WHITE-TAILED DEER ASSESSMENT AND STRATEGIC PLAN 1997

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AUGUSTA, ME
MAY, 1999

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DEDICATION

This report is dedicated to the memory of Chester F. Banasiak (1920-1998). During most years from 1953 to 1985, Chet was affiliated with the Maine Department of Inland Fisheries and Wildlife, initially as a regional wildlife biologist, but primarily as deer project leader. During his final 10 years with the Department, Chet was responsible for moose and black bear as well. Much of what we know about deer management in Maine is directly attributable to the research and management activities Chet initiated during the 1950's, 60's, and 70's. Chet's insight into the ever-changing dynamics of Maine's deer herd had long proven helpful to agency administrators who were responsible for regulating hunting seasons and managing deer wintering habitat. Dr. Banasiak's dedication to his work, and his professionalism in transforming deer data into deer management policy are much appreciated by those who have carried on after him.

INTRODUCTION

Since 1968, the Maine Department of Inland Fisheries and Wildlife (MDIFW) has aggressively pursued development and refinement of wildlife species assessments and implementation of cost-effective comprehensive programs that support selected goals and objectives for the next 15 years. Assessments are based upon available information and the judgments of professional wildlife biologists responsible for individual species or groups of species. Precise data may not always be available or are too limited for meaningful statistical analysis; however, many trends and indications are sometimes clear and deserve management consideration.

The assessment has been organized to group information in a user-meaningful way. The Natural History section discusses biological characteristics of the species that are important to its management. The Management section contains history of regulations and regulatory authority, past management, past goals and objectives, and current management. The Habitat and Population sections address historic, current, and projected conditions for the species. The Use and Demand section addresses past, current, and projected use and demand of the species and its habitat. A Summary and Conclusions section summarizes the major points of the assessment.

Between 1986 and 1997, Maine was divided into 18 districts for the purpose of deer management. In 1998, these Deer Management Districts (DMDs) have been replaced by 30 Wildlife Management Districts (WMDs; Fig. 1). For the sake of continuity, all data dealing with regional deer populations from 1976 to 1998 have been converted to WMDs.

In this assessment, all deer management actions occurring before 1976 are discussed in the “historical” sections. When discussing more recent times (1976 to 1997), deer data were pooled into three time periods (Fig. 2). The first of these (1976-82) represents the final 7 years in which deer of either-sex hunting regulations were in effect for the firearm seasons. The second period (1983-89) is a transitional period during which we regulated firearms antlerless deer harvests using bucks-only seasons along with a limited number of either-sex days (1983-85), or bucks-only, and the Any-Deer permit system (1986-89). The final 8 years (1990-97) represents the remainder of the Any-Deer permit years.

NATURAL HISTORY

Much is known about the natural history of white-tailed deer. Indeed, deer are among the most widely studied wildlife species in North America. The following account describes those aspects of the white-tail's natural history which directly affects deer management in Maine. When possible, literature citations which provided a broad review of important topics were selected over those dealing with more narrow topics.

Distribution and Physical Description

Maine's native white-tailed deer (*Odocoileus virginianus borealis*) occupies the northeastern part of the species' range in North America. Termed the northern or boreal white-tailed deer, this subspecies is distributed from Nova Scotia to Minnesota, extending southward to Pennsylvania, through Illinois (Baker 1984). *O.v. borealis* is distributed throughout Maine at this time. The northernmost extent of the white-tail's range is less than 100 miles north of Maine, along the south shore of the St. Lawrence seaway in Quebec (Huot et. al. 1984). As will be described later, the northern limits of the white-tail's range is dependent on the severity of winter weather. This limit varies over time, as climate changes.

This subspecies is among the 3 largest of the 30 recognized subspecies of white-tailed deer, range-wide (Baker 1984). Mature bucks of *O.v. borealis* may attain live weights exceeding 300 lbs; most does at maturity can reach 150 lbs live weight. Attainment of maximum body size is dependent upon each individual deer's age, diet quality, and genetic potential, in that order of relative importance (Sauer 1984). Skeletal

size, body weight, and antler size increase markedly each year, until maturity (age 4), after which all three attributes of deer size tend to stabilize. Antler size among bucks may decline in old age, i.e. beyond 10 years of age.

Habitat Use

Individual deer tend to remain in habitat (termed "home range") which must provide all their requirements for food, water, and security (concealment) cover (Tierson et. al. 1985). The size of a deer's summer home range is inversely related to habitat quality (Pichette and Samson 1982), and may vary from 100 to 2000 acres during summer and autumn. During winter, home range size tends to be smaller and more variable, ranging from 10 to 200 acres, or more (Lavigne 1991). Deer are not territorial; they generally tolerate the presence of other deer within their home range. At birthing time however, pregnant does establish a birthing area of about 20 to 25 acres, from which all other deer are excluded (Marchington and Hirth 1984).

