicates that it costs from $37 to $53 per deer to run an ad libitum winter feeding program (Ozoga and Verme 1982, Baker and Hobbs 1985).

In Colorado, supplemental feeding of mule deer cost $183 per animal saved. While the program did reduce winter deer mortality, it failed to eliminate substantial losses. Colorado researchers concluded that supplemental feeding can be justified for use during emergency circumstances (e.g., exceptionally severe winter weather) but not as a routine method for boosting local BCC. In addition, the researchers believed that such a program was only practical when deer were densely concentrated on readily accessible range.

Researchers in Michigan concluded that "nutritional supplementation" had potential value as a management tool, but that it would only work within the context of "strict herd control" (Ozoga and Verme 1982). In many areas of North America, supplemental feeding would lead to conflicts with CCC. In addition,

it would enhance the likelihood of disease transmission between deer and predation of deer by dogs.

Supplemental feeding fails to address the cause of overpopulation. In fact, it actually compounds future deer population problems. As a result, it would seem reasonable to reject supplemental feeding as an alternative to active deer population management.

Option 7 – Control Deer Herds with Sharpshooters.----The use of sharpshooters would concede the need for population regulation. Such a task would likely require shooting throughout the year in order to control regional population growth. Even on a small scale, this option would be expensive relative to hunting.

According to the results of an urban deer removal program conducted in Wisconsin (Ishmael and Rongstad 1984), the cost averaged $74 per animal shot over bait. This cost included 13.5 hours of labor for each deer removed, at a cost of $3.65 per hour. An evaluation of techniques employed to control an enclosed deer herd in Ohio revealed that sharpshooting was a less efficient method of deer removal than controlled hunting (Palmer et al 1980).

If a sharpshooter program was instituted, local economies would experience a loss of income from hunters (U. S. Fish and Wildlife Service 1992) paying to control deer numbers (Connecticut deer hunters inject approximately $600 per harvested deer into the state economy, excluding permit expenditures). Finally, the use of sharpshooters would be exceedingly controversial in those situations where regulated hunting could be conducted, because it would deny citizens access to a renewable public resource.

Option 8 – Reintroduce Predators to Control Deer Populations.----In moderately fluctuating environments, a complement of effective predators can maintain stability in a deer herd (McCullough 1984). However, in general terms, predator-prey interactions are highly variable (Mech 1984) and tend to stabilize populations at relatively high densities (McCullough 1979). Wolves and mountain lions are examples of efficient deer predators which have been eliminated from much of the United States. Both species are frequently suggested as candidates for reintroduction to control deer herds.

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

Predator-prey relationships are complex, and the effect of predators on herbivore populations is variable. Although many answers are lacking, several points can be made concerning deer and their predators. Coyotes, bobcats, and bears are potential deer predators that currently reside throughout much of North America. These species appear to be opportunists that capitalize on specific periods of deer vulnerability. None of these predators has demonstrated a consistent ability to control deer populations. Where coyotes, bobcats, and bears are common, deer herds often exceed BCC and/or CCC.

Coyote populations have increased, and their range has expanded in North America during the past 20 years. In many areas, both deer and coyote populations have increased simultaneously. In northern New England, some biologists do suspect coyotes are partly responsible for declining deer numbers. Yet in other areas, changes in deer populations appear unrelated to coyote density. In many circumstances, coyotes and bears represent serious agricultural pests. As a consequence, they are frequently less welcome than white-tailed deer.

Even in the presence of predator-induced stable deer herds, a population reduction may be desirable from an ecological or social perspective. The fact that a deer herd has stabilized is no guarantee that such a herd is in balance with CCC or BCC.

Heavy predation coupled with year-round hunting by Native Americans was the norm for precolonial deer herds. It has been estimated that approximately 2.3 million Indians occupied the precolonial range of the white-tail and that they harvested 4.6 to 6.4 million whitetails annually (McCabe and McCabe 1984). The

human species clearly constitutes an efficient and natural deer predator. Ecological and social constraints preclude the reintroduction of large predators in much of North America.

Conclusion

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

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GOALS OF THE DEER MANAGEMENT PROGRAM

The overall mission of the deer program is to manage the deer resource in the best long-term interests of the citizens of the Commonwealth. Specific goals within this program include:

Population Goal

To manage deer populations at the desired local and regional cultural carrying capacity using technically-sound management practices (*cultural carrying capacity is the desire and/or tolerance for numbers of deer based on social, economic, political, and biological perspectives*).

The VDGIF has the legislative mandate (§29.1-103) to manage Virginia's white-tailed deer resource. The Department's strategic plan states that Virginia's wildlife populations should be managed to maintain optimum populations to serve the needs of the Commonwealth.

A. Objective - **To determine the CCC by management unit by January 1, 2004.**

Cultural carrying capacity (CCC) is defined as the maximum number of deer that can coexist compatibly with humans. CCC is a function of the tolerance levels of human populations to deer and the effects of deer. CCC can vary widely between and within communities. Development of CCC deer management objectives are subjective and involve the combination of social, economic, political, and biological perspectives. The CCC for deer generally occurs well below the biological carrying capacity (BCC).

Ideally, methods/processes used to determine local CCC's should consider all deer interests (i.e., stakeholders) in the management unit, and the community and/or stakeholders should reach a consensus on the desired deer population level/objective (increase, stabilize, or decrease).

Strategies

a. Establish the CCC by management unit using information or input on local opinions, supply, and demands.

Actions:
- Utilize a variety of public involvement techniques (e.g., citizen task forces, surveys, and public meetings).
- Include nontraditional constituencies (e.g., homeowners, motorists, and nonhunters).

B. Objective - **To meet deer population management objectives by management unit through January 1, 2004.**

A deer management plan must have defined management units and contain four components: a measure or index of current deer population status, a population management objective, a management strategy to attain the population management objective, and, lastly, a method to monitor population response (i.e., management success or failure).

In Virginia, deer harvest objectives/regulations are set on a county basis. There are currently 99 county management units ranging in size from 26 to 1,112 square miles in area (average = 401 square miles). There are exceptions to the countywide management rule.

Over the past four years, objectives/regulations have been differentiated between public (e.g., National Forest and Department-owned lands) and private lands for 31 counties west of the Blue Ridge Mountains (including Amherst and Nelson counties east of the Blue Ridge Mountains) in response to public demands. Additionally, in many counties, wildlife management areas, state parks, state forests, military areas, and national wildlife refuges have either-sex general firearms harvest regulations that differ from the county in which they are located.

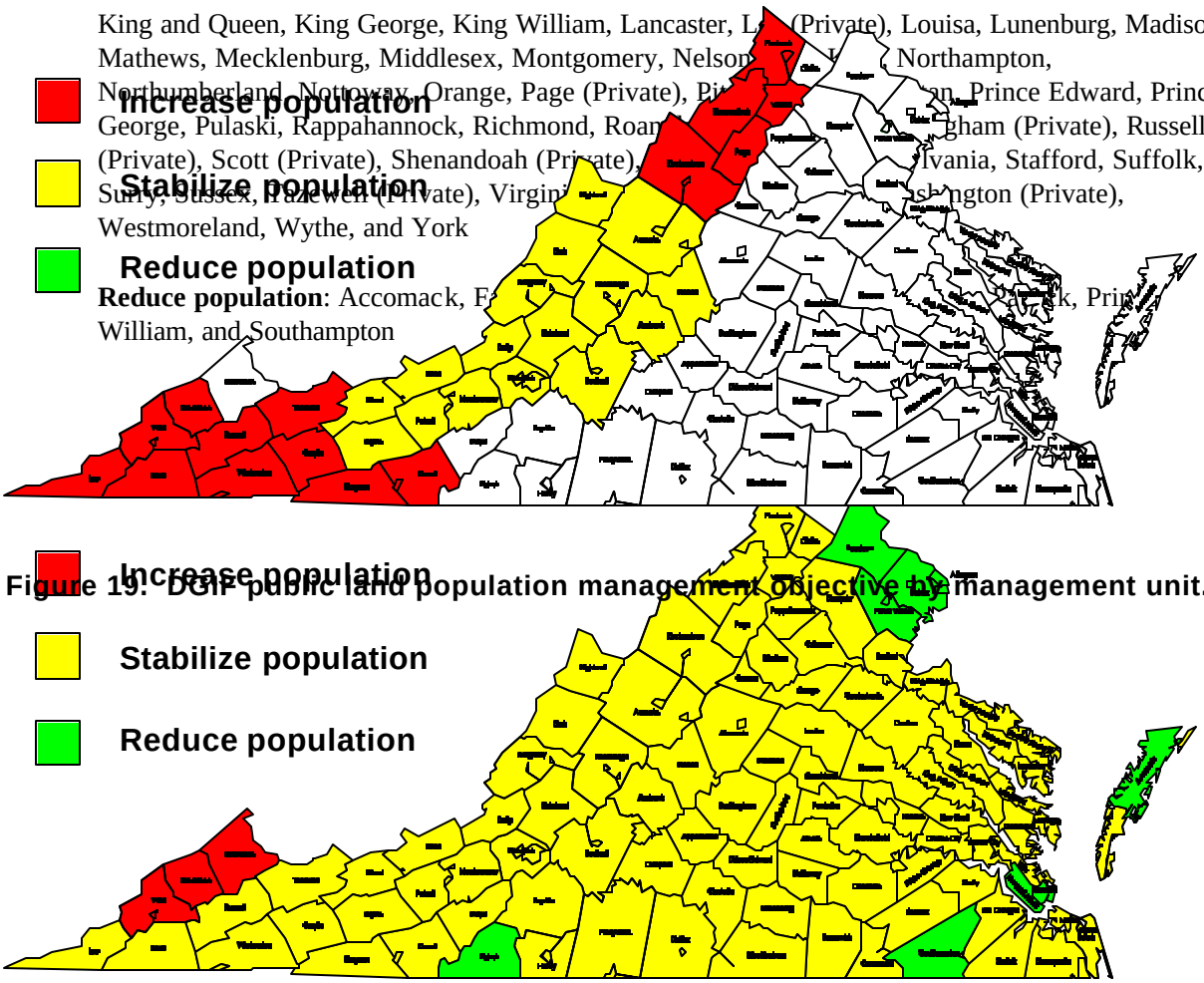
Lastly, general firearms season(s) regulations are split by defined boundaries in five counties (e.g., Amherst, Campbell, Nelson, Pittsylvania, and Suffolk).

