

White-tailed Deer in Minnesota

Information Packet for the
Deer Management Plan Advisory Committee

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NATURAL HISTORY

Historically, white-tailed deer in Minnesota existed throughout the wooded river valleys and woodlands of central and southern Minnesota (Figure 1). Hardwood forests comprised of maple, basswood, and oak were abundant in southeastern and central regions of Minnesota and white-tailed deer were likely common in these areas. In northern Minnesota, deer were absent or rare; moose and caribou were the most abundant members of the deer family. The predominant forest landscape was comprised of extensive tracts of jack pine, and red and white pine, mixed with spruce-balsam and aspen-birch on the uplands and spruce, tamarack and white cedar on the lowlands.

European settlement of southern and central Minnesota during the mid- to late-1800s cleared forests for lumber and agriculture, which improved habitat quality for deer by creating new openings. However, as agricultural land conversion expanded, habitat quantity declined and so did deer numbers. Market and subsistence hunting accelerated the population decline in deer numbers; by the 1880s deer were rare in many parts of Minnesota (Figure 2).

Dr. Thomas S. Roberts, famous author of the *Birds of Minnesota*, witnessed the killing of the last white-tailed deer near Lake Harriet south of Minneapolis in 1885. He described this historic hunt in these words “A few deer were known to live in the woods on the west shore of Lake Harriet. One fall day in 1885 four men from Minnehaha Falls with dogs drove and pursued them all day, finally killing 3 animals. These were the last deer known to exist near Lake Harriet.” It would be 75 years before deer once again returned to Lake Harriet.

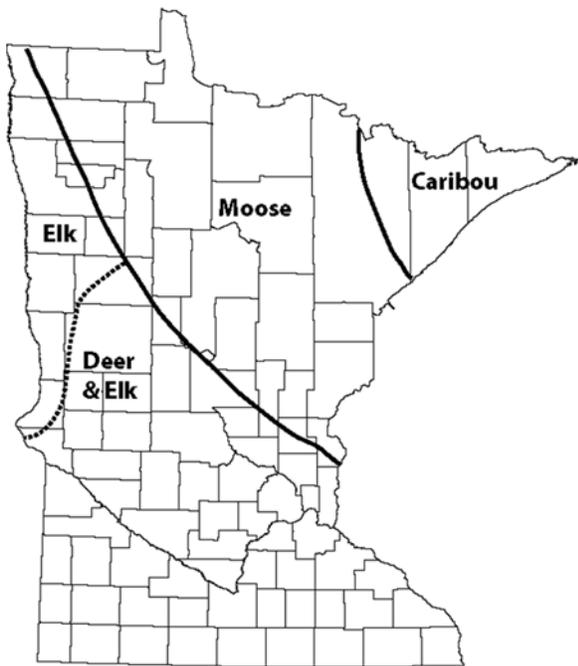


Figure 1. Range map of cervids (deer, elk, moose, and caribou) in Minnesota prior to European settlement.

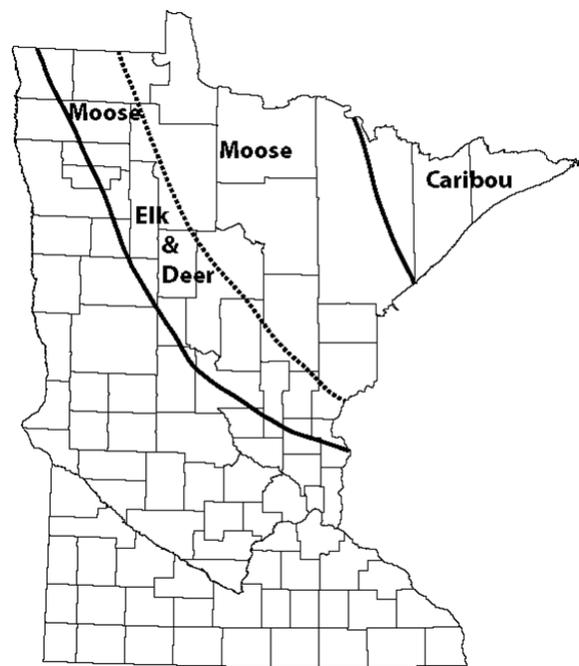


Figure 2. Range map of deer family members in Minnesota around 1880.

During the late 1800s, logging of the red and white pine forests and burning logging slash, as well as clearing land for farming, created new habitats for white-tailed deer in northern Minnesota. By 1920, white-tailed deer were common in northern forests but were rare in much of their former range (Figure 3).

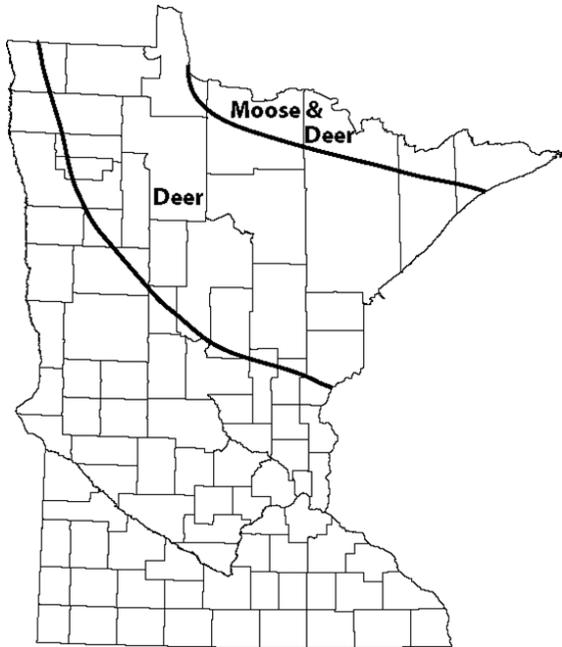


Figure 3. Range map of deer family members in Minnesota around 1920.

