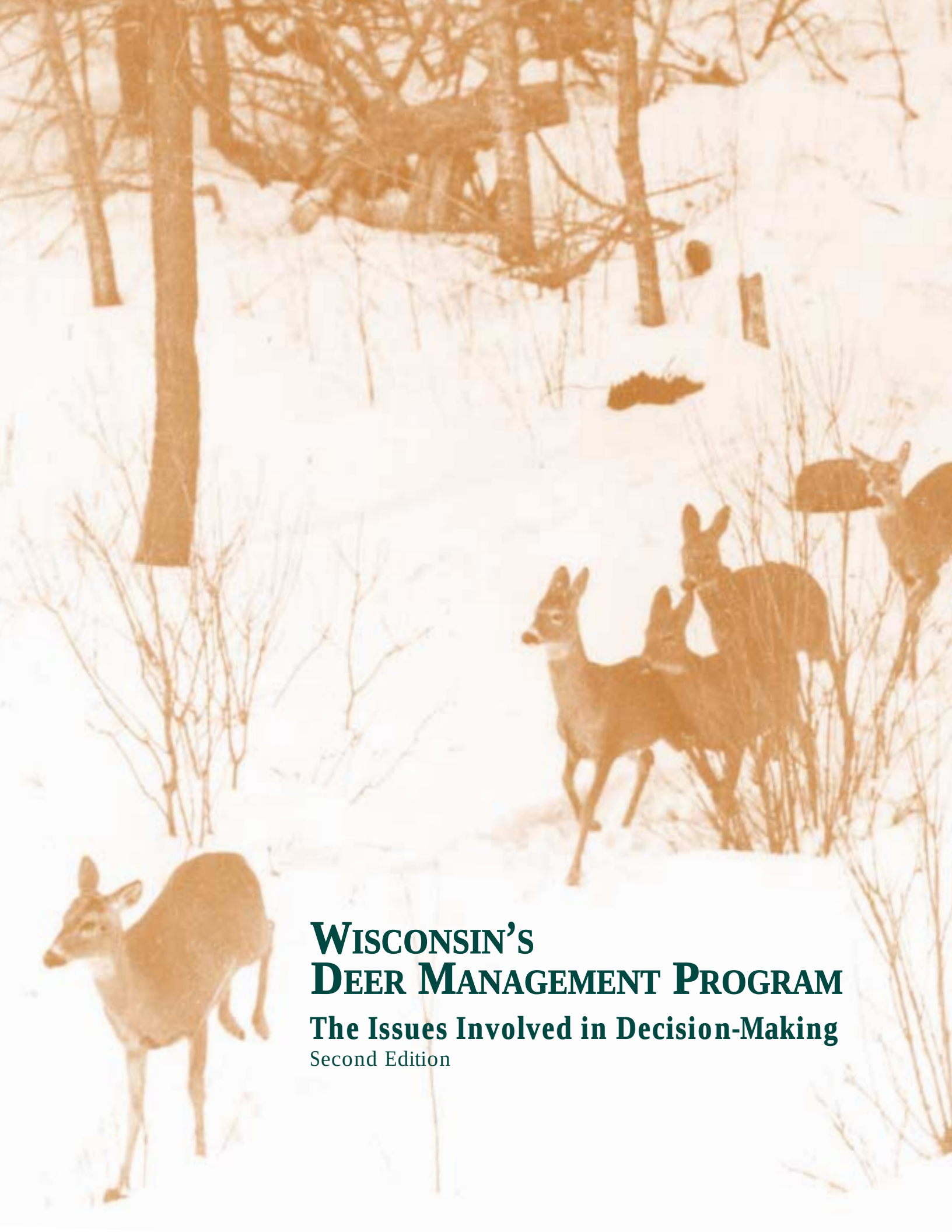

WISCONSIN'S DEER MANAGEMENT PROGRAM

The Issues Involved in Decision-Making

Second Edition

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Wisconsin Department of Natural Resources
1998

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INTRODUCTION

From many perspectives, the white-tailed deer is a very important part of the Wisconsin landscape and culture. Those perspectives include the:

- **hunter** who loves deer season more than any other time of year
- **photographer** who stalks deer with a camera
- **family** who depends on deer for food
- **small business owner** who depends on hunting season for a living
- **forester** whose tree seedlings cannot grow due to deer browsing
- **botanist** who sees grazed wildflowers disappear from the forest
- **farmer** who wants the deer out of the corn field
- **motorist** whose car has been totaled in a collision with a deer.

Deer are a wonderful and troublesome part of Wisconsin, depending on your point of view.

Wisconsin's deer herd is managed by setting overwinter population goals for sections of the state called **deer management units.** The overwinter goal for a deer management unit is the population level at which wildlife managers aim to keep the deer herd. Department of Natural Resources (DNR) wildlife managers strive to take all interest groups into account as they develop management plans and set overwinter population goals for deer. With recommendations from the public, wildlife managers propose overwinter population goals to the Natural Resources Board (a group of citizens selected by the Governor to review DNR policies). Once approved by the Board, the goals are subject to review by the Legislature. These goals then become law, used by wildlife managers to develop harvest recommendations.

Ideally, the overwinter population goals wildlife managers propose to the Natural Resources Board will produce a healthy herd, a healthy ecosystem, few damage complaints, and good hunting opportunities. Part of the challenge of deer management involves the need to set goals that are ecologically responsible and that blend well with the desires of a majority of citizens. While someone will always want more or fewer deer in a given area, the DNR must look at "the big picture" in attempting to keep deer numbers within the tolerance range of most Wisconsin residents.

This publication has been produced to provide an overview of the different factors that come into play in reviewing overwinter population goals, deer management unit boundaries, and other deer management decisions. We want to make this information available so citizens included in the decision-making process will be fully informed and prepared to actively participate.

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The Importance of Deer in Wisconsin

How important are deer to us? We know from numerous studies that deer are the favorite type of wildlife in Wisconsin—among both hunters and non-hunters. The popularity of deer in this state combined with the size of the herd translates into a wide variety of both positive and negative impacts on our economy and our way of life.

Popularity of Deer

Let's first consider deer hunters. Wisconsin is a relatively small state, yet it ranks third nationally (behind Pennsylvania and Michigan) for both the number of firearm deer hunters and the number of bow hunters. This fall the DNR expects about 670,000 gun hunters and about 240,000 bow hunters to take to the field to hunt deer, and with favorable weather, the number of days spent hunting deer will approach seven million. Research conducted by the DNR and the University of Wisconsin consistently shows deer hunters to be a highly committed group. When asked how much they would miss deer hunting if they could no longer participate, over 60% of Wisconsin's deer hunters say they would miss it more than all or most of their other interests. Nearly the same number say they have few or no substitutes for the deer hunting experience. The deer hunting experience is obviously important to deer hunters, providing a satisfaction they cannot find in other activities.

The fall gun season is viewed by many as the biggest social event of the year, and vacation plans often focus around the nine-day gun deer season, which traditionally starts the Saturday before Thanksgiving. Some schools close their doors, northern industries shut down, and businesses downstate adjust work schedules to reduce absenteeism during the gun deer season. Such high levels of commitment feed the social foundation of deer hunting in Wisconsin—encouraging continued participation by passing the tradition down from one generation to the next.

This fall 670,000 gun hunters and 240,000 bow hunters will take to the field hunting deer, and will spend more than $897 million in the process.

In 1982, the Wisconsin legislature declared the white-tailed deer Wisconsin's state wildlife animal.

PHOTO: J MEYER

PHOTO: K WALLENFANG

Deer are the most popular type of wildlife, for both non-hunters and hunters.

Deer are also important from a non-hunting perspective. In 1996, 2.3 million state residents participated in observing, feeding, or photographing wildlife, and 423,000 nonresidents made trips to Wisconsin to do the same. If you think all these people were primarily birdwatchers, guess again. A study by the University of Wisconsin and similar studies across the country found that among non-hunters, deer are the most popular type of wildlife. In fact, when Wisconsin non-hunters were asked what wildlife they most enjoy, deer were chosen as the favorite over songbirds and bald eagles, long thought to be the favorites among non-hunters.

Importance to Chippewa Tribes

Deer and deer hunting are very important in the maintenance of the cultural life of the Chippewa or Ojibwa people. This importance was recognized by Ojibwa leaders in the 1800's, and they specifically reserved their hunting and gathering rights in treaties. In court decisions and in agreements in the late 1980's, six Wisconsin Ojibwa tribes and the State of Wisconsin agreed to strive for consensus in the management of deer in the Ceded Territories (Figure 1). This cooperative management includes establishing deer management unit boundaries and over-winter deer population goals for the deer management units in the Ceded Territories. These discussions take place on a government-to-government basis and not as part of a public-input process. The Ojibwa tribes are legally entitled to a portion of the harvestable surplus of deer in the Ceded Territories. The tribes harvest about 4,000 deer each year.

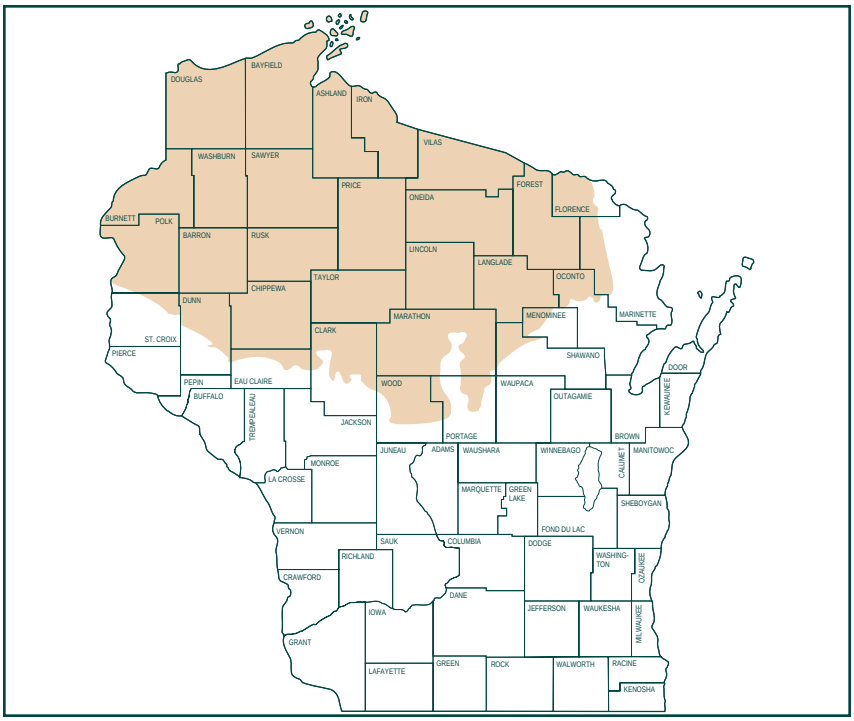

Figure 1. *Ceded territories of Wisconsin. Ojibwa tribes and the Wisconsin DNR cooperate on deer management issues in the Wisconsin portion of the territories that were ceded in the treaties of 1837 and 1842. For the exact location of the ceded territory boundary, please consult the DNR or the Great Lakes Indian Fish and Wildlife Commission.*

DNR PHOTO

Hunters spent an average of about $1,300 each on deer hunting in 1996.

Deer hunting licenses brought in more than $20 million in 1997.

In 1996, 2.3 million Wisconsin residents observed, fed, or photographed wildlife, and spent $1.5 billion in the process. Their favorite animal? The white-tailed deer.

Positive Social and Economic Impacts of Deer

Deer are a major factor in Wisconsin's recreational economy. In addition to direct expenditures, there are many deer-related benefits to Wisconsin citizens and communities.

How much money do deer hunters contribute to the state? The Wisconsin deer hunting season is a major social and economic event. Information for Wisconsin deer hunting expenditures from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation estimated that our hunters spent on average about $1,300 each while hunting deer in 1996, including costs for food and lodging, transportation, equipment, and licenses. For 1996, that translates into more than $897 million in sales flowing into our state economy from nearly 676,000 deer hunters during the nine-day hunting season. In terms of total sales, if all the state's deer hunters spent their money in one place, that business would rank among Wisconsin's top 15 most profitable companies! These expenditures in turn support more than 16,000 part-time and full-time jobs.

What's the size and value of the resource base that provides these economic returns? In terms of numbers, biologists tell us the deer herd this fall will exceed 1.2 million. Getting at dollars takes a little figuring. Assuming 50 pounds of meat per deer at $2 per pound, a Wisconsin harvest of 350,000 deer equals $35 million in venison steaks, sausage, and brats. Adding this food value to the $897 million of recreational sales, the estimate of the annual value of the deer hunt is at least $930 million. When salaries, wages, and taxes are added to sales, the total amount associated with deer hunting in the state is more than $2.6 billion.[1]

[1] Although the number of hunters in Wisconsin remained stable from 1991 to 1996, the trend in spending increased sharply. Nationwide hunting expenditures increased 43% during this period, with hunting expenditures for 4x4 vehicles, campers, vans, cabins, boats increasing by 215%. In Wisconsin, expenditures for purchase and rental of hunting lands increased more than in other states. These increases are attributed to the robust economy in 1996 as compared with 1991, when the U.S. economy was in recession (1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation).

The revenues generated from deer hunting also help support other wildlife programs. Deer hunting licenses brought in more than $20 million in 1997. In addition to deer-related programs and activities, these funds also support a wide variety of wildlife-related activities, including land acquisition and management to benefit wildlife, wildlife education programs, wildlife research, and law enforcement.

How about the economic contribution of non-hunters? While we don't have specific data related to deer, we know that the 2.3 million state residents who observed, fed, or photographed wildlife in 1996 spent about $1.5 billion in the process. Since deer are the favorite type of wildlife for this group, we assume that some undetermined but hefty portion of those expenditures were deer-related.

Negative Social and Economic Impacts of Deer

While the positive economic impacts of deer hunting and deer-related recreation are impressive, not everyone views Wisconsin's deer population as an asset. Deer are associated with some significant problems, including:

- agricultural damage
- deer-vehicle collisions
- commercial forestry damage
- damage to ornamental plants
- airport safety issues
- spread of disease.

Statewide damage by deer to corn crops alone was estimated at $15 million in 1993. Since it began in 1984, the DNR's abatement and compensation program has spent over $23 million to prevent and pay for agricultural damage caused by deer. The number of deer-vehicle accidents has increased along with populations of both deer and motorists. The number of deer killed by vehicles was estimated at over 18,000 in the 1970's—that number swelled to over 44,000 by 1997. Combined property damage and personal injury from deer-vehicle accidents was recently estimated to be over $100 million per year. Damage to non-agricultural plants includes destruction of valuable tree plantings and landscaping. In crowded conditions, deer can carry and spread diseases to domestic livestock and to people.

These negative impacts translate into what we call **social carrying capacity**, which is the limit to which the human population will tolerate the problems associated with deer. These problems are discussed in more detail later.