For deer population management purposes, there are only three logical population objectives: increase the deer population, stabilize the deer population, or reduce the deer population. Traditionally, deer population management objectives have been unspecified and based on an informal combination of public input processes, including staff opinion/perception, deer damage demands, deer hunter demands, hunter surveys, and public meetings. Consequently, county objectives/regulations were often set without significant local input, and input received was often not representative of the general public.

For this effort, population management objectives were based on estimates of regional CCC's calculated by surveying a cross section of deer stakeholder groups at each regional deer management plan meeting. Statewide results of the herd status and management objective surveys are shown in Supply and Demand, Tables 4 and 5 respectively. Using results of the regional planning surveys, past harvest data, herd condition indices, and damage demands, each Wildlife Division regional manager determined a population objective for each management unit. For those counties west of the Blue Ridge Mountains and three counties east of the Blue Ridge Mountains (Amherst, Bedford, and Nelson), population objectives were differentiated within management unit, public versus private lands.

Increase population: Buchanan, Carroll (Public), Dickenson, Frederick (Public), Grayson (Public), Lee (Public), Page (Public), Rockingham (Public), Russell (Public), Scott (Public), Shenandoah (Public), Smyth (Public), Tazewell (Public), Warren (Public), Washington (Public) and Wise

Stabilize population: Albemarle, Alleghany, Amelia, Amherst, Appomattox, Augusta, Bath, Bedford, Bland, Botetourt, Brunswick, Buckingham, Campbell, Caroline, Carroll (Private), Charles City, Charlotte, Chesapeake, Chesterfield, Clarke, Craig, Culpeper, Cumberland, Dinwiddie, Essex, Fauquier, Floyd, Fluvanna, Franklin, Frederick (Private), Giles, Gloucester, Goochland, Grayson (Private), Greene, Greensville, Halifax, Hanover, Henrico, Henry, Highland, Isle of Wight, James City,



King and Queen, King George, King William, Lancaster, L… (Private), Louisa, Lunenburg, Madison, Mathews, Mecklenburg, Middlesex, Montgomery, Nelson… Northampton, Northumberland, Nottoway, Orange, Page (Private), Pi… an, Prince Edward, Prince George, Pulaski, Rappahannock, Richmond, Roan… gham (Private), Russell (Private), Scott (Private), Shenandoah (Private), … lvania, Stafford, Suffolk, Surry, Sussex, Tazewell (Private), Virgini… shington (Private), Westmoreland, Wythe, and York

Reduce population: Accomack, F… k, Prin… William, and Southampton

Figure 19. DGIF public land population management objective by management unit.

Figure 18. DGIF private land population management objective by management unit.

Strategies:

a. Use recreational deer hunting as the primary deer population management strategy.

Tradition, management efficiency, and cost effectiveness necessitate the use of hunting as the primary deer population management strategy. Deer management in Virginia is predicated on the fact that herd density and health are best controlled by regulating antlerless deer harvests levels. Management objectives are accomplished by increasing or decreasing the number of either-sex deer hunting days during the general firearms season. Deer hunting is a viable, cost-efficient management tool that not only maintains a healthy deer resource, but also diminishes deer crop damage levels, deer-vehicle collision rates, and deer-ecosystem impacts.

b. Where hunting is deemed inappropriate or unacceptable, a combination of other management practices will be used.

c. Discourage the feeding of deer.

d. Monitor effects of regulation changes.

Actions:
- Set deer regulations for a period of four years or longer to accurately assess the effect of regulation change(s), when possible. Generally, effects of regulation changes cannot be adequately evaluated after only two years. Additionally, latitude to consider regulation changes as needed should be maintained for unusual circumstances.

e. Monitor population status.

Actions:
- Population objectives will be monitored using an antlered buck harvest rate per unit area population index.

- Monitor deer harvests on a management unit basis annually through the big game check station program.
- Monitor herd condition indices annually through biological harvest data collected at technical check stations and by DMAP cooperators.
- Monitor hunter effort annually through hunter surveys and license sales data.

f. Conduct research to identify differences in the public versus private land deer herds and habitats west of the Blue Ridge Mountains (e.g., biological, habitat, hunting pressure/access, etc.).

g. Conduct research to identify factors limiting deer population expansion in the Cumberland Plateau.

C. Objective - **To identify and develop/continue management programs for unique deer management areas within traditional management units through January 1, 2004.**

Deer hunting regulations are established over large areas to be as simple and uniform as possible and to avoid confusion (i.e., on a county basis). To set regulations on this basis, however, is to assume that deer habitats, deer densities, and hunter pressures and public demands are similar over the entire area. Because these assumptions are not always true, regulations set over a large area will in some areas be too conservative and in some areas too liberal. To meet unique deer management circumstances in these areas, alternative site-specific management regulations (e.g., public versus private west of the Blue Ridge Mountains) and/or programs must be developed/implemented (e.g., DMAP, DCAP, out-of-season kill permits, etc.).

Special deer management areas identified during the planning process include: Accomack (Town of Chincoteague and NASA Wallops Island facility), Albemarle (urban/suburban areas surrounding City of Charlottesville and Shenandoah National Park lands), Alleghany (City of Covington, City of Clifton Forge, and Douthat State Park), Augusta (City of Staunton, City of Waynesboro, and Shenandoah National Park lands), Bedford (City of Bedford, USDI Peaks of Otter property, and City of Lynchburg), Caroline (Fort A. P. Hill), Chesapeake (urban/suburban areas), Chesterfield (Presquile National Wildlife Refuge, City of Colonial Heights, City of Richmond, urban areas north of Route 288, City of Chester, and Pocahontas State Park), Dinwiddie (City of Petersburg), Hampton, Henry (City of Martinsville), Fairfax (Fort Belvoir, U.S. Coast Guard Station, Huntley Meadows and Riverbend County Parks, Bull Run, Fountainhead, Meadowlark Gardens, Northern Virginia, Occoquan, Pohick Bay, Potomac Overlook and Sandy Run Regional Parks, Mason Neck State Park, Mason Neck, Great Falls, George Washington Parkway, and Mount Vernon National Parks and Refuges, and Dulles Airport), Fauquier (Sky Meadows State Park and Whitney Forest State Forest), Henrico (City of Richmond), Greene (Shenandoah National Park lands), Frederick (City of Winchester), James City (Jamestown Island Colonial National Historic Park and City of Williamsburg), Loudoun (Algonkian Regional Park, Harpers Ferry National Park, and Dulles Airport), Madison (Shenandoah National Park lands), Montgomery (City of Blacksburg), Nelson (Wintergreen Resort and Community), Newport News, Page (Shenandoah National Park lands), Orange (Lake of the Woods Homeowner Association), Prince George (City of Hopewell and Petersburg National Battlefield), Prince William (Quantico, Quantico National Cemetery, Woodbridge Research Facility, Locust Shade Regional Park, Leesylvania State Park, Prince William Forest Park and Manassas National Battlefield National Parks, and Marumsco National Wildlife Refuge), Pulaski (Claytor Lake State Park, City of Pulaski, and City of Radford), Rappahannock (Shenandoah National Park lands), Roanoke (urban/suburban areas), Rockbridge (City of Lexington), Rockingham (City of Harrisonburg and Shenandoah National Park lands), Shenandoah (Shenandoah National Park lands), Southampton (Town of Franklin), Stafford (Quantico), Suffolk (urban/suburban areas), Virginia Beach

(urban/suburban areas), Warren (Shenandoah National Park lands), Westmoreland (Washington's Birthplace State Park), Wythe (City of Wytheville), and York (Newport News Waterworks Watershed, Yorktown National Battlefield, Colonial National Historic Park, U.S. Coast Guard Reserve Training Center, and New Quarter Park).

Strategies

a. Provide/promote site-specific deer management programs.

Actions:
- Continue the Deer Management Assistance Program (DMAP).
- Continue the Damage Control Assistance Program (DCAP).
- Continue out-of-season kill permits.

- Develop and implement a site-specific urban deer management program (DPOP). During the 1997 regulatory cycle, the Department amended 4 VAC 15-40-240 (Animal population control) to provide the regulatory latitude to develop an urban deer management program (DPOP) which could extend the season beyond (before or after) the "traditional" deer season on site-specific areas.

b. Develop and adopt standard Department protocol/procedures for addressing urban deer management issues (Appendix IX).

c. Provide technical assistance to help communities implement management programs for urban deer.

d. Develop standard procedures/protocol for monitoring/censusing those deer populations where traditional deer hunting and harvest data is not available or not representative (e.g., Fairfax County).

Habitat Goal

To manage deer habitats consistent with deer population objectives and the effect of deer on other plant and animal communities.

White-tailed deer have specific habitat requirements. These requirements include food, water, cover, and space. Of these four generic habitat components, food is typically the most critical or important.

Habitat quality for deer is significantly correlated with soil quality. Soil fertility will directly and powerfully affect the quality of deer habitat. Following soil quality, habitat type, successional stage, and amount of habitat interspersion or edge have the greatest impact on deer habitat quality. In general, any habitat management practice that improves soil fertility, increases the number of habitat types, reverts habitats to early successional stages, or increases the interspersion of habitat types will result in an increased carrying capacity for deer. Conversely, as a general rule, any habitat management practice that reduces soil fertility, decreases the number of habitat types, results in late successional stages, or decreases the interspersion of habitat types will result in a decreased carrying capacity for deer.

A. Objective - **To determine the status of deer habitat by management unit through January 1, 2004.**

Deer habitat inventory data are maintained on a county basis from the Virginia Department of Forestry and U. S. Department of Agriculture records. Since 1947, there has been an approximate 7% decrease in available deer habitat statewide. Most of this decline has been due to a 25% decrease in

cropland acreage from 9,013 square miles in 1947 to 6,732 square miles in 1994. The amount of forested area has been fairly stable over this period, declining less than 1%.