Importance of deer to society

Deer are important to the economy of Minnesota, particularly in rural regions where hunters typically travel to hunt deer during the firearms deer season. Based on the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, the total annual economic impact of hunting in Minnesota exceeded \$725 million and more than 85% of hunters in Minnesota hunt deer.

Deer hunting is highly valued in Minnesota, and revenues generated from deer hunting support many wildlife programs. Passage of the 1937 Federal Aid in Wildlife Restoration Act, which created the Pittman-Robertson Program, marked the beginning of wildlife management as we know it today. Pittman-Robertson dollars are a result of a federal excise tax on firearms and ammunition. These funds, along with revenues generated directly from deer hunting license sales, are used to support a wide variety of wildlife-related activities including acquisition of conservation lands, management and research activities to benefit wildlife, natural resources education programs and law enforcement.

There are more than 500,000 deer hunters in Minnesota, which means that about 1 out of every 10 Minnesotans hunt deer each year. There are many more Minnesotans who also enjoy

observing deer. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation estimated that more than 1.5 million people spent \$621 million to observe, feed, or photograph wildlife in Minnesota during 2011. While it is difficult to quantify the popularity of deer, they are a valued native species and it is probably safe to assume that a good portion of those people spent time and money enjoying and observing deer.

HUNTING AS A POPULATION MANAGEMENT TOOL

The state of Minnesota attempted to manage deer numbers through regulated hunting as early as 1858 (Table 1). Deer hunting seasons were closed in Minnesota's farmland area in 1923 and remained closed until 1945. The first statewide, any-deer season occurred in 1946. Deer were more abundant in the north and a deer hunting focus and traditions developed in the northern forest, including the far northeastern counties.

Over the past century, deer populations have fluctuated throughout the state in response to changing habitat, patterns of winter severity, and hunting harvest. These factors, especially the latter two, forced season closures in the early 1940s and in 1951. A statewide deer population crash occurred in the late 1960s, which prompted the last season closure in 1971.

An improved management framework evolved during the 1970s that permitted annual hunting, while allowing the statewide population to grow. While the hunting zones, season lengths, and opening dates have changed slightly over the years, today's seasonal framework generally reflects the system developed in the 1970s.

The season centers on an opening firearm season on the Saturday closest to November 6. A hunter may purchase a season license to take a buck or an antlerless deer with an either-sex permit, in a 'lottery' deer permit area (DPA). The either-sex permit quota depends on where the deer population is relative to the population goal, hunter success rates, and other factors.

Because demand for either-sex permits typically exceeded supply in most permit areas, a lottery preference system has been utilized since the early 1980s to equally distribute antlerless permits among hunters through time. Beginning in the 1990s, the Minnesota DNR allowed for issuance of additional either-sex permits (i.e., bonus permits) to help reduce deer populations in permit areas that exceed established goals.

Beginning in 2003, permit areas were annually designated by wildlife managers as lottery, managed and intensive. The latter two designations allowed the issuance of an either-sex license and purchase of one or up to four additional bonus permits, respectively. Hunter choice, a management strategy intermediate to lottery and managed harvest, was instituted in 2011 to allow hunters to take one deer of either sex in a permit area without making a lottery application.

A bucks-only management strategy has been implemented on rare occasion (e.g., after the severe winters of 1995-96, 1996-1997 and again after the severe 2013-2014 winter). Currently, a hunter may purchase up to three seasonal licenses (archery, firearm, and muzzleloader) and harvest up to five deer annually throughout the state, depending upon DPA management designations and strategies.

Managing deer harvest

Hunting is the primary method used to manage deer populations in Minnesota. Population goals for each DPA were developed through a stakeholder-based process administered by the DNR between 2005-2007, 2012 and 2014.

To manage deer densities within target levels, area wildlife managers, the big game program leader and wildlife researchers consult on an annual basis to determine the management designation and the number of either-sex permits offered for each DPA.

The information considered in this process includes annual harvest statistics including hunter success rates, population trend data, and recommendations from the deer population goal-setting process as well as hunter comments and deer damage complaints. When deer population goals are revised for DPAs, management strategies are adapted to move the population toward new goal levels.

Table 1. General frameworks for Minnesota’s firearms deer seasons, 1858-Present

Years	Length	Opening Dates	Limit
1858-63	5 Mo.	Sept. 1	None
1865-73	5 Mo.	Aug. 1	None
1874-86	2.5 Mo.	Oct. 1	None
1887-92	1 Mo.	Nov. 1	None
1893-94	19 Days	Nov. 1	None
1895-96	20 Days	Nov. 1	5/License
1897-98	22 Days	Oct. 25	5/License
1899-1900	21 Days	Nov. 1	5/License
1901-04	21 Days	Nov. 10	3/License
1905-14	21 Days	Nov. 10	2/License
1915-18	21 Days	Nov. 10	1/License
1919-20	22 Days	Nov. 15	1/License
1921-44 ^a	5-11 Days	Nov. 10-21	1/License
1945-58 ^b	1-9 Days	Nov. 8-20	1/License
1959-69	9 days	Nov. 7-13	1/License
1970	2 days	Nov. 14	1/License
1971	Closed		
1972-1976	5-17 days	Nov. 1	1/License
1977-1984	16 days	Nov. 3-10	1/License
1985-1992	16 days	Nov. 3-9	Up to 2 deer with bonus permit
1993-2016	16 days ^c	Nov. 3-9	Up to 5 deer with bonus permit

^a Season closed every other year from 1923 to 1931, closed again 1935, 1939, 1941

^b Season closed 1950

^c Up to 23 days in Twin Cities Metro area since around 2005. Longer seasons have occurred in disease management permit areas

Deer hunters and their harvests

Minnesota's deer program has been largely successful based on hunter numbers and deer harvests. Minnesota firearms deer hunter numbers (Figure 4) and firearms deer harvests (Figure 5) have grown tremendously over the past 95 years.