Ecological Impacts of Deer

As a "keystone species," deer can have a major impact on the natural community in which they live. As deer numbers increase, some plant species they prefer for food become less abundant or are lost, which in turn hurts the other animals that depend on those plants. Meanwhile, other plants may increase in abundance. Generally, large

Deer are associated with some significant problems, including agricultural damage, deer-vehicle collisions, commercial forestry damage, damage to ornamental plants, airport safety issues, and spread of disease. These negative impacts translate into what we call **social carrying capacity**, which is the limit to which the human population will tolerate the problems associated with deer.

Since it began in 1984, the DNR's abatement and compensation program has spent over $23 million to prevent and pay for agricultural damage caused by deer.

Combined property damage and personal injury from deer-vehicle accidents was recently estimated to be over $100 million per year, with an average accident estimated at $2,000 in property damages and personal injuries.

PHOTO: K MCCAFFERY

The number of deer killed by vehicles reached over 44,000 by 1997.

numbers of deer are associated with a reduction in the ground-level plants and shrubs needed by some insects, small mammals, and birds for breeding, nesting, foraging, and escaping predators. Large numbers of deer can also affect tree regeneration, and selective browsing can change the tree composition in the forest. The situation is obviously out of hand when the forest looks like a park with nothing growing under the trees except where fences or fallen tree tops prevent deer from grazing and browsing. On the other hand, plentiful deer support larger numbers of predators such as the timber wolf.

Effective deer management aims for a deer herd size that will allow the animals and their plant environment to be healthy, while striking an acceptable balance between these other positive and negative impacts on people and the environment. It's a complex process, which strives to balance ecological and social realities.

The Basics of Deer Management in Wisconsin

To understand the importance of overwinter population goals and deer management unit boundaries, it helps to know how this process fits into the overall deer management program.

Regions

Wisconsin can readily be divided into three regions of similar soil and vegetation characteristics and land use. The principal regions are the northern forest, central forest, and farmlands (Figure 2). Because deer herds and habitats in these three regions have had different attributes, different approaches have been taken in goal-setting.

Deer Management Units

Deer management units give managers a framework for gathering data. These units are areas of similar land use bounded by major roads or rivers. Managers record deer harvests for each unit every year. Over time, a history of the unit evolves. A harvest and population history is the principal tool a manager uses to predict the status of the fall deer population each year.

Deer management units were initially established in Wisconsin during the mid-1950's. There were 77 units statewide then. Most were blocks of land bounded by as few as three or four major highways. The primary purpose of the units was for conducting deer surveys. Units were about 700 square miles in size, and land use within units was similar.

More than forty years later, the number of units has increased to 130, and some units are now bounded by as many as 13 highways (Figure 3). Of these 130 units, the 12 state parks are considered separate units, but each state park has the same overwinter population goal as its surrounding unit to protect the vegetative features that are a natural part of the preserved area. Today the average total land area of deer management units is 450 square miles.

Deer management units are areas of similar land use bounded by major roads or rivers. Each of these units has a harvest history. A harvest and population history is the principal tool a manager uses to predict the status of the fall deer population each year.

Changes in unit boundaries break the unit history and destroy the long-term perspective that is essential to effective deer management. After a change in boundaries, it usually takes at least 5-10 years before adequate data again becomes available.

Much of this increased complexity in unit boundaries came in the farmland areas where deer populations were historically low but have increased dramatically in the past 40 years. Some of the fragmentation of units was in response to damage complaints. Units in the two forested zones have changed little since they were initially drawn.

Changes in unit boundaries have the effect of breaking the unit history and destroying the long-term perspective that is very important for accurately predicting herd responses to varying harvest intensities and winter conditions. After a change in unit boundaries, it usually takes a minimum of five to ten years before adequate data are available for management decisions. It is often popularly believed that smaller units result in more precise management, but

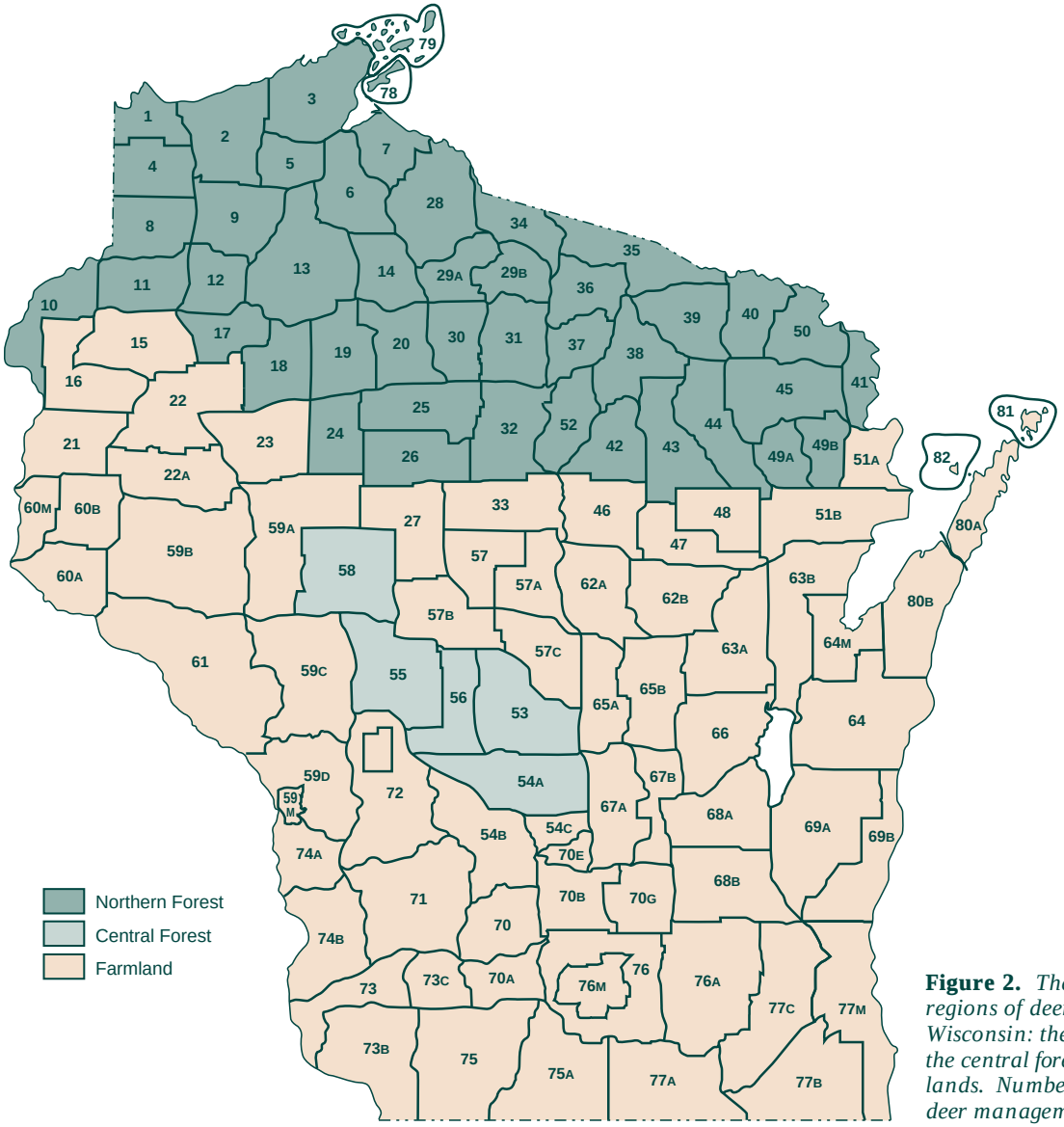

Figure 2. *The three principal regions of deer habitat in Wisconsin: the northern forest, the central forest, and the farmlands. Numbered divisions are deer management units.*

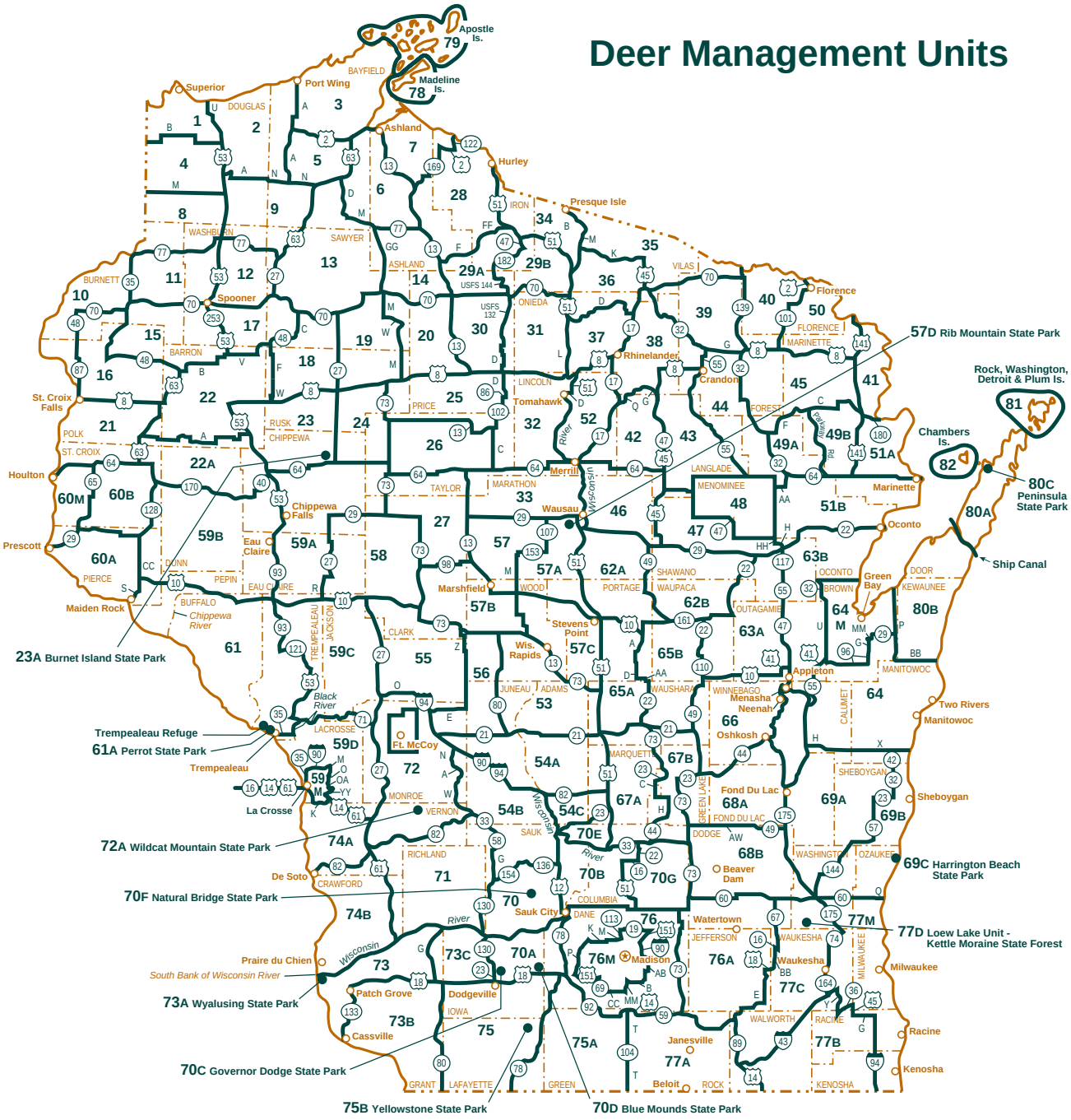

Figure 3. *Wisconsin 1998 deer management units. There are 130 units, including 12 state parks, four islands, and five metro areas.*

the opposite is more often true. Fragmentation of units reduces the precision of herd monitoring capability because sample sizes for key herd data (age data, hunting pressure, productivity) are smaller and subject to more inaccuracy. A change in any unit boundary also affects adjacent units. So, **realignment of boundaries should be a last resort** to resolving perceived problems within a unit. The cost in lost information and consistency of herd management is high every time a unit boundary is changed.

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Deer Range

Not all land within the boundary of a deer management unit provides a good year-round home for deer. For example, deer don't live in lakes and are not often found in heavily urbanized areas or large uninterrupted agricultural fields (Figure 4). Even though deer are never spread evenly throughout a unit, deer harvests

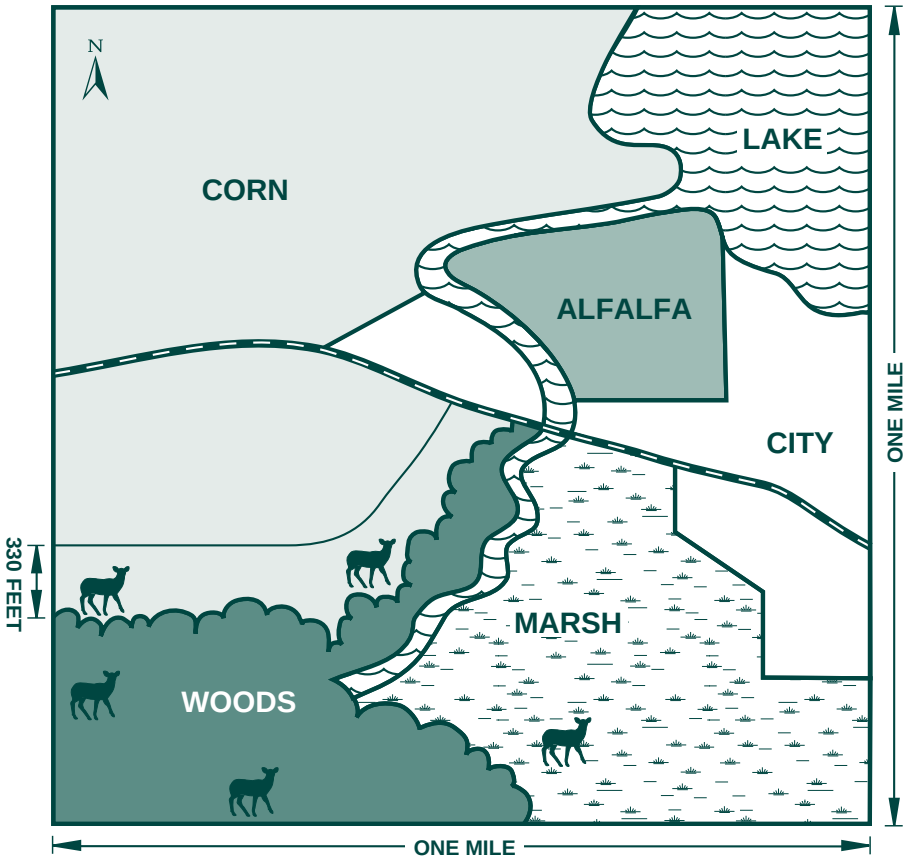

Figure 4. *Not all land within a deer management unit is considered part of deer range. In this square-mile parcel of an imaginary deer management unit, only about a third—the woodland, the marsh, and a portion of the cornfield south of the highway—would be counted as suitable deer habitat. If deer were spread evenly throughout a unit with 15 deer per square mile of deer range, then only five deer would likely inhabit this parcel.*

tend to occur in proportion to deer density, especially in forested regions. Hunters generally scout areas prior to hunting and over time move to the areas with the most deer.