Increased urbanization and development in eastern and northern Virginia are expected to have significant impacts on the amount and rate of habitat loss in the future. Currently, five urban Virginia cities/counties are considered to have less than half their total land area available as deer habitat. These include Virginia Beach (49%), Henrico (44%), York (41%), Fairfax (37%), and Newport News (16%).

Strategies

a. Collect deer habitat inventory data.

b. Monitor changes in habitat status on a management unit basis.

Actions:
- Monitor land use changes.

c. Conduct research to develop more precise measurements of deer habitat on a management unit basis.

Actions:
- Monitor forested habitat by species group and age class.
- Monitor agricultural habitat by crop type.

d. Conduct research to develop estimates of the BCC by management unit.

B. Objective - **In cooperation with the USFS, implement habitat management practices and improvements beneficial to deer on 1% of National Forest lands annually through January 1, 2004.**

A factor that has negatively influenced and will continue to influence deer on public land in western Virginia is deterioration in the quality of deer habitat. The habitat on the National Forest over much of Virginia has progressively grown more mature to the point of becoming less desirable for deer. Deer habitat quality, which is closely related to early successional stages and the interspersion of different habitat types or edge, is lacking on many National Forest lands. Timber harvesting to regenerate mature stands of oaks can provide deer and other wildlife with a lush amount of vegetation for food and cover. However, timber harvests on the National Forest have been reduced significantly during the last 20 years as a result of national public opinion and budget restrictions in the U.S. Forest Service.

Strategies

a. Support USFS habitat management objectives, which seek to manipulate vegetation for wildlife management purposes on 1% of National Forest habitat annually. When and where possible, habitat management practices should be linked to population objectives.

Damage Goal

To manage agricultural, urban, ecosystem, vehicular, forestry, and other deer damage.

Deer management demands in Virginia are not limited to providing deer hunter recreation. Most of the pressure for the change in deer management direction from establishing and allowing deer herd expansion to controlling population growth that has taken place over the past decade can be attributed to deer damage demands and the concept of cultural carrying capacity. Examples of damage demands commonly associated with deer management in Virginia include deer crop depredation, deer-vehicle collisions, urban deer conflicts, and deer ecosystem impacts.

A. Objective - **To quantify agricultural, urban, ecosystem, vehicular and forestry related deer damage by January 1, 2004.**

A reliable estimate of deer damage to Virginia's agricultural producers has been lacking in the past. Traditionally, issuance of out-of-season crop depredation kill permits has been used to monitor deer agricultural damage demands on a county and statewide basis over time. Like deer agricultural damage demands, reliable data on deer-vehicle collisions, urban deer conflicts, and other deer damage demands has been lacking in the past.

Strategies

a. Conduct periodic surveys, 5-10 years, to monitor/quantify agricultural and urban deer damage levels.

Actions:
- Assess agricultural commodity producers' deer damage.
- Assess homeowner deer damage.
- Assess deer-vehicle collision damage.

b. Determine acceptable levels of tolerance to deer damage.

c. Develop a program, in cooperation with the Virginia Department of Transportation (VDOT), to accurately monitor/index deer-vehicle collisions on a management unit basis annually.

d. Conduct research on the effects of deer on ecosystem structure and diversity on a landscape basis over time.

e. Conduct research to assess the effects of nonhunted lands (refugia) on the incidence of deer damage.

B. Objective - **To reduce the demand for out-of-season kill permits for deer to ≤ 1,000 permits annually by January 1, 2004.**

As provided by Virginia State Statute, §29.1-529. *Killing of deer or bear damaging fruit trees, crops, livestock or personal property or creating a hazard to aircraft*, the VDGIF is mandated to permit owners or lessees of land on whose lands deer are causing damage to kill such deer.

Issuance of these kill permits has been used as an index of crop damage demands by management unit. Issuance of these permits has demonstrated a significantly increasing trend over the past several years increasing from 515 permits in 1989 to 1,323 in 1996.

Strategies

a. Use hunting as the primary deer population damage management strategy.

b. Provide/promote site-specific management programs.

Actions:
- Continue DMAP.
- Continue DCAP.
- Develop and implement a site-specific urban deer management program (DPOP). During the 1997 regulatory cycle, the Department amended 4 VAC 15-40-240 (Animal population control) to provide the regulatory latitude to develop an urban deer management program

(DPOP) which could extend the season beyond (before or after) the "traditional" deer season on site-specific areas.

c. Provide technical assistance to help communities implement management programs for urban deer.

d. Develop educational materials for the public regarding deer damage abatement techniques.

C. Objective - **To develop a management program for urban deer by January 1, 2004.**

Unhunted areas or refuges have become increasingly common over the last decade. In these areas, traditional regulated deer hunting is deemed inappropriate or unacceptable (e.g., urban/suburban areas, national parks, etc.). Urban deer management is one of the fastest growing deer management issues in Virginia. To meet unique deer management circumstances in these nontraditional areas, alternative management strategies and/or management programs must be developed and implemented. Urban deer management issues are expected to increase significantly in the northern Piedmont and Tidewater regions as human populations continue to expand.

Strategies

a. Develop and adopt standard Department protocol/procedures for addressing urban deer management issues (Appendix IX).

b. Provide technical assistance to help communities implement management programs for urban deer.

c. Provide/promote site-specific deer management programs.

Actions:
- Develop and implement a site-specific urban deer management program (DPOP). During the 1997 regulatory cycle, the Department amended 4 VAC 15-40-240 (Animal population control) to provide the regulatory latitude to develop an urban deer management program (DPOP) which could extend the season beyond (before or after) the "traditional" deer season on site-specific areas.

D. Objective - **To develop a quantitative objective for deer-vehicle collisions by January 1, 2004.**

Although no reliable data exists, it is currently assumed that the economic loss associated with deer-vehicle collisions and resulting damage is equal to or exceeds deer crop damage. For example, the number of deer-vehicle collisions in the City of Lynchburg alone averaged 110 annually in the 5 years between 1987-91.

Strategies

a. Develop a program, in cooperation with the Virginia Department of Transportation (VDOT), to accurately monitor/index deer-vehicle collisions on a management unit basis annually.

b. Determine public tolerance for deer-vehicle collisions.

Recreation Goal

To maximize opportunities for all citizens to safely enjoy deer hunting and other deer related recreational experiences.

White-tailed deer are the most popular game species in the Commonwealth of Virginia. During the 1995-96 deer season, more than 230,000 deer hunters spent nearly 3.8 million days afield in pursuit of deer. Hunter survey results and bear, deer, turkey (big game) license sales, however, indicate that total deer hunter numbers have declined over the past 20 years.

A. Objective - **To manage deer-related recreation to yield zero (O) deer hunting related accidents annually through January 1, 2004.**

In an ideal season, Virginia deer hunters ranked feeling safe in the field as their most important hunting satisfaction component.

Strategies

a. Promote mandatory hunter safety certification for all deer hunters.

B. Objective - **To manage deer-related recreation to yield greater than or equal to 3,800,000 days spent afield deer hunting by greater than or equal to 230,000 deer hunters annually through January 1, 2004.**

Traditionally, deer hunter numbers and days spent afield hunting have provided the most common measures of demand for deer management programs. Overall, hunter survey results indicate that the number of deer hunters has declined over the past 20 years. The objective listed above is designed to maintain deer hunter numbers and effort at current levels. Current deer hunter numbers and effort levels will be required to meet population management objectives specified in this plan.

Strategies

a. Identify recreational demands for deer hunting through hunter surveys.

b. Maximize recreational opportunities when feasible and acceptable.

Actions:
- Consider Sunday hunting.
- Consider Saturday openings.
- Consider extending seasons.
- Consider increasing either-sex days.

c. Maintain hunting recreation quality by preserving diverse types of hunting opportunities.

d. Manage the allocation of recreational opportunities among users.

e. Promote deer hunting among nontraditional groups.

f. Promote deer hunting among youth.

g. Provide quality deer management areas.

C. Objective - **To manage deer-related recreation to yield a statewide deer gun hunter satisfaction index (HSI) of greater than or equal to 4.0 (adequate) on both public and private lands in all regions by January 1, 2004.**

In addition to maximizing deer hunter numbers and days afield, safety and hunter satisfaction (i.e., recreation quality) must be addressed. Numerous hunter motivation and satisfaction studies demonstrate that many variables are important in deer hunter satisfaction.

Strategies

a. Identify recreational demands for deer hunting through hunter surveys.

b. Maximize recreational opportunities when feasible and acceptable.

Actions:
- Consider Sunday hunting.
- Consider Saturday openings.
- Consider extending seasons.
- Consider increasing either-sex days.

c. Maintain hunting recreation quality by preserving diverse types of hunting opportunities.

d. Manage the allocation of recreational opportunities among users.

e. Provide quality deer management areas.

D. Objective - **To manage deer-related recreation to yield current levels of deer viewing opportunities through January 1, 2004:**

According to the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, nonconsumptive wildlife activities such as observing and photographing wildlife contribute 7.1 millions days of recreation afield and an estimated $146 million dollars to Virginia's economy. Unquestionably, as the most common and widespread large wild mammal in Virginia, the considerable aesthetic and social values of white-tailed deer contribute a significant portion of Virginia's nonconsumptive wildlife value.

Strategies

a. Promote deer-related recreational opportunities for nonhunters.

b. Discourage the feeding of deer.

Education Goal

To educate Virginia's citizens regarding safety, ethics, use of the deer resource, and deer-related conflicts associated with white-tailed deer ecology, management, and behavior.

An effective public information effort is critical to the future success of Virginia's deer management program(s). Public attitudes and perceptions often determine the success or failure of deer management programs. In the future, more emphasis will need to be placed on public education and the concept of cultural carrying capacity.

A. Objective - **To develop public information educational materials and programs related to Virginia's deer management program by January 1, 2004.**

Strategies

a. Promote public awareness of Virginia's deer resource and the VDGIF's deer management program(s).

Actions:
- Conduct cooperative programs with conservation organizations, homeowner associations, civic clubs, other state agencies, etc.
- Produce videos
- Utilize television
- Utilize radio
- Utilize newspapers
- Utilize magazines
- Utilize the Internet
- Produce written materials (pamphlets/booklets).

b. Produce a series of deer educational materials.