More recently, the DNR developed a public goal-setting process to better involve citizens in deer population decisions. The current framework has, for the last 40 years, brought relative stability to deer population management in Minnesota compared to previous decades, when liberal seasons were often followed by season closures.

Population management through season structure and regulation, along with winter weather patterns, has been the most significant factor in both farmland and forest deer populations in the state during the past 40 years.

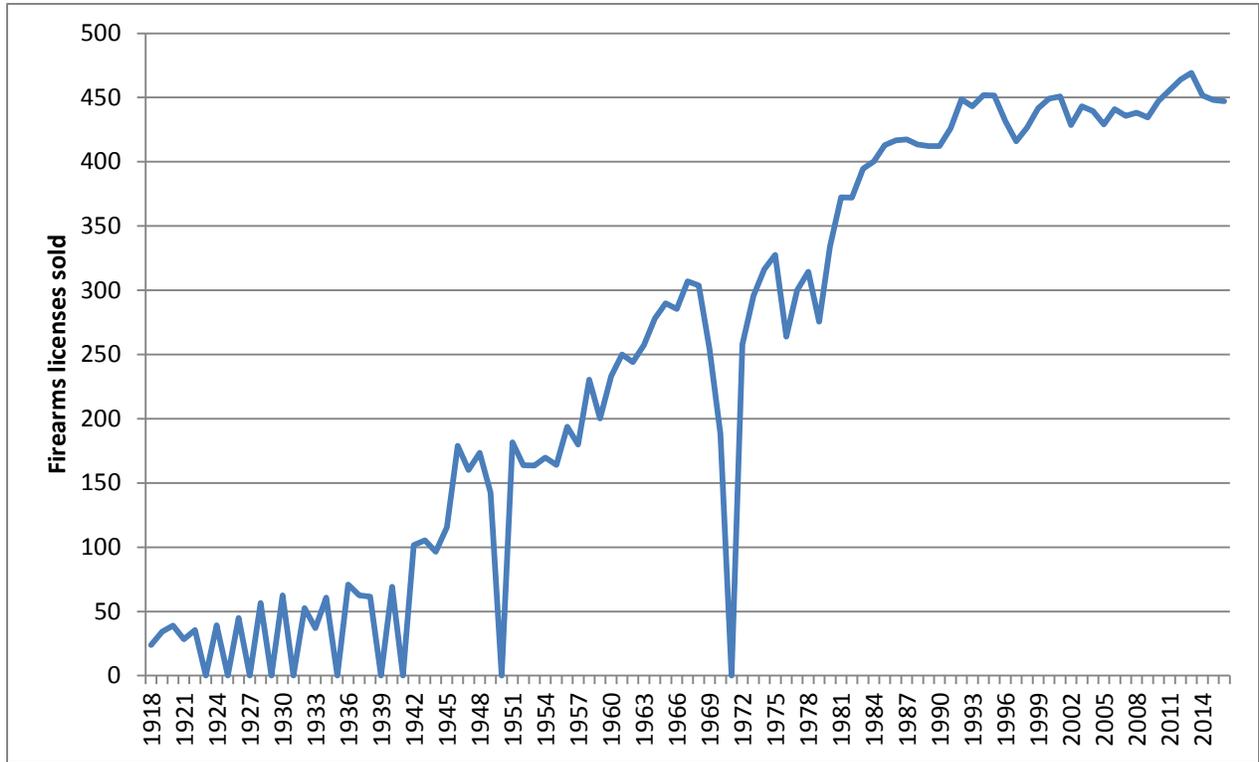


Figure 4. Minnesota firearm license sales between 1918 and 2016.