Managers estimate the number of square miles that provide suitable habitat for deer. The amount of deer range in a unit is always smaller than the total area in a unit. So when wildlife managers say there are "25 deer per square mile" in a unit, they are referring to the number of deer per square mile of **deer range**.

Managers determine how much deer range exists in their units from photographs of the land taken from the air and images from orbiting satellites. Deer range includes all permanent cover—forest, woodlot, brush-covered land or marsh—at least ten acres or more in size. Because deer often use farm fields adjacent to permanent cover, 330 feet into these fields is also included in calculations of the amount of deer range in a deer management unit.

The amount of deer range varies greatly among deer management units—from over 95% in some northern units to less than 30% in some of the highly urbanized and/or agricultural units in the south (Figure 5). (The statewide average is 280 square miles of deer range per unit.) By using deer range instead of overall area, we have a standard comparison for deer densities and their impacts among deer management units.

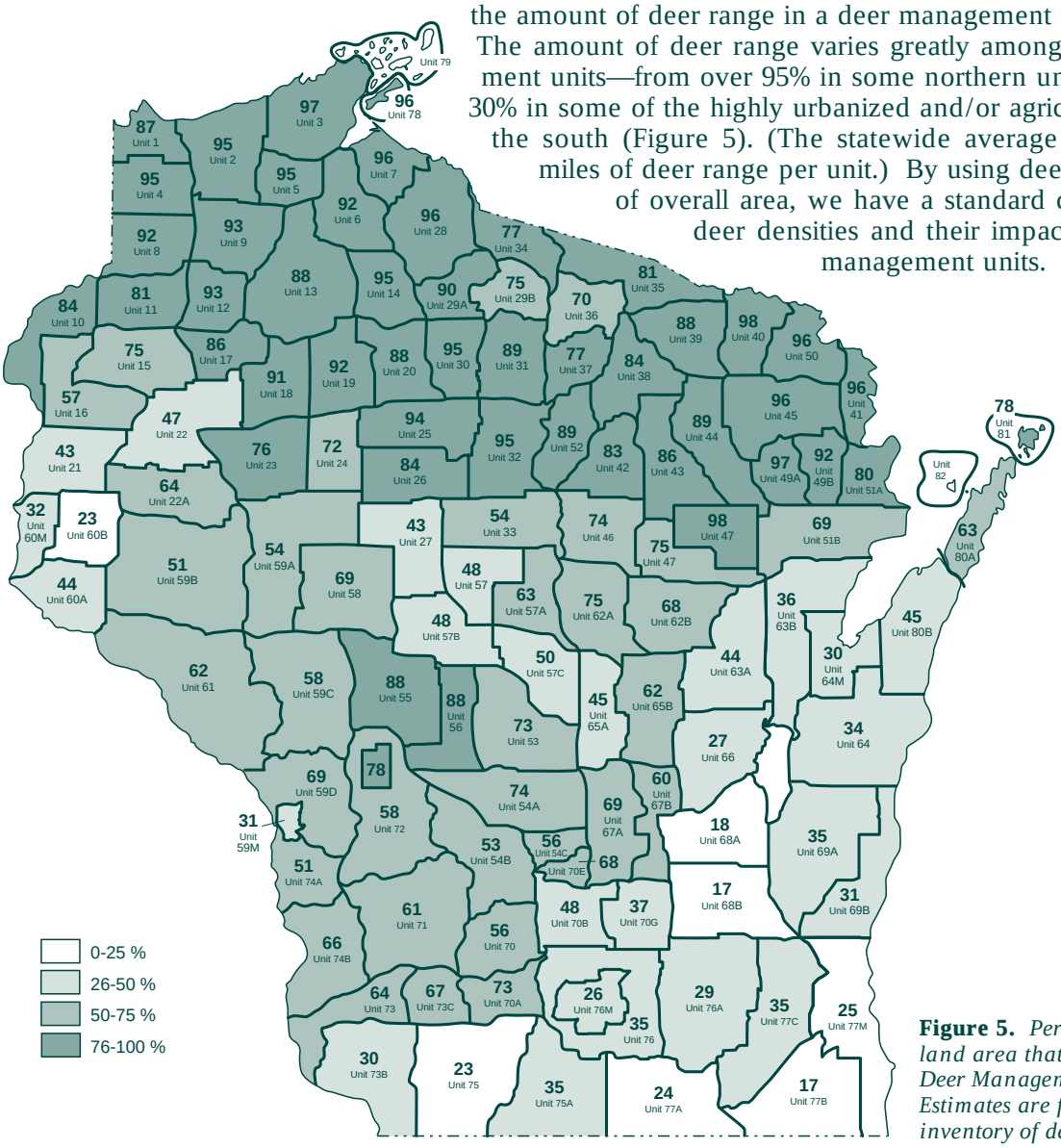

Figure 5. *Percentage of total land area that is deer range in Deer Management Units. Estimates are from the 1986 inventory of deer range.*

Unit Goals

As mentioned earlier, Wisconsin's deer herd is managed by setting overwinter population goals for each deer management unit in the state. By law the DNR must manage the deer herd to be at goal. Throughout Wisconsin, overwinter population goals currently range from 10 to 35 deer per square mile of deer range (Figure 6). In a unit which has only one third of its area in deer range, a goal of 30 deer per square mile of deer range would actually represent 10 deer per square mile of land area.

The two main factors that come into play in setting unit goals are **biological carrying capacity**, which is the maximum number of deer that can survive on the land under average habitat and weather conditions, and **social carrying capacity**, which is the number of deer that people will tolerate. If we could set unit goals based only on biological factors, our job would be fairly easy. But the need to also balance the positive and negative impacts of deer on humans and the environment makes the process of setting goals much more complicated. The biological and social factors and how they interact are discussed in more detail later.

When wildlife managers say there are "25 deer per square mile" in a unit, they mean "per square mile of **deer range**."

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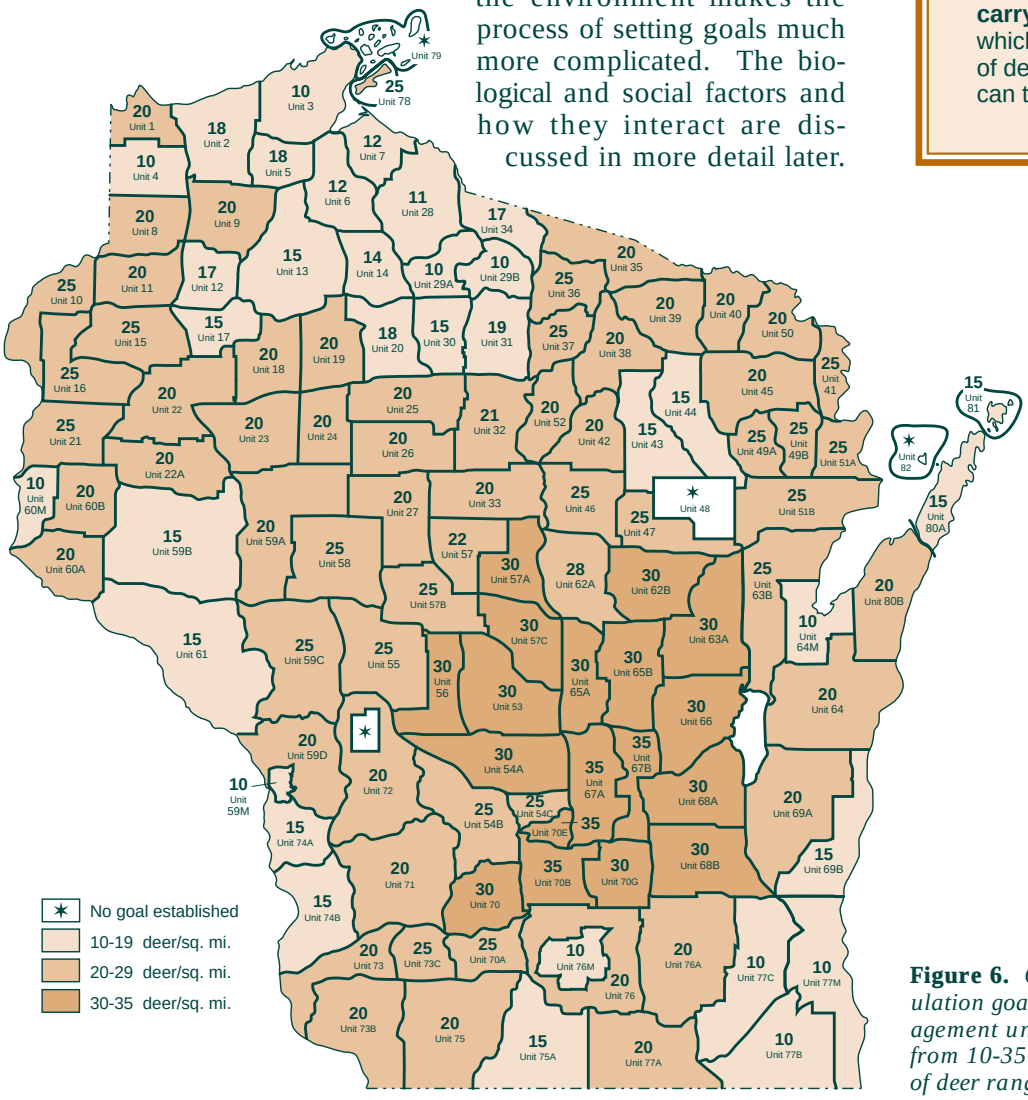


Figure 6. *Current overwinter population goals for each deer management unit. These goals range from 10-35 deer per square mile of deer range.*

Population Monitoring

Wildlife managers monitor deer populations and determine whether they are above, at, or below the overwinter population goal. They use a combination of information to derive population estimates for each deer management unit. These estimates are expressed as an average number of deer per square mile of deer range, even though not every square mile within a deer management unit has an equal number of deer. Some areas in a deer management unit have more deer than others.

Below we'll discuss the different types of information that are used in population monitoring: harvest registration, deer aging, hunting season stability, and summer observations of the number of fawns produced per doe. This information is combined to estimate population size at the end of the hunting season. Based on the post-hunt population estimate, winter weather, and history of herd growth for each deer management unit, fall population predictions are made.

Harvest Registration and Aging

Mandatory registration of every deer harvested during the hunting season began in 1953 and is the backbone of the state's deer monitoring system. When hunters register their deer, valuable information is collected on the date and place of harvest and the sex of the deer. Wildlife biologists also check the ages of deer at some registration stations around the state. About 22,500 deer were aged in 1996 and about 18,000 were aged in 1997, when there was a lower harvest. In 1997, aging was conducted at 89 locations throughout the state and involved more than 151 agers.

PHOTO: H LIBBY

The ages of deer are determined by examining their teeth.

Hunting Season Stability

The nine-day gun deer season traditionally begins the Saturday before Thanksgiving. With uniform seasons, hunting patterns usually change little from year to year. The proportion of the adult buck population taken by hunters is therefore relatively uniform from one year to the next. Under such stable conditions, managers have found that buck harvest trends closely track deer population trends, and population estimates are more accurate. In recent years, deer management has become more challenging due to changes in hunting practices and

hunter desires. Many hunters have developed an interest in the sex- and age-structure of the herd and selectively harvest specific types of deer, which may impact the accuracy of estimated deer numbers that rely on consistency in hunter activity. Current research is evaluating the effect of more selective harvests on the accuracy of population estimates.

Summer Deer Observation

Each July, August, and September, DNR employees and volunteers across the state keep records of the number of does, fawns, and bucks they see. The ratio of fawns to does provides an index to current reproductive rates and is an essential component in the formula used to estimate herd size. It also gives managers an opportunity to assess the impact of the past winter on current reproduction.

Population Modeling

Information from harvest registration and aging, along with other data, is used in a mathematical population model called the Sex-Age-Kill (SAK) formula. Population estimates for most deer management units in the state are calculated using the SAK formula. Information on the age composition of the buck harvest and the number of hunters in the field on opening weekend are used to estimate the percentage of adult bucks killed during the legal hunt. The SAK formula combines this estimate with information on the size of the buck harvest to estimate the size of the pre-hunt adult buck population. The adult buck population is then expanded to the entire population using estimates of the number of does per buck and the number of fawns per doe in the pre-hunt population. The overwinter deer population for each deer management unit is determined by subtracting the harvest from the pre-hunt population estimate.

Harvest Planning

Based on the information from population monitoring, fall population predictions are made and the number of deer that can be harvested are determined for each deer management unit. The objective throughout this process is to keep the population as near to the goal for each deer management unit as possible.

Winter Weather

Harvest plans in northern Wisconsin vary from year to year, in part depending on winter weather. Deer have both physiological and behavioral adaptations that allow them to endure Wisconsin winters—provided the deep snow and extremely cold temperatures do not persist too long. In very severe winters, losses of deer in northern Wisconsin can be dramatic (as much as 30% of the herd). Even in mild winters, some deer die. In the south, winter weather rarely impacts deer survival. To keep tabs on winter weather conditions, the DNR maintains a Winter Severity Index (WSI) at about 35 locations across northern Wisconsin.

The WSI was developed in the early 1970's. It is calculated by adding the number of days with 18 inches or more of snow on the

Based on the information from population monitoring, fall population predictions are made and the number of deer that can be harvested are determined for each deer management unit. The objective throughout this process is to keep the population as near to the goal for each deer management unit as possible.

DNR PHOTO

Winter weather can have a big impact on deer populations in the northern forest.

ground to the number of days when minimum temperatures were 0°F or below between December 1 and April 30. If you think of it as adding up points, a day when both conditions occurred would get two points. At the end of the winter all the points are added up, resulting in the WSI number for the whole winter. A winter with an index of less than 50 is considered mild, 50 to 80 is moderate, and over 80 is severe (Figure 7).

When these WSI numbers are high in northern Wisconsin, deer survival over winter is lower, the number of surviving fawns born per doe in summer is lower, and adult buck harvests the following fall are generally lower. These impacts are predictable enough that managers can use the WSI to calculate useful estimates of how the herd will be affected by winter weather in the north. The WSI is especially important for predicting fall herd status and establishing harvest recommendations in the forested regions of the north.