Actions:
- Address deer biology and management
- Address deer damage and damage abatement techniques
- Address deer habitat principles and habitat management techniques
- Address deer hunting
- Address a deer-viewing guide

c. Provide/promote educational programs on ethics and safety to all deer hunters.

Administration Goal

To provide administrative/funding support for deer management and educational programs.

Full implementation of all the goals and objectives outlined in the deer management plan will depend on administrative support and adequate funding. Current levels of VDGIF funding do not fulfill all of Virginia's wildlife management and public service needs, including those related to the deer program. Increased funding, improved staff capabilities, and elimination of administrative barriers will be important approaches for attainment of deer program goals. Deer projects that do not address the goals and objectives of the deer management plan will result in the waste of limited VDGIF resources. Keeping the VDGIF Board,

VDGIF administration, VDGIF staff, and public focused on the directions articulated by the deer management plan will help maximize success.

A. Objective - **To achieve a 50% increase in VDGIF deer program funding, excluding inflation, by the 2004 fiscal year.**

The Wildlife Division funding of the deer program is $279,349 for the 1997-98 fiscal year. This represents approximately 5% of the total Wildlife Division budget.

Strategies

a. Identify/solicit alternative funding sources derived from nonconsumptive user groups (e. g., general fund revenues, Wildlife Diversity Funding Initiative, etc.).

b. Solicit funding from other public and private organizations (e.g., sportsman groups, federal government, etc.).

c. Influence budget priorities of the VDGIF to receive a bigger proportion of limited revenues for deer management.

d. Use the deer management plan as the basis of deer program budget submissions. Annual budget requests should be based on the Deer Management Planning Committee's recommended priorities for the 16 plan objectives (Appendix XI).

B. Objective - **To provide annual assessments of progress toward meeting deer management plan objectives and to begin work on a revised plan by January 1, 2003.**

The planning process should be dynamic with feedback about progress. Public and agency support for the plan's objectives will be maintained with routine reminders about the deer management plan's progress and problems. The VDGIF should be accountable for meeting the plan's objectives and prepare for possible changes in public values about deer management.

Strategies

a. Convene an annual meeting with the Deer Planning Committee to review progress and problems.

b. Provide deer management plan updates via news releases, magazine articles, Board presentations, and internal reports.

c. Use the existing Deer Management Plan committee to begin plan revisions.

Appendix I. Members of the Deer Management Planning Committee.

Glen R. Askins, Region I Wildlife Biologist Manager, VDGIF
John Bellemore, Forest Ecology Group Staff Officer, US Forest Service
G. Mike Bise, Region V Law Enforcement Division, VDGIF
Jim Bolton, Forester, Chesapeake Forest Products Corporation
Jim A. Bowman, Region II Wildlife Biologist Manager, VDGIF
Allen C. Boynton, Region III Wildlife Biologist Manager, VDGIF
Randy P. Hickman, Region I Law Enforcement Division, VDGIF
Matthew Hott, Superintendent of Parks, Frederick County Parks and Recreation and Virginia Recreation & Parks Society
W. Matt Knox, Deer Project Leader, VDGIF
Mike Lucas, Field Supervisor, Fairfax County Animal Control
Bill McShea, Research Scientist, National Zoological Park, Smithsonian Institution
James Parkhurst, Wildlife Extension Specialist, Virginia Tech
Walt Perkins, Board of Supervisors, Albemarle County
Alvina Pitches, Vice President, Virginia Federation of Humane Societies
Denny Quaiff, Executive Director, Virginia Deer Hunters Association
Robert N. Seltzer, Vice President, Virginia Bowhunters Association
Jared Sims, Region V Wildlife Biologist Manager, VDGIF
Gary Spiers, Region IV Wildlife Biologist Manager, VDGIF
Wilmer Stoneman, Assistant Director of Public Affairs, Virginia Farm Bureau Federation

Appendix II. Region I deer planning meeting participants, Williamsburg, Virginia (June 8, 1996).

Participants Present
John Barr (Northampton County), Ronald S. Bednarick (Chesapeake Forest Products), Ed Bickham (VBA), Mike Caison (VDGIF), Gary Caricoffe, Sr. (Deer Run Hunt Club), Thad Cherry (VDGIF), J. P. Cordell (DCR), D. J. Delgado (Wilcox Bait and Tackle), Kenneth Dill (VDF), Pete Eastman (Tidewater Bowhunters Association), Marvin Everett (VFB), P. H. "Buddy" Fines, Jr. (King George Hunter Advisory Group), John Gallegos (USFWS), Stephen J. Garvis (VDGIF), Deborah Green (College of William and Mary), Bob Grimsley (Latane Farms), Walter D. Hampton, III (DOD), James O. Hertz (Virginia Beach Wetlands Board), Randy Hickman (VDGIF), Ben Lewis (VDGIF), Steve Martin (City of Williamsburg), Robert C. Mathers, Jr. (VDGIF), L. H. McLennan, Jr. (VDHA), J. Dean Miller (VDHA), Mark Northam (Honey Hill Farm), Morris Pearson (Tidewater Bowhunters Association), Steve Pezanowski, (York County Animal Control), Kenneth Pickin (VPSA), Michael Poplawski (Newport News Parks and Recreation), James Pritchard (VDGIF), Eddie Pryor (Wolf Hunt Club), John Randolph (DOD), Walter Robertson (The Governor's Land at Two Rivers), George Shannon (VDGIF), Brad Slaybaugh (VDHA), Robert Swineford (Upper Brandon Plantation), Earle Wagner (Heritage Humane Society), Mack L. Walls (VDGIF), Jeffrey L. Watts (Resource Management Services), and Phillip D. West (VDGIF)
Invited Participants Absent
Lisa Barlow (Wildlife Response), Merritt Basemore (Rangers Hunt Club), Mitchell Byrd (College of William and Mary), Lannie Chitwood (VDGIF), Ronald E. Christian (Deer Run Hunt Club), Wayne Cosby

(Indiantown Hunt Club), Louis Cullipher (Virginia Beach Department of Agriculture), Webster Custalow (Mattaponi Indian Council), Willis J. Dize, (Town of Chincoteague), Theresa Duffey (DCR), Frank Dwyer (VBA), Quintin D. Elliott (VDOT), Douglas Evans (VFB), B. Eugene Falls (Peninsula SPCA), Gene Forrester (VFB), Herb Foster (IWL), David Froggatt, Jr. (Resource Management Services), Anne Gowdey (Gloucester Humane Society), Thomas E. Harris (Northampton County Administrator), Tom Hobgood (Tidewater Bowhunters Association), William J. House (Flowerdew Hundred Plantation), Ralph Keel (Dismal Swamp NWR), Mr. and Mrs. Fred Kern (Citizens for Animal Rights), James Latane, Jr. (Latane Farms), Richard LeHew (IWL), Angie Leigh (Beaverdam County Park), Ruth Ann MacQueen (Midway Veterinary Hospital/Wildlife Response), Fred Maldonado (County of Greensville), Samuel Marston (Kilmarnock Animal Hospital), Bud Nichols (VBA), George H. Northam (Honey Hill Farm), Jon Ober (VDGIF), B.T. "Pete" Onley, Jr. (VFB), Norman Otto (Hampton Department of Health), Peter W. Rowe (The Nature Conservancy), Earl Roye (Union Camp Corporation), Elizabeth Sills (Virginia Beach Humane Society), Tim Smith (Suffolk Parks and Recreation), Daniel Sonenshine (Old Dominion University), Wilmer Stoneman (VFB), Susan Summers (Virginia Living Museum), Hank Teague (Chesapeake Forest Products), Stephanie Turner (York River State Park), Tom Wilcox (Wilcox Bait and Tackle), Peggy R. Wiley (Greensville Board of Supervisors), and Charlie Wilson (Yorktown Naval Weapons Station)

Appendix III. Region II deer planning meeting participants, Lynchburg, Virginia (May 30, 1996).

Participants Present

Al Baughman (IWL), Jim Bolton (Chesapeake Corp.), Jim Bowman (VDGIF), Edward Burnette (City of Lynchburg), Patricia Egan (USFS), W. R. Elliott, III (VFB), Bob Eubank (Native Plant Society & Virginia Society of Ornithology), Mark Ford (Westvaco), Giles Gilley (VBA), Leon Handy (Patrick County Animal Control), Franklin Hanks (DCR Board of Parks & Recreation), David Horne (VDHA & Hunters for the Hungry), Jay Jeffreys (VDGIF), Pat Keyser (VDGIF), Larry Layman (VDF), Gordon R. Metz (VFB), Larry Neuhs (USFS), Alvina Pitches (Federal of Virginia Human Societies), Bill Powers (VDGIF), Robbie Taylor (VFB), Carroll Tuck (Brunswick Board of Supervisors), and Tony Wiedmer (Occoneechee State Park)

Appendix IV. Region III deer planning meeting participants, Marion, Virginia (June 19, 1996).

Participants Present

John Baker (VDGIF), Charles C. Barnes (Craig County private property owner and developer), Bob Boardwine (USFS), David Collins (USFS), Willard Conley (VDGIF), R. J. Cox (VDGIF), George Dietrich (Wilderness Creek Hunt Club), Teresa Dockery (Virginia Federation of Humane Societies), Bill Freeman (VFB & Virginia Horticultural Society), Sid Harvey (Grayson County sportsman), Cindy Holland (USFS), Richard Johnson (Claytor Lake State Park), Eli Jones (Tazewell County sportsman), Jerry Legg (Division Mine Land Reclamation), Bob Leonard (New River Wildlife Club Hunters), Kevin Kyle (Penn Va. Coal Company), Everette Moore (Dickenson County sporting goods retailer), Charles Parry (Preston Forest Homeowners Association), Phil Shelton (Clinch Valley College), Kenneth Sorrels (VBA), Betsy Stinson (VDGIF), and Cecil Thomas (USFS)

Invited Participants Absent

Bill Anderson (Outdoor Writer), Billy Jones (VFB), Sten Olsen (USFS), Buster Phipps (Grayson County sportsman), and Hibert Tackett (VFB)

Appendix V. Region IV deer planning meeting participants, Mt. Crawford, Virginia (June 20, 1996).