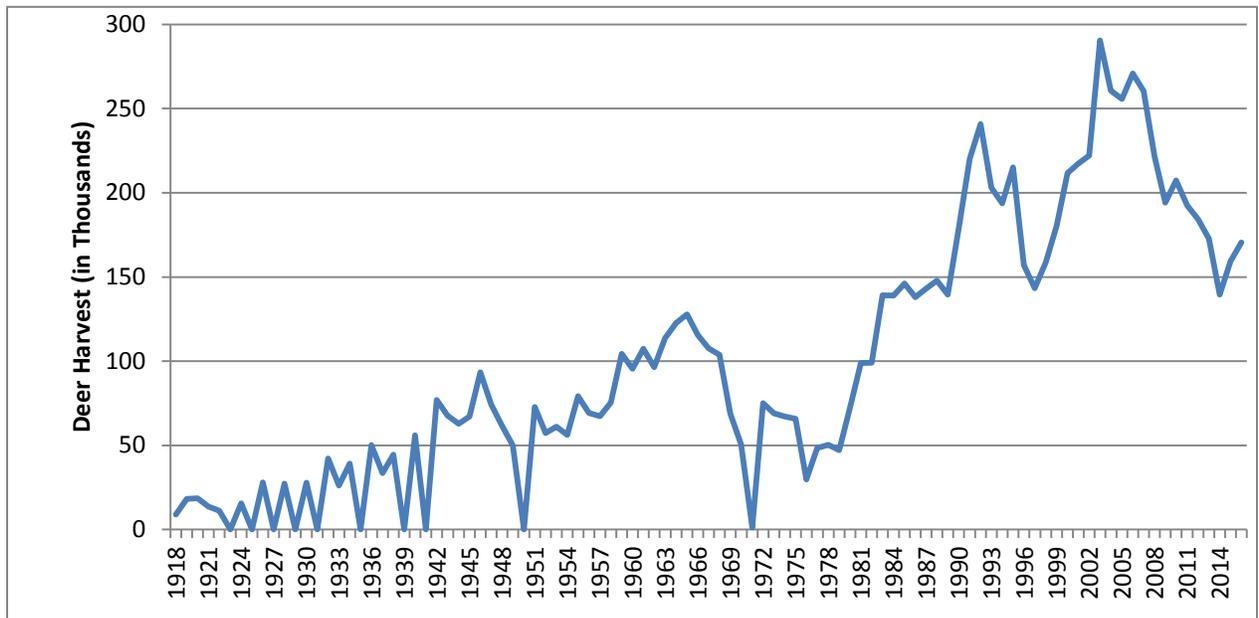


Figure 5. Minnesota deer harvest between 1918 and 2016.

UNDERSTANDING DEER POPULATIONS

Population growth

Deer herds increase annually through recruitment, which is the number of fawns born in spring that survive into fall and become part of the population.

Reproduction is a high priority for deer. Regardless of influences such as food resources, deer densities or the numbers of bucks in the population, almost all adult does are bred every year.

Although winters may be stressful, does rarely abort their fetuses even when they are severely malnourished. Fawns born to mothers that are severely malnourished in winter have lower body weights and are more prone to mortality throughout their first year.

All does that give birth to fawns produce milk of the same quality with the proper composition of nutrients. When does are in poor condition or cannot find adequate food to support lactation, they produce a lower volume of milk for their fawns. Malnourished fawns are more prone to be killed by predators or die of abandonment or disease, which negatively impacts recruitment into the population.

The impact of hunting

Understanding how deer herds respond to different levels of harvest is one of the most complex parts of managing deer populations. When the population is at biological carrying capacity (BCC), deer densities will be high but recruitment of fawns will be low and overwinter survival will be affected (deer will be in poor condition).

To maintain population growth, mortality through hunting and other causes cannot exceed the number of deer recruited into the population. The population will decrease if the number of deer dying exceeds the number of deer recruited into the population.

Predation

Predation is the leading cause of death for deer in their first few months of life. Fawns younger than one month old are especially vulnerable. They spend most of their time away from their mothers during this time, hiding and waiting for the doe to return. Predators search for fawns or happen upon them and fawns are easily killed. After a few weeks, fawns are mobile with their mothers and are capable of eluding capture by predators.

A study conducted by the DNR in the northern forest found that about half of fawns born died by 3 months of age and predation accounted for about 85 percent of mortality. Black bears and bobcats were responsible for most fawn deaths and wolves accounted for only about 5 percent of mortality. In the farmland region of Minnesota, more than 75 percent of fawns survive their first summer. Studies have shown that almost all fawn deaths that do occur in the farmland can be attributed to coyote predation.

Winter weather (severity)

Once deer survive to their first fall, they are more likely to be harvested by hunters than killed by predators. One exception is when winter conditions are extreme. Each year, the DNR calculates a winter severity index (WSI) throughout the state. Among other factors, the WSI is used to help estimate the effect of winter weather on deer survival.

From November 1 through May 31, one point is added to the WSI for each day with snow depths more than 15 inches. One point is also added to the WSI for each day when temperatures fall below zero degrees Fahrenheit. Snow depth, in particular, has a significant effect on deer survival. Winters are considered mild when the WSI is below 100. Severe winters have a WSI more than 180.

Since 1968, only a few winters were classified as severe over significant portions of the state (i.e. 1995-1996, 1996-1997 and 2013-2014). Still, each year conditions in some localized areas, like within the moose range, can prove difficult for deer.

Many research studies have shown that severe winters can impact deer populations. The ability of deer to accumulate fat reserves in the summer and fall is important to their survival in winter. In quality habitats and in years when acorns and other mast crops (e.g., nuts) are plentiful, deer accumulate fat in the bone marrow, around the internal organs and under the skin. Throughout winter, as snow deepens and food resources are depleted, deer rely primarily on body fat to survive.

In north-central Minnesota, a 15-year DNR research study on adult female deer found that, over the long term, adult female deer have a strong winter survival capacity and mortality is relatively low. Female deer were the focus of the study because they represent the reproductive component of the population and have the greatest impact annually on population dynamics.

In most years, less than 10 percent of does died during the winter; however, more than 30 percent of radio-collared deer in the study died during the severe winter of 1995-1996. The study found that fawns and does older than 5 years were most likely to die during winter.

Where there are established populations of wolves, predation by wolves during winter is typically the leading cause of death rather than death solely due to starvation. Deep snow, and snow crusted to allow easy travel by wolves, can give wolves an advantage. Wolves have wide, padded paws; narrow deer hooves more easily penetrate the crusted snow.