The 30-year average WSI in northern Wisconsin is 67. The most severe sequence of winters occurred between 1964-65 and 1971-72, when five out of eight winters were in the severe category and northern herds declined by more than half (Figure 8). The mildest sequence of winters occurred between 1987 and 1995, when only one winter had a WSI above 50. Weather records indicate that the 1980's was the mildest decade on record, and Northern States Power Company has indicated that the 1986-87 winter was the mildest winter in 114 preceding years. Northern

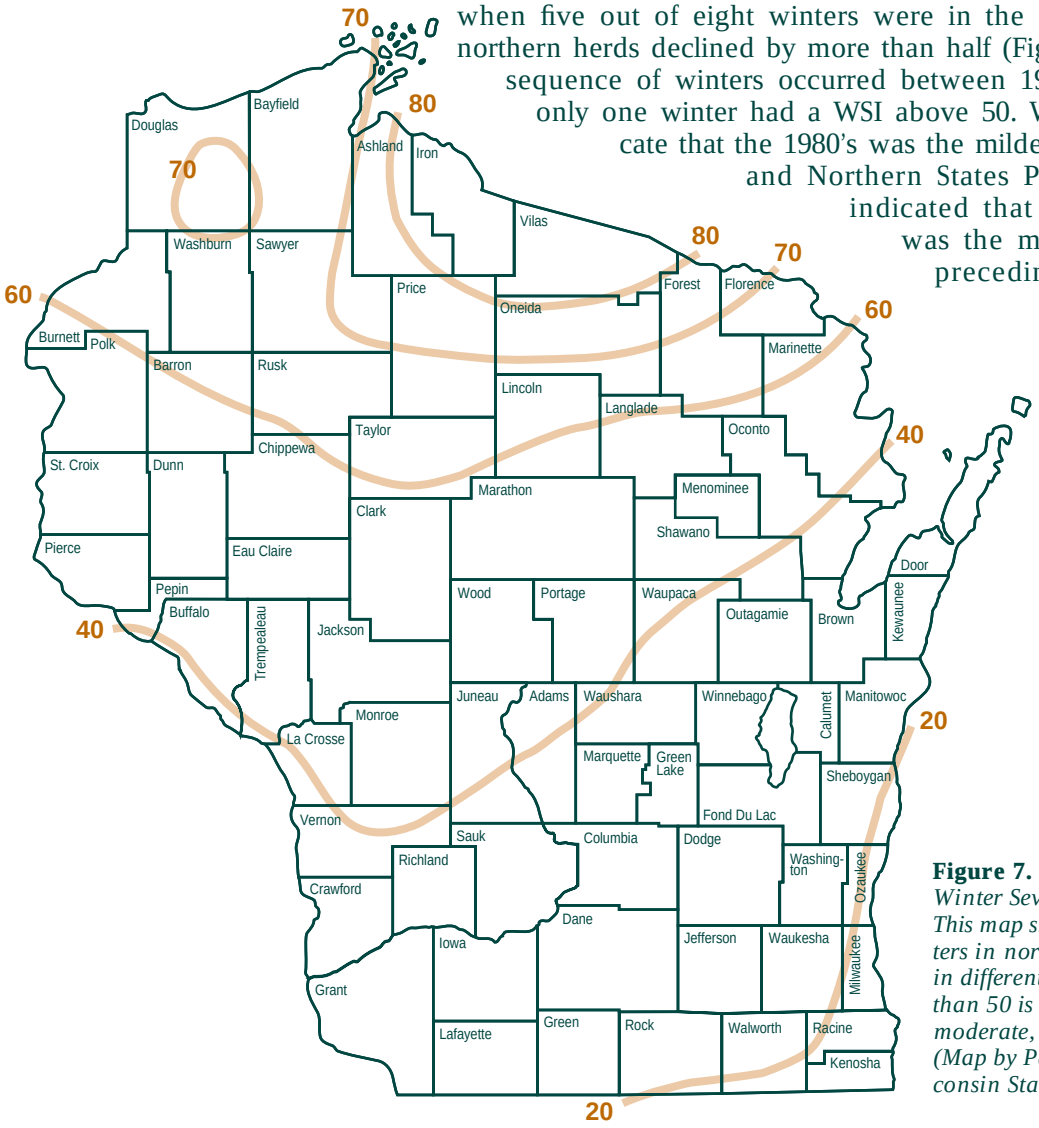


Figure 7. *Average regional Winter Severity Indices, 1961-1990. This map shows that severity of winters in northern Wisconsin varies in different areas. An index of less than 50 is considered mild, 50-80 is moderate, and over 80 is severe. (Map by Pam Naber Knox, Wisconsin State Climatologist.)*

deer populations responded by increasing at spectacular rates and set new expectations in the minds of many hunters. The mild winters continued until two consecutive severe winters occurred beginning in 1995. In 1995-96 the WSI reached a record high of 127, followed by a WSI of 116 in 1996-97. These severe winters decreased the deer populations in the north by approximately 35%. Such short-term weather patterns are unpredictable. It is important to consider the long-term patterns of winter severity over the past 30 years in the goal-setting process.

Fall Population Prediction

The overwinter population estimate is the starting point for predicting the herd status for the following fall. The prediction of fall population size is what harvest plans are based on. To make our best possible prediction, we depend upon past records on productivity and growth rates for the herd. In northern units, herd growth can be greatly affected by winter weather. Therefore, the history of each deer management unit is extremely important for providing the perspective needed to accurately predict future herd status before planning harvests each year.

Fortunately, most units in forested zones have unbroken histories extending back to 1959. This record incorporates a wide variety of experience with winters of varying severity and patterns of occurrence. It also spans a variety of harvest intensities and hunting conditions. Great differences in environmental conditions (hunting weather and winter severity) make the unit history especially important in forested zones.

It is important to consider the long-term patterns of winter severity over the past 30 years in the goal-setting process.

The history of each deer management unit is extremely important for providing the perspective to accurately predict future herd status.

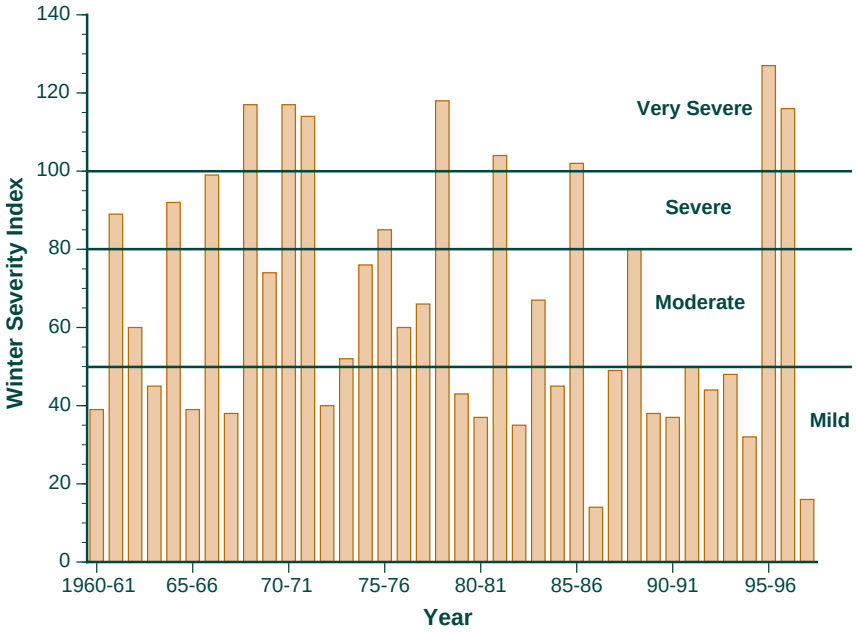


Figure 8. *Winter Severity Indices for northern Wisconsin, 1960-1998. Note the sequence of severe winters from the mid-1960's through the early 1970's when deer populations declined. Populations increased during the mild winters of the late 1980's and early 1990's, but the two consecutive severe winters of 1995-1997 again caused a population decline.*

Normally, winters are less severe and weather has less impact on hunting in the farmland region than in the northern forest. But harvest prescriptions must be very precise in the farmlands because of the great reproductive potential of the herd in this region. Again, long-term unit histories are very important to the development of precise harvest prescriptions.

Quota Setting

Because it is difficult at a distance to tell buck fawns from either adult does or doe fawns, they are included in a group called "antlerless deer." To manage at goal, we focus on the harvest of this group of deer. Most of the adult and yearling bucks can be harvested with little affect on the future size of the deer herd. Managers are most concerned about the harvest of does, because does bear the next generation of deer. Therefore, wildlife biologists from both the DNR and the Wisconsin Ojibwa tribes participate in an agreed-upon process to determine how many antlerless deer should be taken in each deer management unit to achieve the population goal for that unit. This figure is referred to as the **total harvest quota**. For units in the Ceded Territory, the Ojibwa tribes are responsible for informing the DNR of the number of antlerless deer out of the total quota they wish to harvest in the following season. This is known as the **tribal declaration** or **tribal quota**. The remaining antlerless deer harvest is taken by nontribal hunters and is known as the **state quota**.

Typically, about two thirds of the quota harvest is composed of adult does. In very simple terms, if the herd size is low or "below goal" (perhaps due to a severe winter), then managers set a low (or possibly zero) quota for antlerless deer to be taken in the fall. If the fall herd size is high or "above goal," managers prescribe more liberal harvests of antlerless deer. When "at goal," the statewide gun and bow harvest should include an antlerless harvest of

Unit histories are extremely important for accurately predicting fall herd status each year.

To manage a herd to be at the over-winter population goal, we set harvest quotas for "antlerless deer" so that enough does will be harvested to control herd growth.

DNR PHOTO

It's difficult to tell buck fawns from does at a distance, so for quota-setting, both are included in a group called "antlerless deer."

about 160,000, with a total harvest of about 290,000 deer. There has never been, and may never be, an absolutely perfect quota prescription. Managers work with estimates and predictions, taking errors into account the next year.

Goal-Setting in Detail

With the overview of the basics of deer management in mind, let's take a closer look at what actually goes into setting overwinter population goals.

Biological Carrying Capacity

The physical condition of deer is primarily influenced by the balance between energy obtained from food and the energy required to survive. Because the land can only produce a limited amount of food, the more deer that live in an area, the less food is available for each individual deer, which quickly leads to decreased physical condition. Decreased physical condition in deer shows up as reduced body weight, antlers with fewer points and smaller beams, reduced fawn production, and lower rates of population increase. In extreme instances of high populations, there is not enough nutritious food in summer for deer to lay on sufficient fat reserves and not enough winter browse to maintain them through the winter. The maximum number of deer that a given unit of land can support over a prolonged period of time is termed its **maximum biological carrying capacity**. Habitat quality (food and cover) and climate determine long-term carrying capacity. However, annual weather can profoundly affect carrying capacity in the short term. Because we cannot predict seasonal or annual weather, goal-setting requires looking at average carrying capacity over the long term.

Carrying capacity varies greatly across the geographic areas of Wisconsin. In Wisconsin farmlands, there is abundant food in the form of agricultural crops, and the winters are milder and shorter. Over 100 deer per square mile of deer range could be sustained in much of this region, if the public was willing to tolerate the resulting high damage to crops and landscaping, hazardous driving conditions, and extensive damage to vegetation in the remaining natural communities.

In contrast, the northern forest region produces substantially less nutritious foods, and the winters are harsher. Also within the northern forest region there is great local variation in production of food for deer. For example, forests growing on sandy soils tend to be dominated by oaks, aspen, and jack pine. These tree species allow more sunlight to reach the forest floor, so more of the shrubs and herbs favored by deer can grow. These habitats could support up to a maximum of 40-45 deer per square mile. Forests on loamy soils tend to be dominated by maple, basswood, and fir. Less nutritious foliage grows in the deep shade under these trees. These forests could support fewer deer, often fewer than 15 deer

The physical condition of deer is primarily influenced by the balance between energy obtained from food and the energy required to survive.

The maximum number of deer that a given unit of land can support over a prolonged period of time is its **biological carrying capacity**. Carrying capacity varies greatly across geographic regions in Wisconsin and over time.

A herd at maximum biological carrying capacity is not a pretty picture. Deer are in miserable condition and habitat is harmed. Physical condition of all deer is much better at intermediate population levels.

Carrying capacity varies greatly across the geographic areas of Wisconsin. In the farmlands, there is abundant food in the form of agricultural crops and the winters are milder and shorter. In contrast, the forested northern part of the state produces substantially less nutritious foods, and the winters are harsher. In fact, due to changes in the northern forests, biological carrying capacity for deer is decreasing in the north.

PHOTO: D TVEDT

Occasional starvation of deer is normal near the northern limit of white-tail range. Starvation can be minimized in severe winters if deer herds are maintained well below maximum carrying capacity.

per square mile of deer range given average weather. In any of these locations, herds held at maximum biological carrying capacity would mean a miserable existence for deer.

Carrying capacity also varies over time. In areas of the forest that have been recently disturbed by fire, wind storms, or logging, sunlight is able to reach the forest floor. This promotes the growth of nutritious forage. As these forests mature and gradually grow shadier, the amount and nutritional quality of understory plants diminishes. Across much of northern Wisconsin, extensive areas were logged and burned during the late 1800's and early 1900's. The seedlings and saplings of maples, aspen, and other trees that regenerated during the 1930's and after provided an abundance of deer forage. Upland conifers had been much reduced by logging and fires. Peak deer populations in the northern forest were reached in the early 1940's. At that time and for the next few decades, winter range conditions were seen as the main constraint on northern deer populations, and deliberate efforts were focused on improving browse production in and around deer yards. (Deer population goals had not yet been established.)

Today, forest stands across the north are much different. Maples have long since grown out of the reach of deer, and sun-loving tree species are naturally giving way to shade-tolerant species. Winter survival habitat (conifer thermal cover) has remained about the same or may be increasing as a result of pine planting, fire protection, and natural growth of balsam fir and white pine. But non-winter habitat (aspen, oak, and openings), which supports herd production, is declining as a result of natural succession (long-lived, shade-tolerant trees replacing shorter-lived, sun-loving trees) and forest management practices (Figure 9). Aspen is being lost and openings are closing. Because of these changes, biological carrying capacity for deer is decreasing in the north. The expansion of corn production on the southern fringe of the northern forest, and the practice of baiting and feeding deer, have partially off-set this trend in some areas, perhaps to the detriment of natural plant communities.

This variation of carrying capacity over space and time is also related to the duration and severity of winter weather in different parts of the state and during different periods of history. Deer in southern Wisconsin rarely suffer as a result of winter severity. Those living in the northern forest region are often confronted with the extreme energy demands of coping with deep snow and below-zero temperatures for prolonged periods. Within the northern forest, deer living inland from the Great Lakes usually must deal with greater snow depths than deer living elsewhere. Since 1960-61, winter severity indices for northern Wisconsin have varied from a low of 14 to a high of 127 (see Figure 8). (Remember, an index of less than 50 is considered mild, between 50 and 80 is moderate, and greater than 80 is severe.) The 30-year average is 67. Overwinter population goals must be established with long-term climate in mind because short-term weather patterns are not predictable.