Participants Present
Peggy Allen (Humane Society), John Bellemore (USFS), John Coleman (USFS), Charlie Conner (Douthat State Park), Alvin Estep (Western Virginia Deer Hunters Association), Ed Haverlack (USFS), Matthew G. Hott (Frederick County Parks & Recreation Department), Carl Martin (VDGIF), Kenny Mohler (Rockbridge County farmer and VDF), David Proctor (VBA), Tad Robertson (IWL), Boyd Skelton (IWL), and Elvin Walker (VFB)

Appendix VI. Region V (Northern Virginia) deer planning meeting participants, Fairfax, Virginia (May 8, 1996).

Participants Present
Bob Alger (Fairfax County farmer), Susan Alger (VDGIF), Al Alkins (Occoquan Watershed Coalition and Lakewood Estates Civic Association), Olin Allen (Fairfax County Parks), Rick Busch (VDGIF), Denise Chauveth (Arlington County Parks), William C. Cole (Occoquan Watershed Coalition), Carrillo Deam (Prince William County Parks), John Hadidian (Humane Society of the U.S.), Elanor Heastie (Fairfax County Supervisor's Office), Anne P. Hocker (Loudoun Wildlife Conservancy & wildlife rehabilitator), Earl L. Hodnett (Northern Va. Regional Park Authority), Clint Horton (Fort Belvoir), Christie Huffman (Wildlife Rescue League), Kent Knowles (Wildlife Rescue League), Jerry L. Little (Occoquan Watershed Coalition), Dan Lovelace (VDGIF), Mike Lucas (Fairfax County Animal Control), Kim Miller (Loudoun County Animal Control), Hiu Newcomb (Potomac Vegetable Farms, Fairfax County), Phil Parrish (VDGIF), Gary Rorsum (Fairfax County Parks), Bob Seltzer (VBA & Traditional Bowhunters of VA), Joan Strauderman (Fairfax County Supervisor's office), Dorothy Wadel (Manassas Park Animal Control), and Byron Wates (N. Va. landscaper)

Appendix VII. Region V (Central Piedmont) deer planning meeting participants, Goochland, VA (June 17, 1996).

Participants Present
Brad Ashley (Hanover County Parks and Recreation), Jim Barbour (Albemarle County Parks), Rick Busch, (VDGIF), Jim Ervin (White Oak Hunt Club), J. B. Gilliland (Waterloo Hunt Club), Russell Holland (Landowner Fluvanna, Goochland, Hanover, Henrico, and Powhatan counties), Brad Howard (VDGIF), Kevin Kilgore (Hanover County Animal Control), Shirley Lavin (Va. Federation of Humane Societies), Martin Lowney (USDA, ADC), Denny Quaiff (VDHA), and Dale Woods (DCR, Pocahontas State Park)

Invited Participants Absent
George Beal (Spotsylvania County landowner), Bruce Dove (Chesterfield County Parks), Walter Perkins (Albemarle County Supervisor), Regina Seaver (Wildlife Rehabilitator), Matt Sheifer (Landowner), Tim Southard (AP Hill), and David Tice (Albemarle County forest consultant)

Appendix VIII. Public comments on draft deer management plan.

County Comments

Accomack.----Letter advised that Accomack County Board of Supervisors supported the request from the Eastern Shore Chapter of the Virginia Deer Hunters Association that requested:

Population: Accomack County deer population should be reduced.
Damage: reduce out-of-season kill permits.
Recreation: maximize opportunities for all hunters.

Albemarle.----Presentation was given to Albemarle Board at their request. No written comments were received.

Floyd.----Letter advised that deer population in Floyd is excessive and needs to be controlled. "Floyd County Board of Supervisors respectfully request a decrease or at least a stabilization of the deer population in Floyd County." Presentation was given to Floyd Board at their request.

Patrick.----Letter advised that the Patrick County Board of Supervisors had "very serious concerns about the directions, emphasis and positions stated in the plan."

Petition

One petition with 103 signatures and 6 written comments circulated by the Northampton County Farm Bureau was received. The petition read as follows:

Dear Producer Member:

Enclosed you will find a copy of a recent newspaper article regarding the deer population in Virginia. Please help us pressure the state for help in managing the deer population on the Eastern Shore by completing and returning the form below in the enclosed self-addressed stamped envelope.

Thank you for your support.
Sincerely,
Ralph W. Dodd, President
Northampton County Farm Bureau

Dear Mr. Knox:

Please help us control the deer population in Northampton County. The deer population is causing our farmers major economic loss.

_____ Signature
_____ Date

In General Comments

Good plan (13)*, Virginia does not care about deer, money is the most important (3), keep politics out of deer management (2), astounded in lack of urgency in both content and tone (1), put names and numbers of committee members so public can contact (1), plan is too technical for average hunter (1), plan lacks clarity on how tasks would be carried out (1), Department should purchase more public land (1), plan should note that funds are derived solely from hunters (1), Department should get funding from general fund/nonconsumptive uses (2), hunter funding biases management decisions (1), need priorities (1), state should fund Hunters for the Hungry (1), Hunters for the Hungry not noted (1), Virginia Bow Hunters Association offered help and support for plan (1), need someone from Carroll, Floyd, Franklin, Henry, or Patrick counties on the Board (1), and provide for annual evaluation and correction measures to deer regulations (1)

* Indicates the number of times the comment was noted.

Population Comments

In general population comments.----Posting of private land is a management/access problem (5), increase access to private property (2), noted negative impact of DMAP on adjacent property: Amelia (2) DMAP gives unethical hunters full season of doe hunting and does not work and Department should monitor DMAP more closely, Craig (1), Lunenburg (1), and Statewide (1) problem with people/hunt clubs given permits to kill does when others have to follow the general rules liberal seasons/limits have been applied too widely, should be targeted to specific areas (1), support concept of unique management areas within traditional units (1), increase deer populations (1), manage deer on a landscape basis, more logical than county (1), first priority should be to manage for integrity of environment (1), require scales/weighing of all deer at check stations (1), Virginia does not have an overpopulation of deer but people (1), big change over the past has been a shift of deer from National Forest to private land (1), no hunters on National Forest (Page and Shenandoah) but plenty of deer (1), dog hunting is necessary to control deer in eastern Virginia (1), oppose Southampton reduction population objective (1), and southwest Virginia: southwest Virginia forgotten in plan (1), give southwest Virginia public land more attention (1), deer in southwest Virginia should be managed at BCC not CCC (1), and CCC must be raised in southwest Virginia (1)

Increase deer population.----Albemarle (1), Amelia (2), Appomattox (1) reduce damage permits, Augusta National Forest (2) reduce either-sex days, Buckingham (1) reduce either-sex days, Cumberland (1), Clinch Mountain WMA (1), Craig (1), Floyd (1), Fluvanna (2), Goochland (1), Hanover (1), Hidden Valley WMA (1), Highland National Forest (1) reduce either-sex days, Louisa (1), Lunenburg (2), Madison (1), Prince Edward (1), Rockingham National Forest (1) close for one year or one deer per hunter per year, Southampton (1), Southside Virginia (1), southwest Virginia (3), and Statewide (1)

Support stable population objective.----Bedford (1), Greensville (1), Montgomery (1), Nelson (1), Powhatan (1), and Prince Edward (1)

Reduce deer population.----Accomack (1), Bedford (2), Campbell (2), Chesterfield (1) full season either-sex, Franklin (1), Floyd (1), George Washington National Forest (1), Hampton (1), Henry (1), James City (2), Newport News (1), Patrick (1), Southampton (1), Williamsburg (2), and York (3)

Liberalize deer hunting regulations/seasons.----Accomack (1) make full season either-sex and multiple bonus tags, Albemarle (1) increase either-sex days and go back to unlimited bonus permits, Bedford (1) increase season and limits, Campbell (1) increase limits, James City (1), Northampton (2) more either-sex days (2) and full season either-sex (1), Southampton (1), York (1), and Statewide (6) more either-sex days (3), longer season (1), and every Saturday either-sex (1)

Population management options.----Support hunting as primary option (13), support trap and transfer (7), send deer to Montana (1), oppose trap and transfer (1), support supplemental feeding (1),

support birth control (2), support sharpshooters (2), oppose sharpshooters (1), evaluation of management options biased to hunting (1)

Habitat Comments

In general habitat comments.----Improve National Forest deer habitat: Augusta (1), Craig (1), and Statewide (3), cease timber harvest on public land (1), and study/consider impact of deer on ecosystems in management decisions (2)

Damage Comments

In general damage comments.----Stop issuing out-of-season kill permits (2), reduce out-of-season kill permits (1), kill permits should be issued for long period of time (1), kill permits should be issued quicker (1), public safety cannot be measured in dollars (1), tolerance to deer damage must be raised in southwest Virginia (1), put someone on Board with deer damage (1), if Department paid for damage it would get the "picture" (1), federal refuge is problem (Bedford) (1), and extend deer season year round and put bounties on deer (1)

In general agricultural damage comments.----Pay farmers for damage (4), pay farmers to plant game crops (2), identify special crop damage areas and increase either-sex days (1), hunters do not suffer economically from crop damage and hence are reluctant to take steps to reduce the deer population (1), DCAP and kill permits have not been effective (1), issue DCAP in "closed" counties (1), promote DCAP (1), let farmers shoot unlimited number of deer during season (1), assist landowners in assessing economic losses (1), and persons with damage should allow hunting (1)

Agricultural damage.----Accomack (1), Bedford (2), Floyd (1), Franklin (1), Northampton (2), Patrick (1), Southampton (1), and Statewide (1).