Deer in poor body condition, with limited fat reserves and high parasite loads, are especially vulnerable to predation.

Biological Carrying Capacity (BCC)

The term carrying capacity is often used when speaking about deer numbers and goals, but it must be defined to be useful as there are a range of common uses. Ecologists use the term carrying capacity to define the maximum population of a particular species that a given area of habitat can support over a given period of time.

The ecological principles that govern a habitat's carrying capacity are the same for all species. A sustainable supply of resources – including nutrients, energy and living space – define the carrying capacity for a particular population in a particular environmental system. This population level is generally referred to as the “biological carrying capacity” (BCC).

It is important to note that as a deer population increases, so does competition for quality forage and other habitat components. In other words, the amount of food and cover available for each deer decreases as deer numbers increase toward BCC. As a result, individual deer will be in poor physical condition exhibiting lower body weights and productivity. Bucks – particularly yearling males – will possess antlers with fewer points and smaller beam diameters and the number of fawns recruited per doe will decrease. When food resources are limited, adult and young of the year survival also declines.

As an additional result, the quality of habitat degrades through time.

At points approaching BCC, the physical condition of the herd is usually chronically poor, disease problems may be chronic and winter survival is reduced. This is one reason why populations are not managed at the BCC. However, harvest levels are maximized when deer densities are well below the BCC because fawn recruitment is maximized and adult and young of the year mortality is minimized. These factors make annual population recruitment (i.e. fawns surviving to 1 year) higher with a smaller overall population than a larger population closer to BCC. For harvest management this creates a counter-intuitive situation where more deer can annually be harvested from a smaller population (where deer are in better physical condition, surviving at high rates and having more fawns that are more likely to survive their first year) than from a larger herd in poorer physical condition. When a population is at BCC, there is no harvestable surplus and any additional mortality (harvest), by definition, reduces the population.

Minnesota's biological carrying capacity varies

Minnesota is a very large and diverse state with nearly 400 miles separating the northern and southern borders. Within the state, four different ecosystems are present (prairie grassland, deciduous forest, coniferous forest, aspen parklands). Each of these ecosystems provides differing quality and quantity of deer forage.

Measuring BCC is very difficult. Habitat and climate differences complicate it. Long-term BCC in Minnesota is a function of both habitat quality (primarily food resources) and climate. In general, BCCs decrease on a gradient from south to north because climate and latitude in the Midwest are strongly related.

Simply put, southern Minnesota climate is significantly milder than northern Minnesota. Also, the habitat gradient changes from south (hardwood) to north (conifer), thus leading to a corresponding decrease in habitat quality.

Functionally, BCC for deer in Minnesota declines northward because of climatic differences, the energy demands that climate places on deer and the resources available to support those energy demands.

Monitoring Population Trends

The DNR primarily uses harvest data and a population model to estimate and track trends in white-tailed deer abundance. Research staff members conduct population modeling to understand how deer populations change over time, to predict population sizes and to explore the impacts of various hunting regulations on deer populations. The deer population model uses harvest data and estimates of other vital statistics (e.g., deer reproductive rates and non-hunting mortality rates) to tell us if a population is likely to be increasing, decreasing, or staying the same in a deer permit area. Modeling, along with local manager expertise, are the primary tools the MNDNR uses to help make decisions about deer seasons and regulatory packages. A comprehensive review of the MNDNR's deer model is found in the 2016 Office of the Legislative Auditor's evaluation report.

SOCIAL ISSUES AND DEER MANAGEMENT

Deer management must balance social considerations, including conflicts with other land uses and human tolerance. The desires of farmers, foresters, ecologists or others who experience conflicts with deer and favor lower deer densities must be considered along with those of hunters, wildlife watchers, and others who may support higher deer densities. While by no means a comprehensive list, some of the social concerns are discussed below.

Agriculture

In 2012, over 50% of Minnesota's land area was used for farming, 83% of which was used for cropland (USDA 2014). Minnesota's agricultural industry accounts for approximately 20% of the state's income and employment.

Many agricultural plants are preferred forage for deer. Limiting damage caused by deer is an important consideration in managing deer populations in Minnesota. The DNR has an animal damage program with staff committed to minimizing human-wildlife conflicts.

Complaints of deer damage (depredation) from agricultural producers do occur in localized areas and may occur at any deer density. Complaints of depredation by deer in Minnesota include consumption of forage stored for livestock and damage to specialty crops such as produce, row crops including corn and soybeans, and commercial forest stands.

Minnesota does not compensate farmers financially for crop damage caused by deer. Wildlife managers are available to work cooperatively with agricultural producers to develop strategies to reduce deer damage and improve deer population management.

By excluding deer from stored forage, the damage can be effectively eliminated. Farmers who enter into a Cooperative Damage Management Agreement with the DNR are eligible to receive material assistance from the state, including installation of exclusion fencing.

Sound and visual deterrents and taste and smell repellents have proven ineffective for reducing deer damage in most agricultural settings. Typically, agricultural fields are too large in area to deploy these strategies effectively. Therefore, to minimize damage to standing crops in Minnesota, localized population management techniques (including hunting and shooting permits) are used to decrease deer numbers where they are causing damage.

If sport-hunting is utilized to the fullest extent and damage is still excessive, the agency may issue shooting permits to agricultural producers to harvest deer outside of hunting seasons. In addition, a pilot program was instituted in 2012 in southeastern Minnesota that allows the use of depredation permits allocated to specific properties where deer damage is occurring. Depredation permits allow increased limits for private sport-hunters to harvest additional antlerless deer during regular hunting seasons on ownerships where cooperative damage management is occurring.