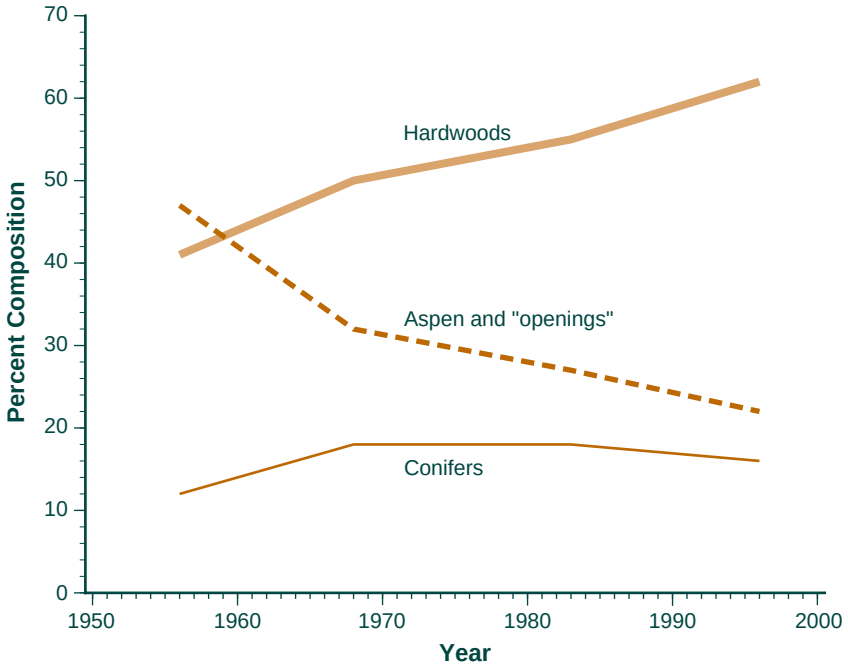


Figure 9. *Statewide forest composition trends, 1956-1996. Local deer carrying capacity is strongly related to the proportion of the forest that is in aspen and "openings" (meaning grass, upland brush, and clear-cut). Carrying capacity in forested regions continues to decline. The presence of agricultural crops for food is a more important factor for deer carrying capacity in the farmland regions.*

Severe winters are a reflection of climate and seem to occur in northern Wisconsin on average about once every 3+ years. Winter deer losses are normal at this latitude since it is near the northern limit of white-tail range (ending in southern Canada). Some losses will occur irrespective of deer population size, but losses will be minimized if herds are maintained well below maximum carrying capacity.

Social Carrying Capacity

In some areas of the state, the deer population is limited less by biological carrying capacity than by people's tolerance of deer-damaged crops; car-deer collisions; damage to commercial forests, orchards, and ornamental plantings; damage to natural plant and animal communities; and public health problems. This limit is sometimes referred to as **social carrying capacity**. In the farmlands, where agricultural crops provide prime deer forage, the deer management units could carry 80 to 100 (or more!) deer per square mile—but impacts, such as increased car collisions and damage to vegetation and natural plant communities, would be unacceptable to many people.

In some areas of the state, the deer population is limited less by biological carrying capacity than by people's tolerance of deer-damaged crops, car-deer collisions, and damage to other vegetation.

Agricultural Damage

High populations of deer are responsible for 90% of the wildlife crop damage reported in Wisconsin. The Wisconsin Department of Agriculture, Trade and Consumer Protection estimated agricultural damage caused by deer in 1984 at $37 million. Wisconsin's deer population is even higher now. In 1993 the U.S. Department of Agriculture conducted random damage appraisals in 14 eastern

states to determine deer damage to corn crops. Wisconsin was found to have the most severe damage among the states sampled, with corn damage alone estimated at $15 million.

Conflicts have occurred between farmers (traditional crop farmers, Christmas tree farmers, orchard growers, cranberry growers, and many other agriculturists), who are trying to protect their crops, and a public that wants abundant deer for viewing and hunting. Shooting permits for deer causing agricultural damage have been a focal point for this conflict. In deer management units where populations are over goal, or where overwinter goals are 30 to 35 deer per square mile of deer range, there is high demand for deer-damage shooting permits. Since 1987, 4,473 deer-damage shooting permits have been issued by DNR and 38,789 deer have been killed under these permits (Figure 10).

The DNR's responsibility for the management of the state's deer includes working with **all** stakeholders in the deer resource. DNR has a long history of providing assistance to growers with deer damage to crops in order to promote a tolerant coexistence with wildlife. Wisconsin has had a deer-damage assistance program for agriculturists since 1931; the most recent program to serve this purpose is the Wildlife Damage Abatement and Claims Program (WDACP). The primary purpose of this program is to provide prevention measures to reduce deer damage to crops.

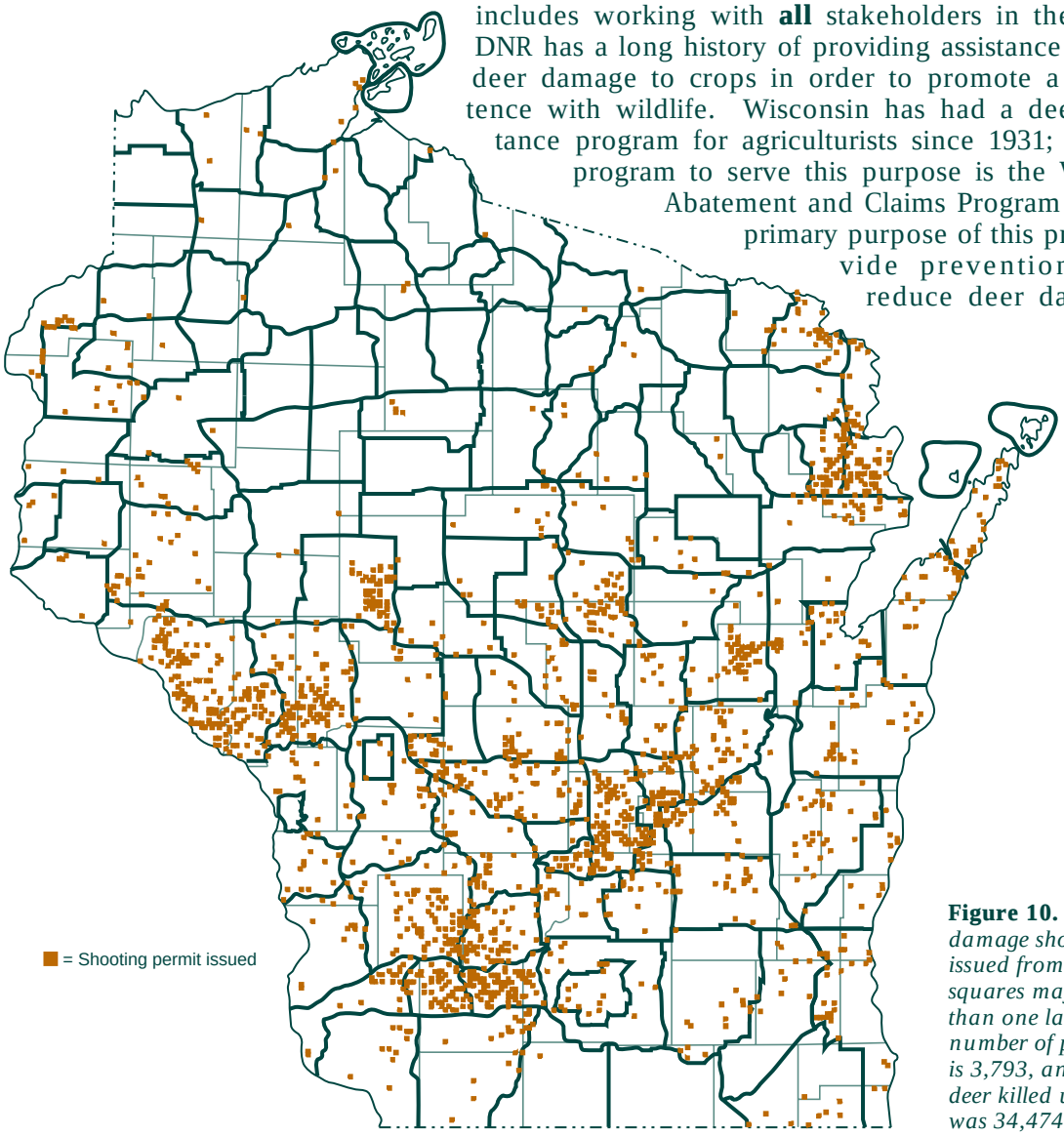


Figure 10. *Locations of deer-damage shooting permits issued from 1990-1997. Single squares may represent more than one landowner. The number of permits represented is 3,793, and the number of deer killed under these permits was 34,474.*

The program also provides compensation for damage appraised by a county specialist (Figure 11).

Since the WDACP began in 1984, over $19 million of hunters' money, $1.5 million of Wisconsin taxpayer dollars, and $2.5 million of federal funding have been spent on deer damage. Program expenditures for compensation of claims have more than doubled from 1993 to 1997, and abatement costs are again on the increase. These expenditures have included building 613 miles of permanent deer fences, 505 miles of temporary deer fences, and application of 16,466 gallons of deer repellent. At existing population levels, demand for deer-damage control will continue to increase, meaning increased demand for shooting permits, prevention assistance, and compensation—and greater conflict among Wisconsin citizens.

PHOTO: L STOWELL

This photo shows deer damage to an alfalfa field. Appraisers use exclosure fences to calculate how much crop is lost to deer damage.

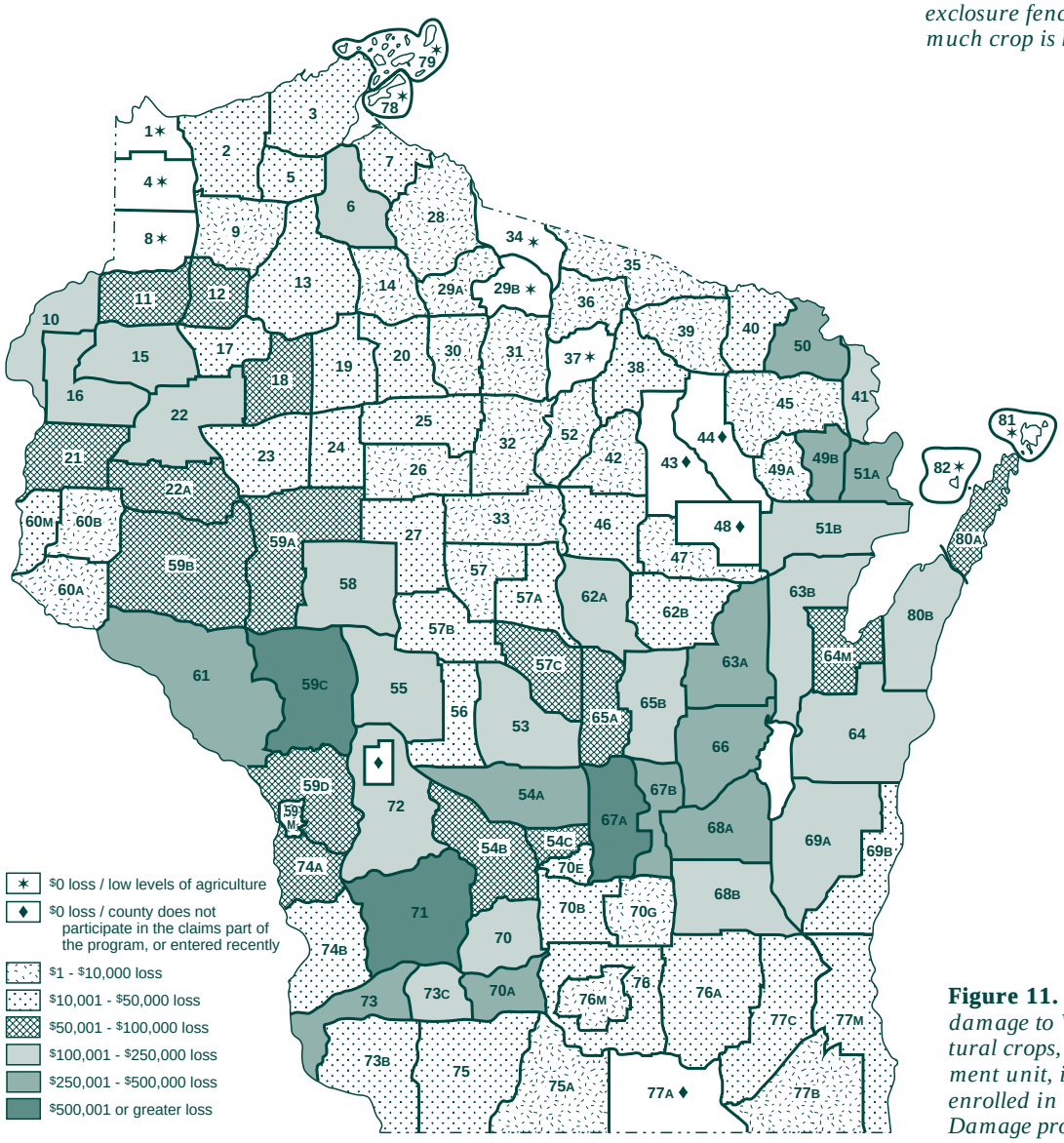


Figure 11. *Total appraised damage to Wisconsin agricultural crops, by deer management unit, in those counties enrolled in the DNR Wildlife Damage program, 1990-1996.*

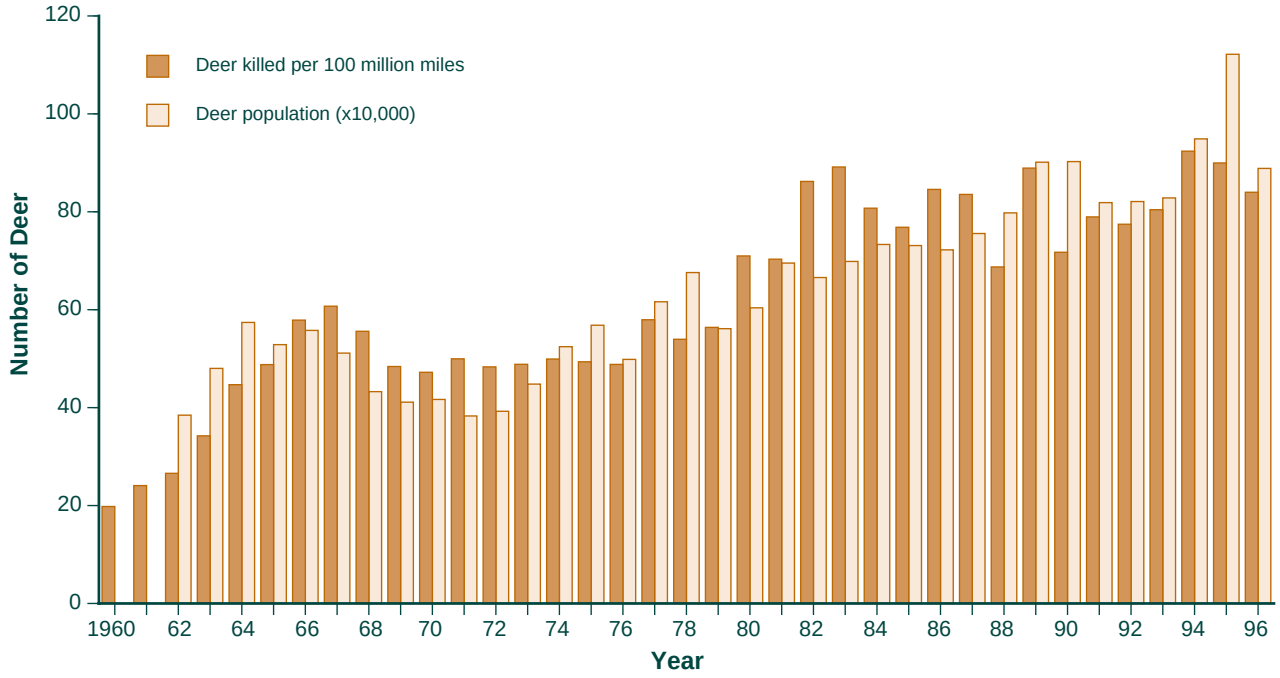
Deer-Vehicle Accidents

Research during the late 1960's and early 1970's demonstrated that the number of deer-vehicle accidents is determined by both the density of deer and the volume of traffic. When increases in traffic volume were accounted for, the number of deer-vehicle accidents closely paralleled the number of bucks harvested per 100 square miles. Changes in buck harvest density is a good measure of changes in the total deer population. Many Midwestern states use roadkill frequency as an index to deer population changes.