In general urban damage comments.----Use archery in urban damage areas (5), disease concerns noted (3), uncontrolled urban development is responsible for most of the problems (urban and vehicle) (2), need mandatory EIS on wildlife impacts with urban development (2), urban deer problem should be top management priority (1), plan lacks focus on residential areas where deer population is exploding but hunting is not allowed (1), support sharpshooters in urban areas (1), please continue to work with Hampton which recently approved shooting deer within city limits (1), can safely hunt in densely populated areas (1), and urban deer need special programs (1)

Urban damage.----Accomack (1), Albemarle (3), Campbell (2), Chesterfield (1), Fairfax (1), Floyd (1), Hampton (1), Henry (1), Isle of Wight (1), James City (2), Montgomery (1), Northampton (1), Williamsburg (3), York (3), and Statewide (3)

In general vehicle damage comments.----Think deer-vehicle collision data in plan cannot be validated (1)

Vehicle damage.----Accomack (1), Albemarle (1), Floyd (1), James City (1), Lynchburg (1), Northampton (1), Patrick (1), York (2), and Statewide (3)

Recreation Comments

In general recreation comments.----Provide/promote quality deer management (7), allow Sunday hunting (3), enjoy seeing deer (2), amend Virginia's baiting law to allow (2), promote youth hunting (2), study why hunters are decreasing (1), notes decrease in number of deer hunters in Suffolk (1), free roaming dogs are a problem (2), eliminate dog hunting (1), encourage localities to establish ordinances that prohibit use of dogs outside the deer season (1), maximize hunting opportunities (1), make eastern seasons like west (1), have separate antlerless deer season (1), make Tidewater season earlier (mid September) and first 22 day

either-sex (1), agree with limiting antlered buck harvest per hunter (1), dog hunting is dying out and should be promoted (1), and would like to have all of Nelson County seven weeks with dogs (1)

Archery recreation comments.----Department could develop bow hunter certification course (1), legalize crossbows for everyone (1), reestablish definite separation between archery and firearms (1), and would like to have archery either-sex all seasons (1)

Muzzleloader recreation comments.----Want primitive weapon muzzleloader season (1), cut eastern muzzleloader season to one week and buck only (1), increase muzzleloader season (1), want muzzleloader season in Southampton (1), do not like Monday either-sex day during western early muzzleloader season (1), and early muzzleloader season has had negative impact to general firearms (dog hunting) (1)

License comments.----Make bonus tag antlerless only (2), go back to unlimited bonus tags (1), combine licenses (1), create WMA permit (1), raise license fees (1), put deer tags back on archery and muzzleloader license (1), make 2 deer limit on big game license (1), and license fee too high (1)

Hunter education/safety comments.----Support mandatory hunter education for all deer hunters (2), mandatory hunter safety will be a problem (nonresidents) (1), promote hunter safety (1), oppose mandatory hunter education for all deer hunters (1) mandatory hunter safety is #1 reason for decline in hunters, hunter safety noted (1), nonhunter safety noted (1), require more hunter orange (1), and zero hunting accidents is unattainable (1)

Law enforcement comments.----Need more law enforcement (8), unethical behavior of deer hunters noted: slob hunter (1), dog hunters (7) and road hunters (4), poaching is a problem: Spotsylvania is "lawless" (1), more deer kill illegally than legally in Halifax (1), and illegal activity common and accepted practice (Page) (1), stress ethics (1), and have cased gun law statewide (1)

Education Comments

In general education comments.----Need to promote food value of deer (1)

Appendix IX. Draft proactive strategies text for addressing urban deer management issues.

Application

For the VDGIF to actively participate in suburban/urban deer management problems and/or authorize depopulation activities, a written request from the local governing body to the Department will be required. This would include, but not necessarily be limited to, County Boards of Supervisors, City Councils or their Managers, Homeowner Associations and/or Community organizations. Pursuant to receiving a written request for assistance with urban/suburban deer management, the Department will assign the local District Wildlife Biologist as the Department's official contact/spokesman. This staff member will be responsible for all Department responsibilities and duties related to the citizen's task force (CTF).

Methodology

Suggested Approach.----To address suburban/urban deer problems, a local citizen's task force (CTF) is suggested. The CTF's responsibility is to recommend a deer population objective and the management option/strategies required to achieve the population objective. Additionally, the CTF should develop a time line for implementation of any recommended management action and identify the parties responsible for implementation of the recommendations.

Developing, administering, and funding the CTF will be the obligation of the local governing body. CTF meetings should be administered by an independent, trained facilitator. All community stakeholders, not to include government officials, should be included. One representative should represent each stakeholder group. The Department will assign a local Wildlife Biologist to serve as a liaison/technical advisor to the CTF. Department staff will not serve as an active CTF member.

In many cases, it may be desirable and/or necessary to initiate a random survey to determine the local public's knowledge of deer ecology and the community's perception of the current deer population and attitudes towards different deer management options.

Population Objectives

1. Increase Population
2. Stabilize Population
3. Decrease Population

Management Options

Lethal

1. Regulated hunting
2. Trap and kill
3. Sharpshooters

Nonlethal

1. Allow nature to take its course (status quo)
2. Trap and transfer
3. Abatement techniques (fencing and repellents)
4. Fertility control
5. Supplemental feeding
6. Predator reintroduction

The following outline identifies the suggested steps to resolve an urban deer management issue using a Citizen Task Force (CTF):

Suggested CTF approach for urban/suburban deer management in Virginia

1. Select stakeholder groups, facilitator, and technical advisors.
2. Send out invitation letters and background information to CTF members and technical advisors.
3. Initial CTF meeting: background and issue identification.
4. Send meeting notice and minutes.
5. Second CTF meeting: prioritize issues and gather additional information.
6. Send meetings notice and minutes.
7. Third and subsequent CTF meetings: build consensus on issues and work towards recommendations on population objective and management option(s).
8. Send meetings notice and minutes.
9. CTF recommendations finalized and officially forwarded to governing entity.
10. Recommendations implemented (if approved by governing entity).
11. Monitor/evaluate management recommendations implemented (revise recommendations by consensus as needed).

Adapted from:

Stout, R. J. and B. A. Knuth. 1994. Evaluation of a citizen task force approach to resolve suburban deer management issues. Hum. Dimensions Res. Unit Publ. 94-3, Dep. Nat. Resour., Cornell Univ., Ithaca, N.Y. 164pp.

Appendix X. Management of urban deer populations with contraceptives: practicality and agency concerns.

Acknowledgement

Management of urban deer populations with contraceptives: practicality and agency concerns was co-authored by Robert J. Warren and Lisa M. White, of the Daniel B. Warnell School of Forest Resources, The University of Georgia, and William R. Lance, Wildlife Laboratories, Inc. Originally presented at the Urban Deer Management Symposium held at the 55th Midwest Fish and Wildlife Conference, this article was published in 1995. The citation is as follows:

Warren, R. J., L. M. White, and W. R. Lance. 1995. Management of urban deer populations with contraceptives: practicality and agency concerns. Pages 164-170 in J. B. McAninch, ed. Urban deer: a manageable resource? Proc. of the 1993 Symp. North Central Sect., Wildl. Soc., St Louis, Mo.

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MANAGEMENT OF URBAN DEER POPULATIONS WITH CONTRACEPTIVES: PRACTICALITY AND AGENCY CONCERNS

The need to control populations of white-tailed deer (Odocoileus virginianus) in urban environments is increasingly common in wildlife management today. Public opposition, municipal ordinances, or concerns for human safety often prohibit the use of lethal methods of deer population control (e.g., hunting or controlled shooting) in many urban and suburban areas. Therefore, interest in the potential use of contraception as a non-lethal method of controlling deer in these areas has increased dramatically in the past 10 years (Warren 1995).

Our paper will briefly review the biotechnology of contraception, methods of delivery of this technology, the published literature on contraceptive research in white-tailed deer, and the potential for practical application of contraceptives to deer populations in urban or other restricted environments. We also will discuss practical, legal, regulatory, and public interest issues associated with the proposed use of contraceptives in controlling urban deer populations.

Methods of Contraception

There are three basic methods of contraception that have possible application to urban deer management -- surgical sterilization, synthetic steroid hormone supplementation, and immunocontraceptive vaccines. Our paper will primarily consider application of contraceptives to females. The polygamous breeding behavior of deer makes any male-targeted contraceptives ineffective at the population level. In other words, only a few untreated, fertile bucks in an urban deer population would be capable of breeding most of the does in that population.

Surgical sterilization is obviously a permanent method of contraception. It requires the capture of individual deer and the application of field surgery. Both of these requirements increase the cost of this technique of contraception and create concerns for animal safety. Therefore, we will focus our discussion on synthetic steroids and immunocontraception as possible methods for use in urban deer population management.

Exogenous synthetic steroid hormones result in contraception by altering the animal's reproductive hormone balance. The hormones (e.g., synthetic progesterone and/or estrogen) are either ingested or implanted subcutaneously and produce sufficient circulating levels of these hormones to block or inhibit the hormonal stimulation from the brain necessary for normal ovarian activity, ovulation, and pregnancy.

The basic principle of immunocontraception is to inject an animal with a vaccine to stimulate its immune system to produce antibodies against a protein involved in reproduction. The antibodies produced interfere with function of the protein in the reproductive process, thereby resulting in contraception. Vaccines used in this manner are proteinaceous reproductive hormones, or the proteins surrounding the sperm or ovum, or proteins involved in implantation.

Methods of Application

Several technologies currently are available for applying contraceptives to deer. Oral delivery methods, whereby a contraceptive steroid is contained within a bait, generally have been ineffective (see section on synthetic steroids below). Oral delivery methods are being evaluated that may be capable of delivering contraceptive vaccines via a modified live virus or bacterium (see section on immunocontraception below).

Subcutaneous implants potentially can be an effective contraceptive delivery technique in deer. These implants usually are made of a physiologically inert material, which releases the contraceptive steroid for several years. The major disadvantage of subcutaneous implants is that they require time-consuming and costly capture of individual deer for implantation.

Obviously, delivery technologies that could be administered remotely would be more practical for routine application in urban deer management. Most immunocontraceptive vaccines can be delivered remotely by using commercially available syringe darts. Remotely delivered darts have several disadvantages, however. The accuracy depends on the quality of the equipment and the experience and skill of the user. Missed darts may not be recovered and could remain in the environment as a potential human exposure hazard (especially for curious children). Additionally, improperly used darts can produce tissue trauma in deer.