DNR is committed to working with agricultural producers, and strategies to reduce deer damage will continue to be adapted to be effective with changing agricultural practices.

Forests and other habitats

Deer can have a major impact on the natural habitats they use. Deer feeding habits and their preferences for certain plants change the structure and composition of plant communities over time.

Because they are large herbivores, white-tailed deer are highly effective at altering habitat due to their energy requirements and high reproductive potential. For example, high deer densities can cause drastic declines in the number of species of forest plants, the abundance of those species and overall forest structure.

Deer browsing may also reduce food sources, cover, and nesting sites for a variety of other wildlife species. Such alterations influence the number of species of birds, mammals, reptiles, and amphibians that can use habitats degraded by deer.

As the number of deer increase, plants that are preferentially consumed (e.g., orchids or white cedar) become less abundant and may disappear altogether. Other plants have developed a tolerance to high levels of deer browsing and those plants may out-compete more desirable plants for resources.

For example, Pennsylvania sedge, which is not eaten by deer, may form dense mats on the forest floor inhibiting the growth of other plants. Likewise, garlic mustard, which is a non-native species introduced to Minnesota, is not preferred by deer. In this example, selective herbivory (e.g. deer avoiding garlic mustard but eating other nearby plants) can contribute to garlic mustard prevalence at the expense of the native plant community.

Many of the tree species that have commercial value are also preferred forage for deer, which can result in revenue losses due to over-browsing. Deer browsing can kill trees or hinder their growth; both scenarios may result in significant economic losses.

According to a 2011 DNR analysis, the state's forest products manufacturing and related sectors directly contributed \$3 billion value-added to the Minnesota economy. As of 2012, over eight million acres (roughly half) of forests in Minnesota were certified for sustainable forest management through a voluntary third-party process.

In 2005, a forest certification audit noted that deer browse in certain areas of the state was contributing to regeneration failures as well as possible loss of other plant species. Continued certification of the state's forest lands required demonstration by the DNR that deer population targets were consistent with ecosystem health goals.

While there is a natural assumption that deer damage to natural vegetation is related to high deer densities, in some situations damage can occur even where deer population size is not considered high.

Foresters and land managers also have a variety of non-lethal techniques available to reduce deer damage such as adjusting forest management techniques to reduce damage (e.g., natural versus artificial regeneration), protecting seedlings (e.g. by retaining coarse woody debris, bud-capping or using tree shelters), and incorporating browsing risk into landscape-level planning.

Landscaping

In urban and suburban areas, deer damage landscape plants, ornamental trees and gardens. There is a wide range of monetary estimates of deer damage to landscaping. This can be attributed to variations in the costs of landscaping in different residential neighborhoods and personal preferences of homeowners. In some neighborhoods, individual homeowners have reported deer damage to ornamental plants exceeding \$10,000 annually.

Homeowners can employ a variety of non-lethal techniques to reduce deer damage to landscaping including use of alternative plants less palatable to deer, taste and smell repellents, harassment, and fencing. At higher densities, only fencing secured to the ground and 10 feet in height will be effective at reducing deer damage. However, fencing can be expensive and unsightly.

Management of deer in urban areas through harvest or permitted removal is critical to minimize risks to the public and to keep deer numbers in balance with natural habitats.

Deer-vehicle collisions

Deer-vehicle collisions (DVCs) are a major concern throughout much of the United States, accounting for human injury and death, damage to vehicles and waste of deer as a wildlife resource. Of the 2,096 collisions reported to the Minnesota Department of Public Safety (DPS), DVCs resulted in 8 fatalities and 302 reported injuries in Minnesota during 2013.

It is challenging to get accurate estimates of DVCs; DPS notes that reported collisions have decreased in the past decade but “only due to the fact that many are not reported” (MN DPS 2014a). For the year ending June 2014, State Farm Insurance projected the occurrence of over 37,500 DVCs in Minnesota, ranking the state 8th in the country for likelihood of a DVC. State Farm Insurance reports that the average cost of damage of these incidents, nationwide, was \$3,888.

Most states have attempted to minimize DVCs through a variety of techniques, including deer-crossing signs, modified speed limits, highway lighting, roadside fencing, over- or underpasses, habitat alteration, deer hazing, driver awareness programs, and reflective devices. However, most methods designed to reduce deer-vehicle collisions have been proven ineffective, including deer crossing signs.

Proper deer management, improving visibility along roadways, managing the speed of vehicles, and educating residents about the seasonal risks of deer-vehicle collisions are all important. During May and early June when fawns are born, female deer are more mobile and are susceptible to deer-vehicle collisions. Likewise, in late October through November, bucks are actively chasing does for breeding purposes, and motorists should be especially alert.

Social/Cultural Carrying Capacity

The terms social carrying capacity (SCC) or cultural carrying capacity (CCC) also are commonly used when discussing deer populations. The SCC focuses on the impacts deer may have on people and the things people value; essentially, it is the maximum number of deer that humans will tolerate.