Further research during the 1970's estimated that 18,200 deer were killed by vehicles each year during 1976-78. Accident victims suffered an estimated $7.4 million per year in property damage during this period. Since that time, the reported number of vehicle-killed deer has more than doubled, to a high of 46,443 during 1994-95 (Figure 12). In 1997, there were more than 44,000 reported vehicle-killed deer. Combined property damage and personal injury resulting from deer-vehicle accidents was recently estimated at over $100 million per year (Wisconsin Insurance Alliance).

During 1996-97 the density of vehicle-killed deer (number of deer killed per square mile of total land area) was highest in Ozaukee, Washington and Waukesha counties (Figure 13). This is likely due, in part, to the large volume of commuter traffic in these highly suburbanized counties. High commuter traffic likely also contributes to the high frequency of road-killed deer in Dane County and between Sheboygan and Brown counties. A third area of high deer-vehicle accidents is a region of six counties in central Wisconsin extending from Waupaca County south to Columbia County. This region has the highest overwinter population goals in

Figure 12. *Number of vehicle-killed deer per miles driven, compared with statewide deer populations in Wisconsin, 1960-1997. Both deer populations and deer collisions have increased more than two-fold in 35 years.*



the state—30 to 35 deer per square mile of deer range. Undoubtedly, the high deer populations in this region are a principal cause of high rates of deer-vehicle collisions.

Low roadkill densities in some counties are the result of low traffic volumes, so don't necessarily indicate that past deer goals have been acceptably low. But high roadkill rates in other counties may suggest deer populations are uncomfortably high. Risk of deer-vehicle crashes has not been reduced by vehicle-mounted whistles, roadside reflectors, or fencing. The only known way to efficiently reduce deer crash hazards, without reducing traffic, is by reducing deer populations.

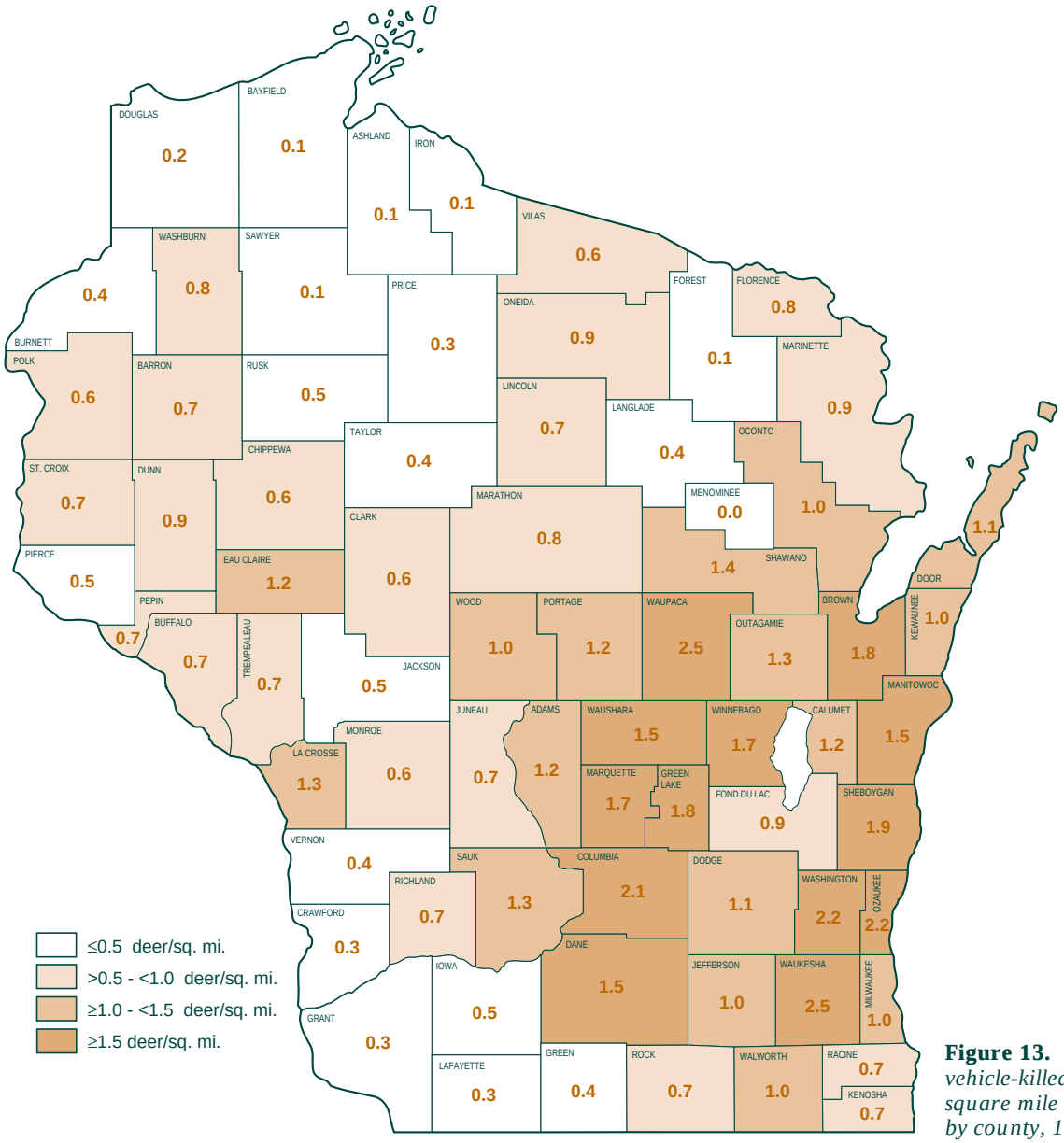


Figure 13. *Number of vehicle-killed deer per square mile of total area, by county, 1996-1997.*

PHOTO: K WALLENFANG

Rural development can benefit deer by providing a relatively danger-free life, protected from hunting, with easy access to gardens and ornamental shrubs for food. Deer densities may increase under these conditions, and nuisance situations often result.

PHOTO: M WERNER

Forestry and Ornamental Plant Damage

Large numbers of deer can affect valuable trees, shrubs, and flowers of forest owners and homeowners. Some foresters have encountered problems regenerating preferred tree species following logging operations due to deer browsing on the seedlings. A few industrial forest owners have even considered selling their land and buying other lands where deer herds have less of an impact on their "bottom line." Some Christmas tree farmers have resorted to high-priced electric fencing to protect their crops. Landowners trying to establish stands of trees have sometimes resorted to expensive tree tubes to help seedlings survive where large deer herds exist. Pine and oak, important to wildlife as well as timber production, are among the most problematic species. While the same number of deer will have different impacts in different areas, some foresters in the central and northern regions have reported substantial problems where deer populations exceeded 20-25 per square mile of deer range.

Homeowners in both rural and suburban settings often complain about deer eating their prized landscaping plants as well as their gardens. Deer will browse trees and shrubs planted for windbreaks, screens between neighbors, backyard wildlife habitat, and scenic beauty. They will often bite off flowers, if not whole plants, in annual and perennial gardens.

Public Health Problems

Deer live with natural environmental stress factors such as food shortages, weather extremes, overcrowding, and nutritional and reproductive demands. Any one of these stressors, but more likely a combination of them, can push deer into a less than healthy state. Disease occurs when deer are in this less than healthy state.

Deer can carry diseases that may infect people. Diseases deer carry usually only cause sickness in people, and are usually passed from deer to people through contact with deer fecal droppings. These diseases include virulent E. coli, and cryptosporidium. Deer may aid in the spread of Lyme disease to people because they carry the tick which harbors the Lyme disease-causing bacteria. However, many other mammals, especially small rodents, also carry this tick.

Deer can carry diseases that may infect domestic and captive exotic livestock and cause death or sickness in these animals. The chance of disease transmission increases when the deer population is high and in close proximity to livestock. Deer and livestock may pass diseases between populations, including epizootic hemorrhagic disease; bovine virus diarrhea; chronic wasting disease; lung, stomach, or brain worms; and bacterial diseases including brucellosis, tuberculosis, salmonellosis, and E. coli infections. Ongoing research will tell us which diseases Wisconsin deer carry and which are of major concern for people and livestock.

Deer can carry diseases that may infect people and domestic and captive exotic livestock.

DEALING WITH DEER IN URBAN AREAS

Managing urban deer populations has become a challenge in Wisconsin. White-tails thrive in the urban "fringe" areas where food and shelter are plentiful and hunting pressure is low or absent. Deer are common in habitat corridors along rivers and streams, parkways, nature centers, the edges of airports and golf courses, and in many residential areas. Although some deer provide much enjoyment for the people who view or hunt them, too many deer in urban areas is a problem that has required special management strategies. Recreational feeding often worsens problems of too many deer.

In areas where the discharge of firearms or bows is allowed, the regular deer hunting season is still the primary tool for managing deer populations. To increase the effectiveness of the hunting season near urban areas, three "metro" deer management units were established in 1992 that provide liberal bag limits for antlerless deer and in some cases a longer gun or bow season. Currently, there are five metro deer units surrounding the Milwaukee, Madison, La Crosse, Green Bay and western St. Croix County metropolitan areas (see Figure 3).

In some areas where regular hunting is banned by local ordinances, other control methods are being used. Two communities trap and re-locate deer, but most communities starting new programs are opting for "sharpshooting," using archery hunters within the expanded metro deer season framework. Deer removed under sharpshooting permits are generally donated to charitable organizations, and revenue gained from the sale of live deer is returned to the state's fish and wildlife account. Contraception of deer is being studied in several states, but is not yet considered a practical or acceptable method for free-ranging deer in most areas.

The DNR has recently added expertise in urban wildlife management and administers a new matching grant program to help fund urban wildlife damage abatement and control. Communities will be able to apply for up to $5,000 in matching funds for projects to plan wildlife damage abatement measures and/or to engage in wildlife control efforts.

Effects of Deer on Other Animals and Plants

The effects of deer on other animals and plants is an area of concern that has recently received a great deal of research attention. These effects may vary considerably, depending on the number of deer, the part of the state, and a variety of other factors. Where deer numbers are very high, the evidence is obvious. Small fenced areas (deer exclosures) around the state have long shown that high deer populations or local deer concentrations can greatly reduce the variety and abundance of plants growing in a forest. The extreme situation is an unhunted deer population, which causes a forest to look like a park where only trees with branches out of the deer's reach can survive. However, there is growing evidence of negative ecological impacts with smaller numbers of deer, particularly where deer carrying capacity is low. While not all research results apply to all landscapes in all areas of Wisconsin, studies show the following effects or trends:

PHOTO: R QUEEN

High deer populations affect the vigor, reproduction, and abundance of plants like this trillium.

High deer numbers reduce habitat for other animals such as this shrub-nesting hooded warbler.

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- Herbaceous plants may be reduced in abundance and diversity as deer numbers rise above 12-15 per square mile. A common example is the Trillium. Examples of vulnerable rare species include the Indian cucumber, showy lady's-slipper, and white-fringed orchid.
- Tree and shrub species composition can change with reduced regeneration as deer numbers rise above 20-25 per square mile. Pines, white cedar, hemlock, oaks, and Canada yew are examples of vulnerable trees and shrubs.
- Large numbers of deer may affect rare insects that are dependent on one or a few plant species that are also preferred for food by deer. A potential example is the federally endangered Karner Blue Butterfly that depends on wild lupine for its larval stage.
- Small mammals dependent on forest floor vegetation may be reduced as deer numbers exceed 25 per square mile. An example of a potentially affected small mammal is the red-backed vole.
- The number and diversity of the bird population may be reduced as deer populations rise from 15 to over 35 per square mile due to impacts on ground level vegetation, the shrub layer, and tree species composition. An example of a vulnerable bird is the shrub-nesting hooded warbler.
- Moose may not be able to inhabit otherwise suitable habitat if deer numbers exceed 12-15 per square mile due to a brainworm that is harmlessly carried by healthy deer, but often fatal to moose.
- The number of wolves that can be supported in a suitable landscape generally increases with the size of the deer population, a primary prey species.

PHOTO: K MCCAFFERY

This "browse line" was created by hungry deer. Deer damage can prevent regeneration of some types of trees.

How Biological and Social Carrying Capacity and Ecological Impacts Affect Overwinter Population Goals

Both biological and social carrying capacity, as well as ecological impacts, affect the decision-making process when overwinter population goals for each unit are reviewed. Many Wisconsin citizens want lots of deer in the state—to see them and to hunt them—and wildlife managers and researchers are committed to enhancing that opportunity. But large deer populations also collide with the property and priorities of many other people, as well as with other animals and plants. With increased public interest in the impacts of deer on the natural community (and more research providing information on the problems) this aspect of deer management has recently gained increasing consideration when we establish deer population goals. Wildlife management personnel are sensitive to these diverse issues and strive to strike a balance among the many interests. Setting unit goals is a process that must include both the scientific and social aspects of the picture.

Reviewing and setting overwinter population goals for each deer management unit is a process that must include both the scientific and social aspects of the picture.

Recruitment is an important biological concept in understanding how we determine deer management goals. Recruitment is the number of fawns born in spring that survive to the hunting season. To maintain a population at a particular goal, a number of deer equal to the annual recruitment must be removed by harvest and other non-harvest losses (such as poaching, accidents with cars and farm equipment, predation, disease, and starvation). If harvest and non-harvest losses are less than recruitment, the population will increase. If harvest and non-harvest losses are more than recruitment, the population will decrease.

Recruitment is a tricky concept to understand because it's not a constant—it varies not only with habitat and weather, but also with the size of the population. Here's how it works: as deer populations increase and there's less food available per deer, the percentage

DNR PHOTO

The greatest number of fawns (and thus the largest sustainable harvest) are produced when the population is at an intermediate level.

of yearling does that bear fawns decreases and the number of older does that bear two fawns decreases. So when the population is at maximum biological carrying capacity, the number of does in the population is highest, but the number of fawns produced by each doe is lowest. Because of this dynamic relationship between population size and rate of reproduction, it turns out that the greatest number of fawns (and thus the largest sustainable harvest) are produced when the population is at an intermediate level. As population density increases beyond this point, total fawn production decreases. Also, at higher population densities, fewer fawns survive the winter because their small size makes it harder for them to reach the woody browse that adult does and bucks eat when other food gets scarce.