Recent research has evaluated the use of remotely deliverable, intramuscular implants (i.e., "biobullets") containing contraceptives. BallistiVet Inc. (Minneapolis, Minnesota) produces an implant "gun" that is capable of remotely injecting a 0.25-caliber, biodegradable "biobullet" at ranges of up to 20 or 30 m. The biobullet is made from compressed food-grade material (hydroxypropyl cellulose) and contains a hollow chamber into which a freeze-dried compound can be placed. The biobullet degrades within a few hours after implantation and releases the freeze-dried compound. The biobullet technique has been used successfully to vaccinate free-ranging bison (Bison bison) against brucellosis in Montana (Davis et al. 1991) and to remotely deliver an immunocontraceptive vaccine to free-ranging feral horses (Equus caballus) on Cumberland Island, Georgia (Goodloe 1991). The biobullet also has been used successfully to remotely deliver contraceptive vaccines to deer in large enclosures at the University of Georgia (L. M. White, unpubl. data) and at Purdue University (R. K. Swihart, pers. commun.). It also has been used to remotely treat deer with an intramuscular implant containing a contraceptive steroid (see section on synthetic steroids below).

Synthetic Steroids in Deer

Daily, oral administration of synthetic steroid hormones can inhibit ovulation in female deer. Roughton (1979) demonstrated that daily administration of oral melengestrol acetate (MGA: a synthetic

progesterone) effectively inhibited ovulation in captive white-tailed deer. However, orally administered synthetic steroids are not practical for urban deer management because it is impossible to guarantee daily treatment necessary to maintain infertility. Harder and Peterle (1974) also showed oral treatment with diethylstilbestrol (DES: a synthetic estrogen) was not a practical method of contraception in deer. Microencapsulation of DES can allow treatment intervals to be extended up to 30 days, but the high doses of microencapsulated DES required to be effective are not readily accepted by deer (Matschke 1977a).

Subcutaneous hormone implants have had only limited success in preventing pregnancy in female deer. These contraceptives require trapping and handling of individual deer, which are very costly. Bell and Peterle (1975) reduced reproductive rates of deer by using silastic-silicone rubber tubing implants containing MGA and DES. Matschke (1977b, 1980) examined fertility control in deer with silastic implants of DES and a synthetic progesterone (DRC-6246). These implants have limited application in the field because of the short time span of effective hormone release. Calculated release times for DES were 1-2 years versus 3 years for DRC-6246 (Matschke 1977b); however, in a field trial, suppressed reproduction lasted for only 2 years (Matschke 1980).

Plotka and Seal (1989) showed that MGA implants induced infertility for 2 years in nonpregnant captive deer. However, when applied to 5 pregnant does during winter, pregnancy was not interrupted. They removed the implants in late pregnancy, but nonetheless one of the treated does died. Plotka and Seal (1989) recommended that pregnant deer not be treated with MGA implants unless pregnancy is first terminated. It is unfortunate that contraceptive steroid implants cannot be used in winter, because, at this season of the year, deer generally are easiest to bait and capture for treatment, which would improve the practicality of applying this technique.

The main limitation of using steroid implants for contraception in deer is the relatively short time of efficacy. Efficient and practical management of deer populations in the absence of regulated hunting or trap-and-removal programs requires a contraceptive capable of lasting the reproductive life of the doe (Matschke 1980). Levonorgestrel (LNG) is a synthetic progesterone that provides effective, long-term (>5 years) contraception when implanted in humans (Diaz et al. 1982). Contraception of deer for >5 years from 1 contraceptive treatment might justify the time and cost associated with capturing and treating individual deer, and hence has potential for providing a practical technique for contraceptive management of urban deer populations.

Despite the potential for LNG, 2 studies with LNG implants in captive white-tailed deer have proven them to be ineffective. In the first study, Plotka and Seal (1989) implanted 5 does with a single, solid silastic-silicone rod containing 200mg LNG; 3 of the 5 does became pregnant. Plotka and Seal (1989) did not measure LNG concentrations, so the lack of contraception may have been related to the shape and matrix of the silastic implant, all of which can affect steroid hormone release (Robertson et al. 1983).

In the second study with LNG implants in deer, White et al. (1994) used the technique as it is applied in humans, which consists of 216mg of LNG sealed inside 6 small silastic-silicone tubes. White et al. (1994) compared 6 versus 9 LNG implants (containing a total of 216 versus 324mg of LNG) in adult versus fawn does. Fawns were included to determine the effects of LNG implantation on puberty attainment. Despite significant release of LNG from both doses of implants, White et al. (1994) observed that 3 of 5 implanted adults and 1 of 2 fawns that survived 2 years' post-implantation became pregnant. These researchers did not recommend the use of LNG in deer.

Researchers at Purdue University and the University of California have successfully applied remotely delivered norgestomet (NGM) as a contraceptive in white-tailed deer (R. K. Swihart, pers. commun.) and black-tailed deer (Odocoileus hemionus) (Jessup et al. 1993). This synthetic progesterone was developed and is marketed for synchronizing estrus in domestic livestock.

Antech Laboratories, Inc. (Champaign, Illinois) has complexed 42mg of NGM into silastic-silicone rods and loaded it into biobullets for remote delivery purposes (D. J. Kesler, pers. commun.). In both species of deer, NGM was nearly 100% successful in preventing pregnancies; however, it only was effective for one year (Jessup et al. 1993, D. J. Kesler, pers. commun.). Therefore, annual treatments would be required to maintain control over deer reproduction. More importantly, these annual treatments would need to be

administered before the autumn breeding season (i.e., NGM would need to be administered before ovulation could occur).

This requirement would limit the applicability of this contraceptive technique primarily to smaller sites within urban areas where substantial control over the deer herd exists. In these situations, it might be possible to annually treat deer with NGM delivered via biobullets. Deer in urban areas usually are accustomed to vehicles. Therefore, it might be practical to remotely administer NGM biobullets to deer along roadways prior to the breeding season. However, applying a synthetic steroid in an urban environment where residues might enter the human food chain creates a significant concern for federal and state regulatory agencies (see section below on agency concerns).

Immunocontraception in Deer

Immunocontraception is a new contraceptive technology that may be more applicable to urban deer populations. The results of research on this new technology for birth control have proven so successful and safe that contraceptive vaccine trials have been conducted on human females with favorable success (Jones et al. 1988).

Immunocontraceptives have advantages over synthetic steroids that may make them effective and efficient for use in urban deer management. Immunocontraceptives can be delivered remotely, which makes them more feasible for field application than methods that require capture of individual deer. Also, protein-based contraceptive vaccines likely would be deactivated if ingested orally by nontarget species, thus eliminating the problem of residues from synthetic steroids.

Digestion of the contraceptive vaccine after oral ingestion would render the vaccine immunologically ineffective and would minimize the risk to nontarget species or humans. The major disadvantage of immunocontraceptive vaccine technology today is repeated injections (i.e. booster vaccinations) are necessary to maintain effective antibody levels.

Generally, contraceptive vaccines are prepared by adding a protein (i.e. the antigen) to an adjuvant. The adjuvant increases the immunological reaction to the antigen. The most commonly used antigens in contraceptive vaccines are proteins involved in fertilization. One immunocontraceptive tested in captive deer is based on stimulating antibody response to the zona pellucida (ZP). The ZP consists of a series of proteins surrounding the ovum that is essential to sperm-egg binding during fertilization. The ZP immunocontraceptive stimulates the female to produce antibodies to ZP. Normal fertilization of the egg is prevented by blocking the sites of attachment for the sperm cells to the ovum. The ZP used in these contraceptive vaccines is commonly obtained from pig ovaries; thus it is termed porcine zona pellucida or PZP.

Turner et al. (1992) used syringe darts to vaccinate female white-tailed deer with PZP and Freund's complete adjuvant (a mixture of oil, water, and killed bacterial proteins). These researchers then administered a second and third injection (i.e., boosters) at 3 and 6 weeks, respectively, after the initial injection. Six months after the first injection, the does were bred by a fertile buck. None of the PZP-treated does (0 of 7 treated does) produced fawns in this study, compared to 86% (6 of 7 control does) of control does.

The results of the study by Turner et al. (1992) are encouraging, but the need for multiple booster injections limits the practicality of using PZP in urban deer populations. It will be difficult to consistently administer a second and third vaccination to individual does in a free-ranging urban deer population. Does that do not receive booster vaccinations would have ineffective antibody levels against ZP and, therefore, would remain fertile.

This problem of individual females not receiving their booster vaccinations and remaining fertile was noted by Kirkpatrick et al. (1990) in their study of PZP vaccine and free-ranging feral horses on Assateague Island, Maryland. In this study, they observed foaling rates of 0% in 18 mares that received two boosters of PZP vaccine, compared to 12.4% in 8 mares that received only 1 booster.

The need for booster vaccinations may not be a limitation in the future. Recent research with PZP has included microencapsulation of the booster vaccinations so that only 1 vaccination per year is required.

The vaccines are microencapsulated for release over a period of weeks or months after injection (J. F. Kirkpatrick, pers. commun.). If perfected, this research will enable the booster vaccinations to be administered in the same injection (i. e., in the same syringe dart) with the initial vaccination.

In addition to ZP proteins, one other possible source of antigens for use in contraceptive vaccines are proteins of the sperm cell membranes. Several different sperm proteins have been considered for use in anti-sperm contraceptive vaccines (Naz and Menge 1990). The potential use of anti-sperm vaccines in deer populations would involve treatment of the female, not the male. In other words, females would become immune to sperm cells. Infertility in treated females could then result because anti-sperm antibodies can bind sperm cells (reviewed in Shulman 1986), reduce the movement of sperm through the reproductive tract (Clarke 1988), or alter sperm binding to the ZP (Naz et al. 1992).

Very little research exists on the use of anti-sperm vaccines in deer. White et al. (1993) presented preliminary data on an anti-sperm vaccine for deer. They developed anti-sperm vaccines using sperm from deer, bull, and boar testes. These vaccines were injected into adult does, from which blood samples were collected for antibody analysis. High anti-sperm antibody levels occurred in does injected with anti-sperm vaccines made from all species tested. However, antibody recognition of deer sperm was greatest in those does injected with either deer or boar sperm. The high antibody levels persisted for a period of at least seven months post-immunization. The does treated in this preliminary trial became pregnant (L. M. White, unpubl. data).