That number is always lower than the BCC because social tolerance is always lower than the

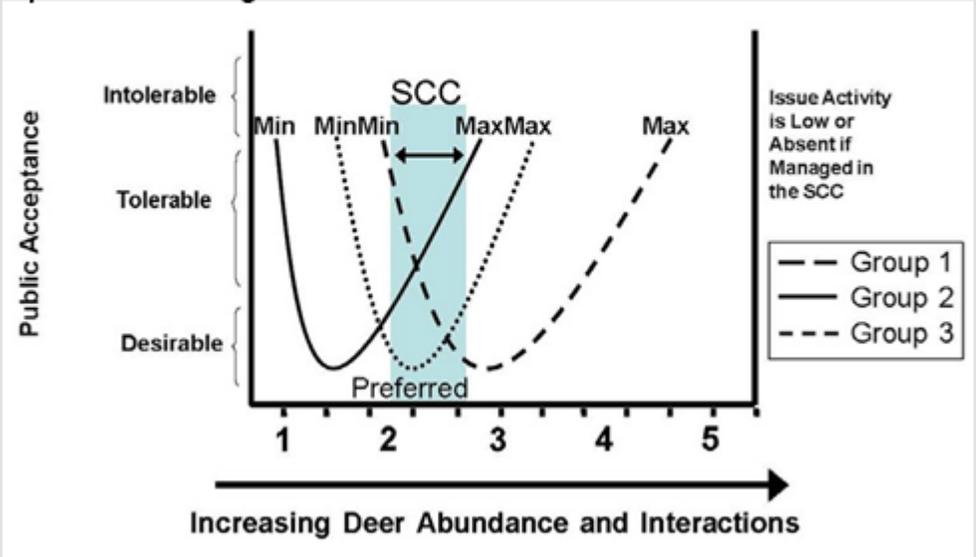
biological maximum. Negative impacts of deer that contribute to SCC include degraded natural ecosystems and associated negative impacts on other wildlife species, loss of biodiversity, deer-vehicle collisions, agricultural damage, and damage to residential landscaping.

One problem with SCC is that people’s tolerance varies greatly depending upon their social context. If your livelihood depends upon growing a crop, your tolerance may be very different from an avid deer hunter. Thus, stakeholder groups will have varying levels of acceptance of deer populations.

For each stakeholder group, the minimum and maximum number of deer that are supported is described as the latitude of acceptance. Ideally, if we overlay minimum and maximum densities for each stakeholder group, we can create a range of densities (SCC) that can be supported by all groups.

Figure 6, from the Michigan DNR, illustrates how three hypothetical stakeholder groups accept deer on a scale ranging from 1 to 5, yet a range of acceptance can still be achieved within that scale.

Figure 6. Hypothetical deer population acceptance curves and the resulting range of acceptable deer densities (social carrying capacity).
Adopted from Michigan DNR.



DISEASES AND HEALTH CONCERNS

The risks of deer-related disease for deer, people, other wildlife, and domestic animals are an important consideration in deer management. Since 2002, DNR has spent approximately \$6 million on surveillance and management of chronic wasting disease (CWD) and over \$4 million on the eradication of Bovine Tuberculosis (TB) in Minnesota's deer.

Despite their close association with humans, white-tailed deer pose few direct disease risks to humans or livestock. Most diseases known to be found in deer occur naturally and are endemic to the U.S.

SCALES OF DEER MANAGEMENT

Deer population management in Minnesota occurs at various scales. Most harvest-related laws, rules, and regulations are applied statewide. The DNR also reports annual harvests and population estimates at the statewide level.

Few management decisions are made at this broad level due to differences in land use, climate, topography, human population and hunter densities, and habitat differences throughout the state.

Differences in deer populations and management can also be interpreted and understood according to ecological landscape features. The state of Minnesota uses an Ecological Classification System (ECS) that separates the state into progressively smaller and similar landscape units based upon biotic and environmental factors (e.g., climate, soils, and vegetation). For example, Minnesota's forest deer population model closely reflects the Laurentian Mixed Forest at the ECS province level (Fig. 8). Habitat management activities, which influence deer densities, are implemented on a smaller scale based on subsection plans and more local landscape features.

Finally, deer population management decisions and strategies are implemented at regional and local scales that reflect both ecological and administrative boundaries. For example, the length of Minnesota's firearm deer hunting season varies statewide by zone (Figure 9) as a result of factors including differences in deer vulnerability and habitat, hunting pressure, and land ownership.

The finest scale of deer population management occurs at the DPA level. In general, DPAs are the finest scale at which populations can be estimated and monitored (Figure 10).

At the DPA level, the agency primarily uses harvest data and population models to estimate and track changes in white-tailed deer abundance with a focus on estimating whether populations are increasing, stable, or decreasing. Subsequently, the DNR develops harvest recommendations given management goals, regulatory options, and the likely deer population response over the next few years. Consequently, either-sex permit quotas are allocated by DPA.