The result of lower recruitment and poor overwinter survival is that few deer are available for harvest when populations are held at densities near maximum biological carrying capacity. This is true for both antlered bucks and antlerless deer. In contrast, when deer populations are held at intermediate densities, larger harvests are possible. In fact, large antlerless harvests are required to hold deer populations at intermediate densities because of the large production of fawns. Physical condition of all deer is much better at intermediate rather than high population levels.

Here's an example. In the northern forest, where maximum biological carrying capacity averages 30 deer per square mile of deer range, the largest allowable harvest is reached when the overwinter population density is kept at about 15 deer per square mile, or about 50% of maximum carrying capacity (Figure 14). At this density, approximately 3.4 antlered bucks and 3.4 antlerless deer could be harvested per square mile each year without reducing the size of the population for the following year. If this same deer population was held at 27 deer per square mile (about 90% of maximum carrying capacity), then only 1.2 antlered bucks per square mile could be harvested on a sustained basis. If overwinter population goals are set at or near maximum carrying capacity, then the herd will be in poorer nutritional condition, antler development will be poor on bucks of all ages, deer will enter winter with low fat reserves, and they will be especially vulnerable to winter severity. A greater percentage of the herd will die during severe winters than in herds held at lower densities. Survival of newborn fawns will be low. It will take longer for these herds to return to goal level following periodic severe winters.

Currently, overwinter population goals for most units in the north are set at approximately 65-70% of the estimated maximum biological carrying capacity. At this level, densities are high enough so there is a good chance of seeing deer and sustainable harvests can be relatively high while still leaving a population level that will remain at goal. Populations at this level tend to be self-regulating—if they are reduced in one year either by over-harvest or severe winter there will be more fawns born in subsequent years and the population will rapidly return to goal levels. Likewise, if the population is under-harvested and allowed to

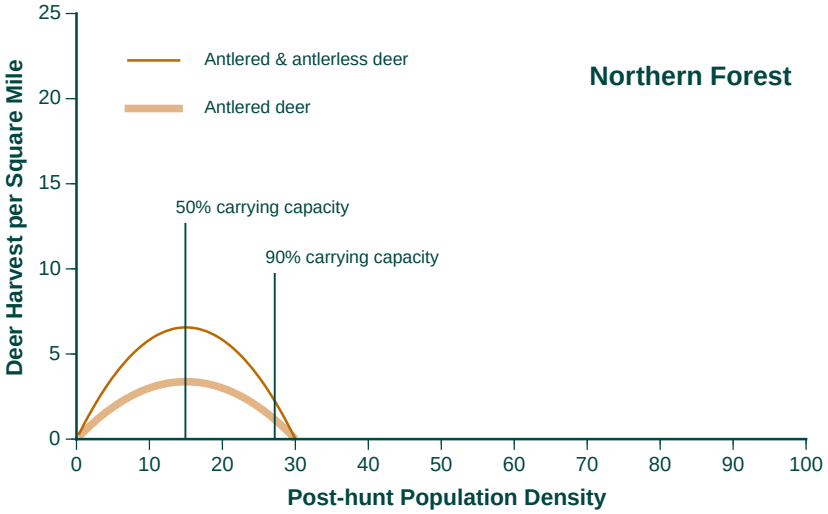


Figure 14. *Sustainable harvest for a maximum biological carrying capacity of 30 deer per square mile. This carrying capacity is typical of the northern forest region. Note that the largest number of deer can be harvested when the population is at about 50% of carrying capacity.*

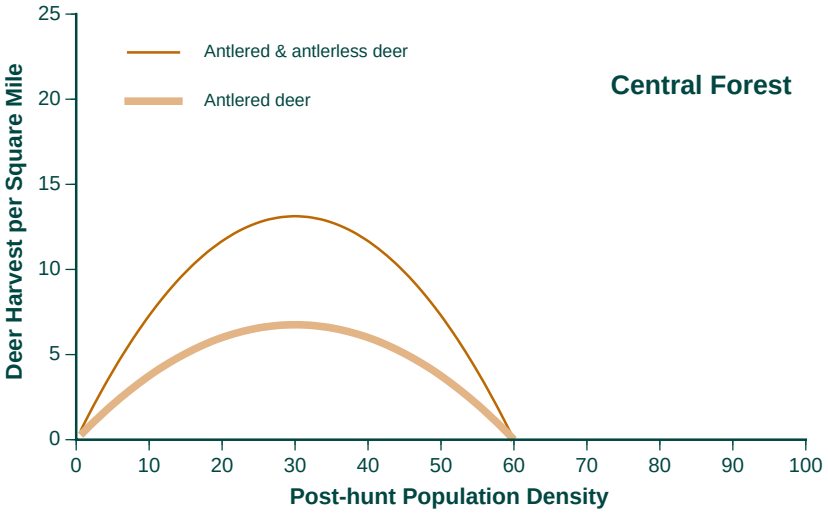


Figure 15. *Sustainable harvest for a maximum biological carrying capacity of 60 deer per square mile of deer range. This carrying capacity is typical of the central forest region.*

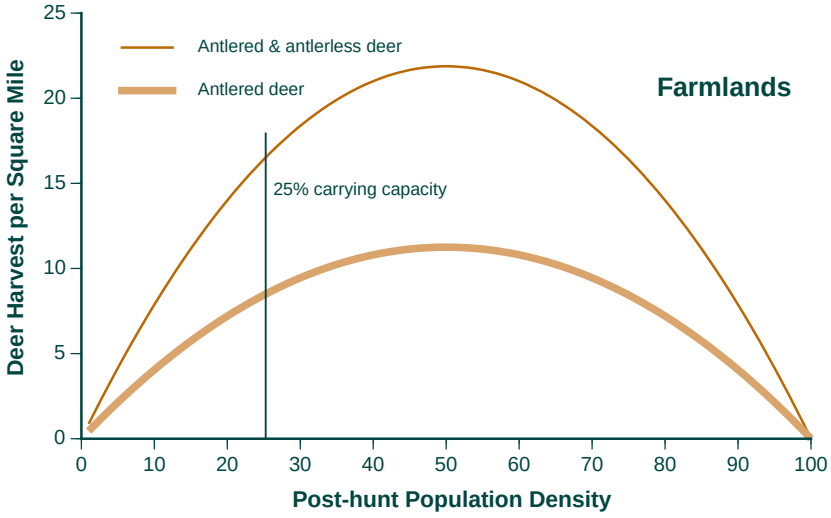


Figure 16. *Sustainable harvest for a maximum biological carrying capacity of 100 deer per square mile of deer range. This carrying capacity is typical of the farmland region. Because of conflicts between deer and people in this part of the state, overwinter population goals are generally set well below 50% of carrying capacity.*

In the farmlands, it has become increasingly difficult to keep harvest levels high enough to hold the population at goal. During the last decade, many farmland units have had a greater supply of deer than what hunters would (or could) harvest. If the population goals were increased further, the problem would get even worse.

DNR PHOTOS

grow, fewer fawns will be added to the large population, and it is relatively easy to correct the under-harvest in subsequent years to return the population to goal levels.

In the central part of the state, conditions for deer are quite different than in the northern forest and the farmlands. The winters in this region are much more moderate than in the north, but—although there is agricultural interest in the central forest area—the food base for deer is not nearly as rich as it is in the farmlands. Social carrying capacity starts to play a greater role in this region, with higher rates of agricultural damage and deer-vehicle accidents. Maximum biological carrying capacity for most units in the central part of the state is about 50-60 deer per square mile of deer range (Figure 15). Overwinter population goals in this area are currently 55-60% of carrying capacity.

In the farmlands, there is an abundance of food for deer. Maximum biological carrying capacity in this region may be as high as 100 deer per square mile of deer range—and much higher in some units (Figure 16). The management challenge here is different than other areas of the state. Large harvests of antlerless deer are required to hold the population at levels that meet social carrying capacity. Overwinter population goals for most units are less than 50% of maximum biological carrying capacity, but with such a large carrying capacity, that's still a huge number of deer. Because the population is kept well below carrying capacity, the reproduction rate stays very high every year. As overwinter population goals have increased during the last decade, total annual recruitment has increased, and it has become increasingly difficult to keep harvest levels of antlerless deer high enough to hold the population at goal. During the last decade, many farmland units have had a greater supply of deer than what hunters would (or could) harvest. If the overwinter population goals were increased further, the problem would get even worse. This is the ultimate challenge in balancing the realities of biological carrying capacity with the realities of social carrying capacity.

Adding further complexity to the goal-setting process are the ecological implications of potential deer population goals. The impacts depend on the plant and animal communities in question, the abundance of alternative foods such as agricultural crops, whether or not deer in the area congregate in dense groups in winter, the impacts of winter feeding on deer distribution, and winter weather conditions. For example, a population density of 15 deer per square mile might have few negative consequences for other animals and plants in the farmland region, where there is an abundance of alternative foods, biological carrying capacity is high, and deer remain well-distributed in winter. In contrast, 15 deer per square mile may have significant ecological consequences in the northern forest region, where biological carrying capacity is low, few alternative foods are available, and deer migrate to concentration areas in winter. Some have even suggested that northern deer goals be set below 50% of biological carrying capacity to maximize the diversity and abundance of other animals and plants.

REGIONAL POPULATION TRENDS

Northern Forest

The northern forest contains about 15,000 square miles of deer range. Deer populations reached their all-time peak abundance in the early 1940's following the extensive logging and fires of prior decades, which greatly increased growth of herbs and shrubs. Populations were also high in the late 1940's and late 1950's. More recently, populations peaked in 1964 when surveys indicated a region-wide population of about 400,000 deer (Figure 17). The population then declined to fewer than 200,000 following a series of severe winters. Five out of eight winters from 1964-65 through 1971-72 were severe, ending with back-to-back severe winters in 1970-71 and 1971-72. Populations recovered to goals with periodic impacts of severe winters between 1972-73 and 1985-86. The winter of 1986-87 was the mildest winter on record and was followed by a sequence of mild winters during the late 1980's and early 1990's. The deer herd responded with rapid growth. In 1992, poor recruitment and impaired hunting conditions, combined with an unexpected decline in buck harvest, caused a loss of public confidence and support for the management program among the leadership of the sportsmen's Conservation Congress. Consequently, antlerless gun quotas in 1993 were reduced to zero in many northern units despite a mild 1992-93 winter. The deer herd again "exploded" with back-to-back mild winters, and reached a "modern" high post-hunt population of 500,000. A liberal 1995 harvest and a record severe 1995-96 winter resulted in a significant herd correction. A second severe winter in 1996-97 caused conservative antlerless quotas in 1997. However, the effect of the second severe winter was not as great as expected, so herds remained about 20% above goals following the 1997 hunt.

Unit overwinter population goals were initially established in 1962. Despite several reviews and three decades of additional experience, the goals and boundaries have undergone only minor changes. During the mid-1980's, northern deer management was carefully reviewed by the courts and the Chippewa tribe as part of treaty litigation. At that time an independent expert calculated the maximum biological carrying capacity for northern Wisconsin to be about 400,000 deer, with recommended overwinter population goals of about 65-70% of maximum carrying capacity. Our most recent goals total about 270,000 deer, or 70% of maximum carrying capacity.

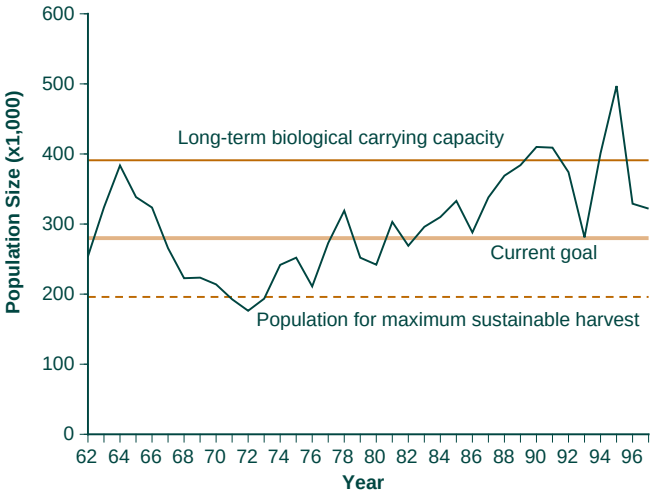


Figure 17. *Northern Wisconsin forest January deer population estimates, 1962-1997, compared with the current overwinter population goal, maximum biological carrying capacity, and population level for highest sustainable harvest. Compare this graph with Figure 8—note that when the winters are severe populations fall, and when winters are mild, populations bounce back.*

PHOTO: R QUEEN

Central Forest

The central forest contains about 2,300 square miles of deer range. Overwinter density goals in the central forest have traditionally been higher than in the northern forest because of the longer growing season. Severe winters occur only about half as often here as in the northern forest. However, severe northern winters from 1964-65 through 1971-72 clearly impacted the central forest deer population, as did the winter of 1978-79. The fall blizzards of 1991 also set in motion conditions that caused a major loss of deer in much of the central forest (Figure 18). Reproductive data (recruitment rates) and intensive studies at the Sandhill Wildlife Area (in Unit 56, Wood County) suggest that maximum biological carrying capacity for this region may average about 55 deer per square mile, or about 125,000 deer. The current goals allow an annual harvest very near the long-term sustainable maximum.

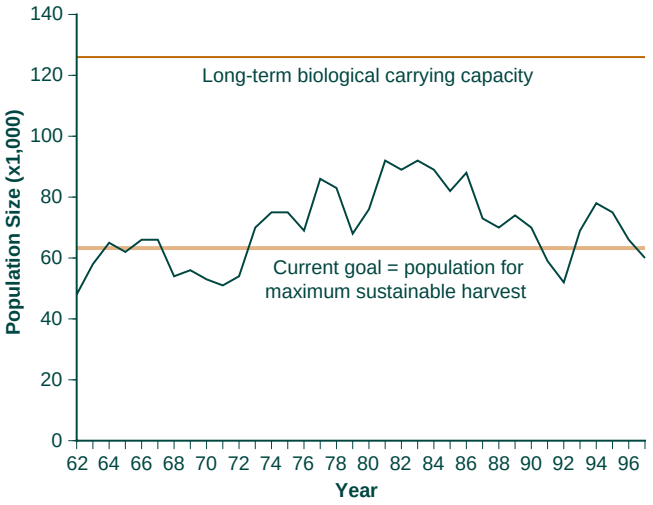


Figure 18. *Central Wisconsin forest January deer population estimates, 1962-1997, compared with the current overwinter population goal, maximum biological carrying capacity, and population level for highest sustainable harvest.*

PHOTO: R QUEEN

Farmlands

The most recent deer range inventory measured about 17,000 square miles of deer range in the farmlands of Wisconsin, or about half the deer range in the state. Maximum biological carrying capacity for deer here is very high (100+ per square mile), with intermixed farms and woodlots providing prime deer habitat. However, the maximum number of deer that could be produced in this region is well beyond what people would tolerate.