A new area of research in immunocontraception is to develop a biologically vectored, oral delivery method. This technology is in the early stages of development. The goal is to genetically modify a bacterium or virus so that it contains either the ZP or sperm proteins described previously. The microorganism then serves as a live vector to orally deliver an immunocontraceptive vaccine to a deer population. Similar technologies have been used recently to deliver orally effective rabies vaccines to wildlife populations (Wandeler et al. 1988).

A microorganism-vectored technology for the delivery of contraceptive vaccines would greatly reduce the cost and time required to apply immunocontraceptives to free-ranging deer populations. This technology would enable delivery of immunocontraceptives to a much greater number of individuals in a population than by other remote delivery technologies. However, serious concerns may exist regarding the potential risk of applying this technology. For example, nontarget species, including humans, might be at risk of being exposed to microorganism-vectored contraceptive vaccines. Controlling the spread of the bacterium or virus to other deer populations would be difficult if not impossible. Much more research is needed before this technology can even be considered for field testing.

Practical Applicability Concerns

Will eliminating reproduction in treated individuals control a deer population? Current research results indicate several contraceptive techniques are effective in individually treated deer. Limited research has been conducted to determine the effectiveness of contraceptive management at a population level. Applications of contraceptives to captive deer are not equatable to applications in free-ranging deer populations. Reduced reproduction rates by does treated with contraceptives may result in greater survival rates for fawns produced by untreated does that escape treatment with the contraceptive. Additionally, immigration of deer from areas surrounding a treated deer herd may negate density reductions in the treated herd. This problem could be rectified by erecting a deer-proof fence. Controlled research to evaluate the effectiveness of deer contraceptives at the population level is needed. Wildlife population numbers are dynamic and are the result of multiple factors, only one of which is reproduction.

The potential effect of contraception on deer behavior and population dynamics is another practical concern. The rutting period might be extended by treating does with contraceptives. Does that fail to conceive can continue estrous activity for up to seven months (Knox et al. 1988). In response to an extended breeding season, bucks might continue territorial and reproductive behavior for a much longer period of time than normal. Rutting bucks significantly reduce their food intake, which leads to significant body weight

losses (Warren et al. 1981). Thus, if an extension of the rutting period occurs, then bucks might experience significant over-winter mortality rates. An extended rut also might indirectly increase the potential for deer-vehicle collisions, because deer generally are more active and move greater distances during the breeding season (Kammermeyer and Marchinton 1977).

The inability to identify individual females in a free-ranging population for remote vaccination is another practical limitation to the field application of immunocontraceptives in urban deer management. The feral horses that Kirkpatrick et al. (1990) treated with PZP vaccine had unique color markings which enabled the researchers to identify individual mares for repeated vaccination. It is not possible to identify individual white-tailed deer does from a distance for remote delivery of a contraceptive vaccine.

Thus, some does in a treated population might receive unnecessary boosters (i. e., more boosters than necessary to maintain effective antibody titers). If this were to occur, there would not likely be a concern regarding vaccine overdose or toxicity. Rather, urban deer managers would be unnecessarily wasting time, effort, and vaccine. It might be possible to mark deer at the time of vaccination using remotely delivered paint balls to minimize double boosting individual does. This technique has been used successfully to remotely mark elk (Cervus elaphus) after vaccination via biobullet against brucellosis on the National Elk Refuge near Jackson Hole, Wyoming (E. T. Thorne, pers. commun.).

Legal, Regulatory, and Public Interest Issues

Although the technology to enable effective contraceptive management of certain urban deer populations likely will be available someday, several questions regarding legal, regulatory, and public interest issues must be answered before this technology can be applied in routine urban deer management programs. Each issue can potentially block the future use of contraception.

There are basic legal questions that must be answered. The foundation of wildlife laws established in the original 13 American colonies was that wild animals were owned in common by the people of the states (Matthews 1986). The wildlife resource was managed in trust for the people of the state by the state wildlife agency. The state wildlife agency then, by virtue of license, granted limited rights to an individual to legally take game under certain conditions. The concept of state ownership of wildlife within the states' boundaries, whether on private or public lands, was the foundation of North American wildlife law. Over the past 200 years, as international migratory bird treaties, endangered species laws, and other federal statutes have been enacted, the overriding regulatory authority regarding some species has been transferred from state to federal agencies. The questions of state control, public ownership, and the state's duty to protect the wildlife resource within its borders constitutes a body of law that is in transition and open to political debate (Matthews 1986).

This question becomes pivotal when determining who has authority to capture urban deer for application of contraceptive techniques and under what conditions. State officials have management authority over white-tailed deer, even in urban environments. However, county and municipal ordinances may restrict the control options that state officials can consider.

A related legal issue is whether a federal agency (e. g., USDA Animal Damage Control) has authority to apply this technique to deer in urban settings. Do state wildlife agencies need to establish separate policies or regulations for the application of wildlife contraceptives? To date, at least 3 state wildlife agencies (Indiana, Minnesota, and New Jersey) have developed or drafted policies regarding applications of wildlife contraceptives.

Federal and state licensing procedures also may require that only certified wildlife biologists, veterinarians, or registered pesticide applicators may apply these vaccines for urban deer population control. If any agency intervenes to control a wildlife population through contraception, then a flurry of legal challenges by coalitions representing the wildlife resource utilization interests of that state are likely to follow.

A critical legal question deals with liability. Which agency or individuals would be legally liable if there were alleged secondary effects from the contraceptives to nontarget species, such as domestic animals

or humans? Eventually, some entity must manufacture and distribute the contraceptive technology. If a public agency manufactures and distributes the final product for the field, then it may or may not have legal protection against product liability lawsuits. Private, nonprofit or profit entities will be forced to address the liability and risk associated with misapplication of wildlife contraceptive technology. The potential liability associated with a product that has potential to adversely affect reproductive performance in any species may be too great for a company to ever consider producing the product.

If all legal issues could be addressed and a manufacturer found that was willing and capable to produce the technology, then the next hurdles would be the federal regulatory barriers. All methodologies discussed in this paper, except surgical sterilization, fall under the regulatory authority of 21 CFR and Food and Drug Administration Center for Veterinary Medicine (FDA/CVM). The sponsoring agency or company would have to provide FDA/CVM with well-controlled studies to demonstrate an optimum effective dose, the safety of that dose for the target species, and the effectiveness of that dose under actual conditions of field use.

The manufacturing procedure for that product must be in full compliance with FDA's current Good Manufacturing Practices (cGMPs) along with validated analytical procedures to warrant the safety, purity, and strength of the final product. If the contraceptive technology requires oral delivery in broadcast baits applied to an area, then the regulatory concerns of the Environmental Protection Agency (EPA) also will have to be addressed. The use of oral delivery technology would greatly exacerbate the inherent liability issues that could arise from ingestion by nontarget species.

An important question regarding wildlife contraceptive technology is, "Who will pay the bill?" The actual contraceptives may be economical, but the personnel and operating expenses associated with delivering contraceptives to significant numbers of individuals in an urban deer herd likely will be costly. Certainly the hunting public would object to the use of state wildlife agency funds, which are derived largely from license sales and Pittman-Robertson revenues, for wildlife contraceptive programs.

The general tax-paying public of a state may object to paying for a contraceptive program to be mainly applied to 1 county or a specific urban area within that state. The cost of the program on a county or municipal level may be too great for a municipality to bear. The question of "Who is going to pay the bill?" has never been adequately addressed. In the economic environment of the 1990s and the future, federal funding is not guaranteed.

A diversity of public interest groups likely will support or oppose wildlife contraceptive programs. Humane and anti-hunting groups likely would support contraceptive applications, but may find themselves opposed by other groups that are against the application of any new biotechnology. Likewise, groups representing interests of the hunting public generally would oppose the use of such technology and may be joined in their position by organizations that consider such applications of the biotechnology to be "ecological barbarianism."

In conclusion, contraceptive techniques represent one possible management tool that may be useful in the control of urban deer populations in the future. However, many research, management, ecological, and biopolitical questions must be answered before contraceptive management programs can be implemented as a possible solution to the problem of too many deer in urban environments. The questions and concerns regarding the application of wildlife contraceptives we identified in this paper are only the major ones recognized at this time.

In our opinion, if the technology were perfected and available today, another 10-20 years will be required before all legal, regulatory, and public interest issues discussed in this paper will be settled to permit routine managerial application of contraceptives to free-ranging wildlife populations.

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Appendix XI. Priorities for plan objectives based on deer planning committee survey.

Mean Score [a]	Ranked Objectives [b]

Highest Priorities

1.28 Damage: To develop a management program for urban deer by January 1, 2004.

1.39 Damage: To quantify agricultural, urban, ecosystem, vehicular and forestry related deer damage by January 1, 2004.

1.61 Population: To determine the CCC by management unit by January 1, 2004.

1.61 Population: To meet deer population management objectives by management unit through January 1, 2004.

1.61 Population: To identify and develop/continue management programs for unique deer management areas within traditional management units through January 1, 2004.

1.61 Education: To develop public information educational materials and programs related to Virginia's deer management program by January 1, 2004.

Medium Priorities

1.89 Recreation: To yield zero (0) deer hunting-related accidents.

1.89 Habitat: To determine the status of deer habitat by management unit through January 1, 2004.

1.94 Administrative: To provide annual assessments of progress toward meeting deer management plan objectives and to begin work on a revised plan by January 1, 2003.

2.06 Recreation: To yield a statewide deer gun hunter satisfaction index (HSI) of $\geq$ 4.0 (adequate) on both public and private lands in all regions.

2.06 Damage: To reduce the demand for out-of-season kill permits for deer to or below 1,000 permits annually through January 1, 2004.

2.11 Administrative: To achieve a 50% increase in VDGIF deer program funding, excluding inflation, by the 2004 fiscal year.

2.17 Damage: To develop a quantitative objective for deer-vehicle collisions by January 1, 2004.

2.28 Habitat: In cooperation with the USFS, implement habitat management practices and improvements beneficial to deer on 1% of National Forest lands annually through January 1, 2004.

Lower Priorities

2.61 Recreation: To yield $\geq$ 3,800,000 days spent afield deer hunting by $\geq$ 230,000 deer hunters.

2.89 Recreation: To yield current levels of deer viewing opportunities.

[a1] 1= highest priority, 2 = medium priority, 3 = lower priority (n = 16)

[b] priority groups based on cluster analysis