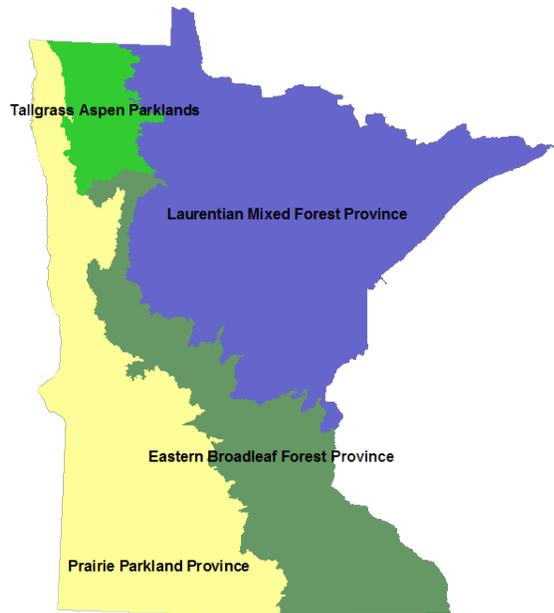


Figure 8. Ecological provinces in Minnesota

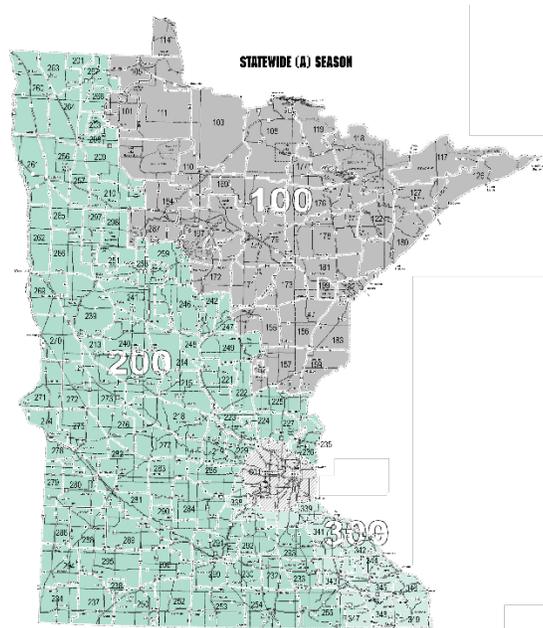


Figure 9. Deer Season Zone Map, 2016. Dates for the firearm season differ by deer management zone. In 2016, the season was held November 5-20 (100-series) and Nov. 5-13 (200- and 300-series). The 300-series also has a late (3B) season which ran from Nov. 19-27.

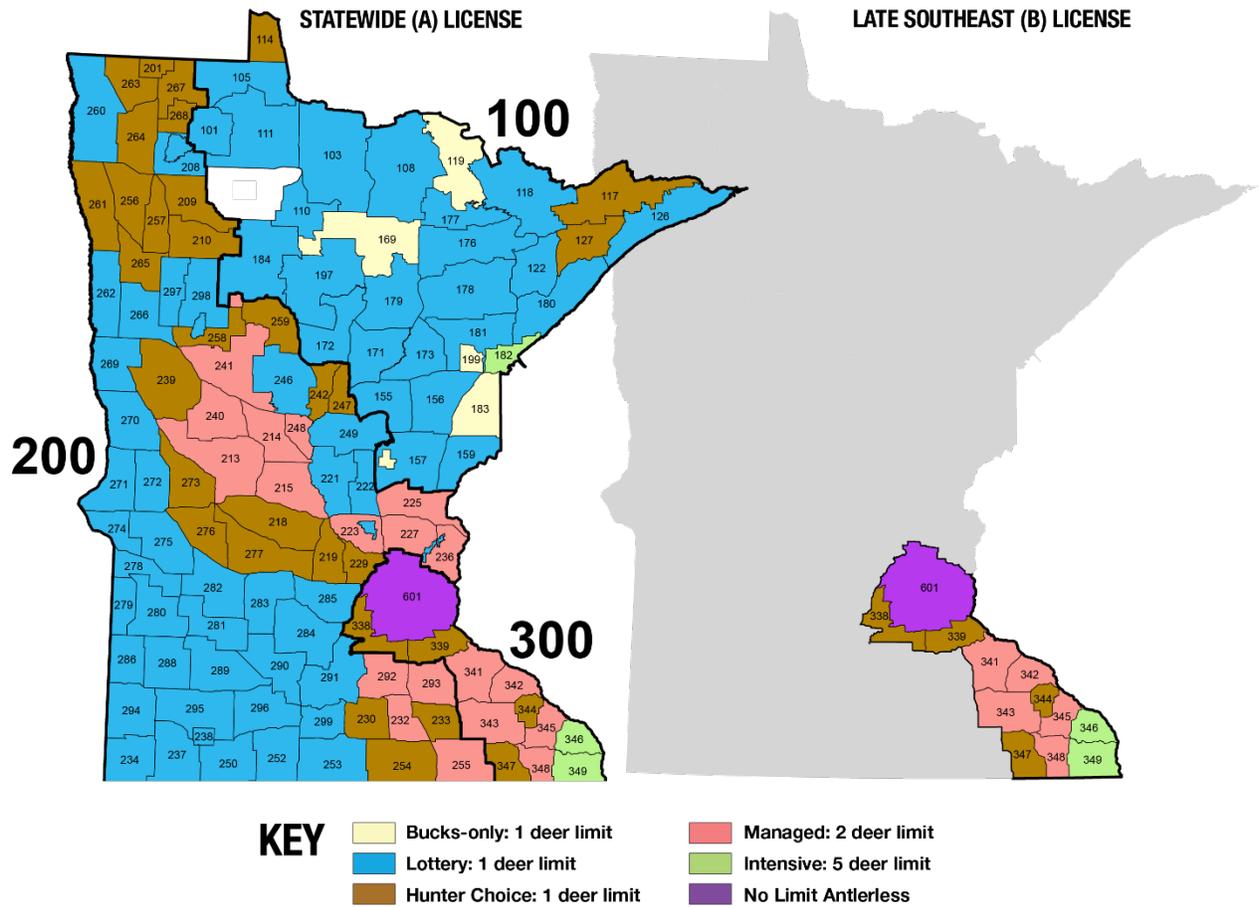


Figure 10. Minnesota deer management zones, permit areas and harvest management Strategies, 2016