Overwinter population goals were initially established in 1962, at a time of few deer and few conflicts with people. Since that time, overwinter goals have doubled but deer populations in this large area have increased more than five-fold (Figure 19). As goals have been gradually adjusted upward, herds have grown and agricultural damage has increased. Deer populations exceeded goal levels during the early 1980's and again in the late 1980's. Populations were reduced to near-goal in the early 1990's, but conservative quotas in 1993 allowed the population to greatly exceed goal. Recent high harvests are bringing the population nearer to goal. Current overwinter population goals in the farmland units of the state average about 22 deer per square mile of deer range. Human tolerance seems to have been exceeded in much of the farmland. In recent years, crop damage complaints have become more numerous, and nearly $3.5 million has been spent on damage abatement. Deer-vehicle crashes and damage to oak and pine have also become major concerns.

Relatively high overwinter population goals, highly productive deer, urban sprawl, and shrinking hunter access have caused great difficulty in maintaining herds at goals in many units. For some people, the current abundance of deer has cheapened their value for hunting and viewing. Lower goals and fewer deer numbers may restore their charm and mystery.

Figure 19. *Wisconsin farmland January deer population estimates, 1962-1997, compared with the historical overwinter population goal, maximum biological carrying capacity, and population level for highest sustainable harvest.*

PHOTO: A RUSCH

SUMMARY

1. The white-tailed deer is a very important part of the Wisconsin landscape. The popularity of deer in this state combined with the size of the herd translates into a wide variety of both positive and negative impacts on our economy and our way of life.

2. The economic value of deer in Wisconsin is a major factor in our recreational economy. In addition to direct expenditures, there are many deer-related benefits to Wisconsin citizens and communities. Deer are also very important to Wisconsin's native people, including the Chippewa, who have treaty rights to deer harvests.

3. Deer are also associated with some significant problems, including crop damage, deer-vehicle collisions, commercial timber damage, ornamental plant damage, and health and safety issues. These negative impacts translate into what we call **social carrying capacity**, which is the limit to which the human population will tolerate the problems associated with deer.

4. Deer can have major impacts on the natural communities in which they live. Deer grazing and browsing can affect the composition and structure of the plant community and consequently the animals depending on this vegetation for habitat.

5. **Deer management units** are areas of similar land use bounded by major roads or rivers, which give managers a framework for gathering data. Managers record deer harvests and other important information for each unit every year; over time, a history of the unit evolves. The unit history is an essential tool for managers, especially for predicting herd status each fall. Changing unit boundaries breaks the unit history and greatly diminishes the usefulness of unit data.

6. **Deer range** is usable deer habitat, including all permanent cover at least ten acres or more in size and includes borders of agricultural fields next to permanent cover. The amount of deer range varies greatly among deer management units. By using deer range instead of overall area, we have a standard basis for comparing deer densities and their impacts among deer management units.

7. Wisconsin's deer herd is managed by setting **unit overwinter population goals** for each deer management unit in the state. The two main factors that come into play in setting unit goals are **biological carrying capacity**, which is the maximum number of deer that can survive on the land, and **social carrying capacity**, which is the number of deer that people can tolerate. The need to balance the positive and negative impacts of deer on humans makes the process of setting overwinter population goals much more complicated. With increasing research and interest in the effects of deer on other animals and plants, ecological impacts are a growing consideration in this process.

8. Deer managers monitor deer populations in each unit and determine whether they are above, at, or below goal. These population estimates are based on harvest registration, deer aging, hunting season stability, and summer observations of the ratio of fawns per doe.

   - **Harvest registration** provides information on the number of deer harvested, the date and location of harvest, and the sex and age of harvested deer.
   - With **uniform hunting seasons**, managers have found that buck harvest trends closely track deer population trends and population data is more easily interpreted.
   - **Ages of harvested deer** are important because they provide the basis for determining mortality rates (how fast deer die), recruitment rates (how fast deer are added to the population), and adult sex ratios (how many bucks to how many does).
   - The **ratio of fawns to does** provides an index to current reproductive rates.
   - The **Sex-Age-Kill** formula is a mathematical model that combines harvest, age, and fawn-to-doe ratio data to estimate the size of the deer population.

9. Because **winter weather** is a key factor in herd survival and fawn production in northern Wisconsin, the Department of Natural Resources determines a Winter Severity Index each year. The index allows winter weather to be factored into a formula for predicting survival and reproduction, and it provides a long-term picture of how deer populations are affected by multiple years of severe or mild weather. It is important to consider long-term patterns (30+ years) of winter severity in the goal-setting process because short-term patterns are unpredictable.

10. Harvest quotas are based on **fall population predictions**. The overwinter deer population for each deer management unit is calculated based on data from the harvest of the previous fall. This estimate is the starting point for predicting the herd status for the following fall. The history of herd responses to varying winter severity, antlerless harvest levels, and hunting conditions in each deer management unit is extremely important for providing the perspective needed to accurately predict future herd status. *When unit boundaries are changed, we lose that essential historical perspective.*

11. To manage a herd to be at goal, we set harvest **quotas** for "antlerless deer" so that enough does will be harvested to control herd growth.

(continued on next page)

SUMMARY *(continued)*

12. The maximum number of deer that a given unit of land can support over a prolonged period of time is termed its **biological carrying capacity**. Overwinter population goals anywhere in the state should be no higher than 65-70% of carrying capacity. A popular perception is that carrying capacity is a desired state for a deer herd, but it is really a miserable life for deer. Population goals higher than 65-70% will result in:

    - substantial damage to habitat for deer, other wildlife, and plants,
    - deer in very poor physical condition, less prepared to make it through the winter, and
    - much reduced allowable harvest.

13. Food, cover, and climate determine long-term carrying capacity. Carrying capacity varies greatly across geographic areas in Wisconsin, and it also varies over time. Again, the long-term patterns resulting from consistent data collection provide the best basis for determining carrying capacity.

14. In some areas of the state, the deer population is limited less by biological carrying capacity than by people's tolerance of deer-damaged crops, car-deer collisions, and damage to other vegetation. This limit is sometimes referred to as **social carrying capacity**.

    - Large populations of deer are responsible for most of the wildlife **agricultural damage** that is reported in Wisconsin. This damage causes social conflicts and currently costs farmers, hunters, and taxpayers millions of dollars each year.
    - The number of **deer-vehicle accidents** is steadily increasing in areas where both human and deer populations are growing larger. These accidents cause millions of dollars worth of damage each year.
    - Large numbers of browsing deer can dramatically affect **commercial forest** interests, including both tree farms and natural timber stands where trees can't regenerate following logging operations. Deer can also substantially damage valued **ornamental plantings** in arboretums and homeowners' landscaping.
    - Large numbers of deer may carry and spread a variety of parasitic, viral, and bacterial **diseases** to domestic and captive exotic livestock and to people.

15. In addition to social and economic effects, deer also affect the **natural communities** they live in by grazing or browsing on natural vegetation. Generally, larger numbers of deer are associated with greater adverse effects on some herbaceous plants, shrubs, trees, and the insects, small mammals, and birds that need these plant communities for habitat. The same number of deer can be more or less of a problem depending on the biological carrying capacity of the landscape, the seasonal movement patterns of the deer, the presence of vulnerable rare plant species, winter weather conditions, and the abundance of alternative cultivated foods.

16. Varying deer numbers can also affect the suitability of the landscape for **other animals**, including moose, which may contract a lethal brainworm parasite harmlessly carried by healthy deer, and wolves, which depend on deer as a major food source.

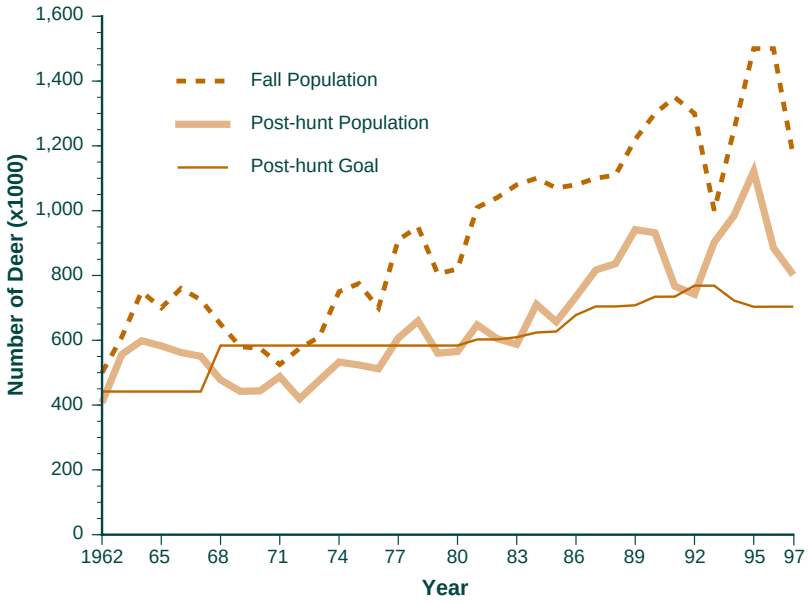
17. Many people think that the larger the deer herd in a given area, the larger the allowable harvest will be. This is not the case. **Recruitment** (the number of fawns born in spring that survive to the hunting season) is an important biological concept in determining deer management goals. Because the rate of recruitment declines as populations grow, more harvestable deer are produced when populations are at about 50-60% of biological carrying capacity. This is true for both antlered bucks and antlerless deer. A deer herd existing at biological carrying capacity produces **no** harvestable bucks or does without reducing the population.

18. In the **northern forest**, overwinter population goals have usually been set at 65-70% of maximum biological carrying capacity. This level provides a good chance of seeing deer and harvesting deer while leaving the herd relatively productive.

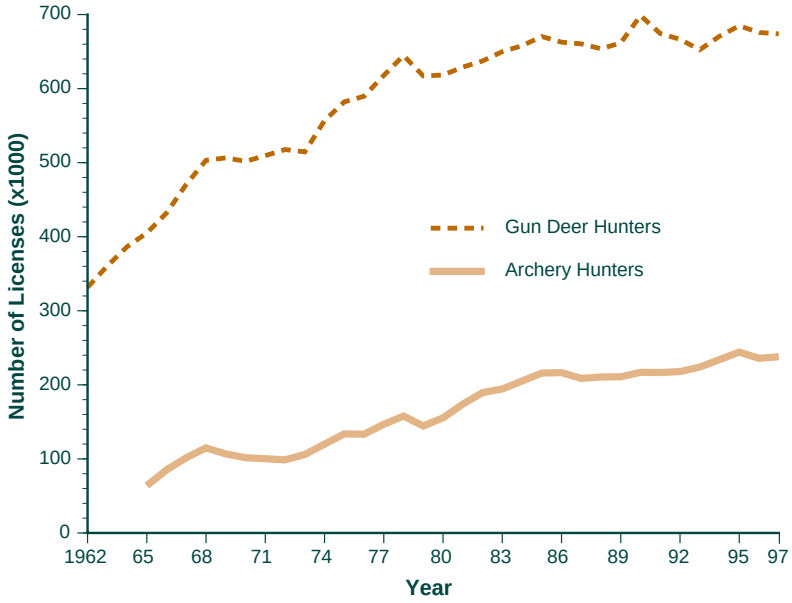
19. In the **central forest** part of the state, overwinter population goals have generally been about 50-60% of biological carrying capacity as a result of agricultural considerations.

20. In the **farmlands**, social carrying capacity limits the number of deer that we can have on the land. Overwinter population goals for most units have been well below 50% of biological carrying capacity. In this part of the state, the challenge is to keep antlerless harvests high enough to keep herd growth under control.

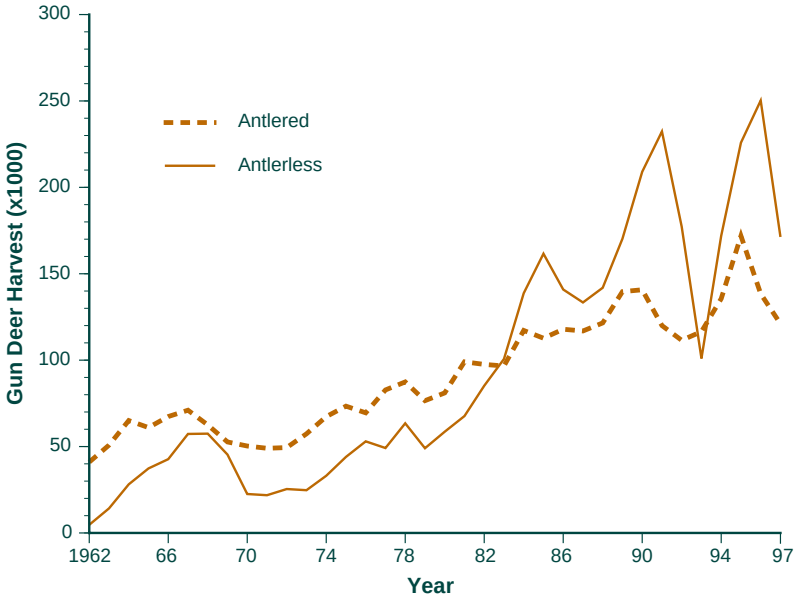
APPENDIX. Historical Trends in Deer Management



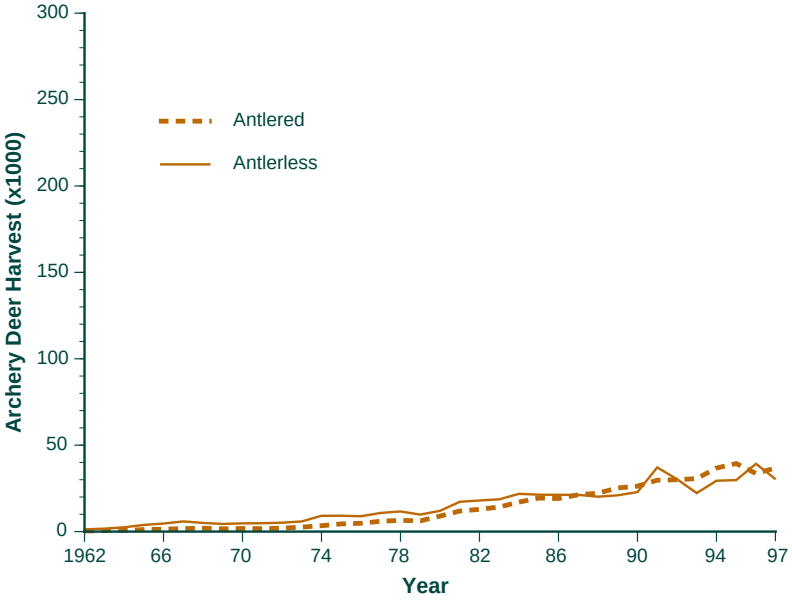
Population Goals and Estimates. Statewide fall and overwinter deer populations and overwinter population goals, 1962-1997.



License Sales. Number of archery and firearm licenses sold, 1962-1997.



Gun Harvest. Number of antlerless and antlered deer killed during gun season, 1962-1997.



Archery Harvest. Number of antlerless and antlered deer killed during archery season, 1962-1997.

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