Behavior

White-tailed deer populations are organized into a matrilineal (female-led) society (Hirth 1977) in which adult does are accompanied by related females, and their immediate offspring (fawns). Fawns accompany their mother from birth through at least one year. As yearlings (12 to 23 months old), bucks tend to disperse outside of their mother's home range. Typically, doe yearlings remain in or near the summer home range of their mother (Marchington and Hirth 1984).

Yearling bucks tend to associate with older bucks. Although bucks share home ranges with doe family groups, yearling and older bucks tend to keep to themselves, or to remain in small bachelor groups during most of the year. Adult bucks tend to interact more frequently with each other, and with does during the breeding season.

Deer establish a dominance hierarchy which manifests itself when food resources are limited in quality or distribution (Ozoga 1972). Mature bucks, because of their superior size and strength, tend to dominate all other deer. Mature, highly aggressive does rank next in dominance, followed by immature bucks and does. Fawns are typically the least dominant individuals in the population. During winter, adult does may chase their own offspring away from preferred forage. Hence, during times of food scarcity, aggressive interactions among deer may limit forage allocation to only those deer which are most dominant in the herd.

Population Dynamics

White-tailed deer in Maine can reach 18 or 19 years of age, although less than 10% of does and fewer than 5% of bucks survive beyond 10 years in the wild (MDIFW unpubl. data). Survival to older age classes is directly correlated with mortality rates, including hunting by man (McCullough 1979). When subjected to heavy hunting mortality, deer populations will be dominated by younger individuals. Conversely, deer populations which incur few losses have more individuals which survive to old age.

Even in unhunted populations, adult (yearling and older) does will outnumber adult bucks, because bucks incur much higher natural mortality related to the breeding season (the rut). Adult doe to adult buck ratios in the population may reach a biological

maximum of 500 adult does: 100 adult bucks under extreme hunting pressure (applied only to adult bucks). In practice, normal ratios of does to bucks in Maine are more typically 110 to 200 adult does: 100 adult bucks (Lavigne, in prep. (a)). Maine simply does not yet generate enough hunting pressure on bucks to distort doe: buck ratios to any greater degree.

Deer populations can withstand enormous buck losses, and still remain viable. In some states, deer remain productive and abundant despite annual removal of 90% of the antlered bucks from the herd. Among does, however, annual losses must be limited only to that which can be replaced by production of doe fawns, if population size is to remain stable. When producing fawns at their genetic maximum, deer populations can sustain adult doe losses approaching 50%. This level of productivity rarely occurs in the wild (McCullough 1979).

At the other extreme, there is a minimum sustainable mortality rate, below which deer populations cannot be maintained over long periods of time. Deer populations will naturally exhibit an annual mortality rate no lower than 18 to 20% for either sex (Lavigne, in prep. (a)). Since deer cannot survive beyond 15 to 18 years, individuals in the population will inevitably be lost to "old age" if mortality rates are held below 18% for too long. This is the rationale behind the old adage that "you cannot stockpile deer". They all will die eventually.

Reproduction

The breeding season for white-tailed deer in Maine occurs from early October to early January. Timing of breeding activity is controlled by day length, but is also

influenced by the physiological condition of individual does (Verme and Ullrey 1984). Mature does tend to reach estrus (breeding condition and receptivity) before younger does. The peak in breeding activity in Maine occurs during the third week of November, when most mature does are bred (Lavigne 1991a). If younger does participate in the breeding season, yearlings (1 1/2 years old) conceive in late November, and fawn (<1 year old) does (if they breed at all) breed in mid to late December or early January. This breeding pattern does not appear to vary annually or regionally in Maine, nor anywhere from Nova Scotia to North Carolina or Minnesota (Lavigne 1991a).

Reproductive rates in deer are not static. Pregnancy rate, litter size, and age at first pregnancy all are strongly affected by the quality of food available to does. This relationship will be discussed in more detail in the carrying capacity section. The following data reflect the current level of productivity in Maine. They are indicative of a deer population in good to excellent nutritional condition.

Nearly all (96%) mature does breed annually in most parts of Maine (Lavigne 1991a). They typically bear twins, although triplets occur (9%). We have records of 3 does which conceived quadruplets, over the years. Few (23%) mature does produce only a single fawn in Maine. About 75% of yearling does in Maine typically conceive, usually a single fawn, but occasionally twins. Nearly a third of our doe fawns annually conceive. When pregnant, these 7 month old does carry only a single offspring.

The gestation period of white-tailed deer is about 200 days (Verme and Ullrey 1984). Consequently, fawns in Maine are born from late May into mid July; the peak fawning period is the first two weeks in June (Lavigne 1991a). Given current reproductive rates, production averages 132 fawns per 100 does in early summer. If no

fawns or adults were to die, this rate of production could cause the herd to double in size in less than 3 years! However, the first few months of life are a perilous time for young deer. Some fawns die at birth because the doe was undernourished during the previous winter (Verme 1977). Consequently, neo-natal fawn mortality is high following severe winters. Young fawns may also fall prey to bears, coyotes, fox, fisher, dogs, bobcats, drowning, accidents, and illegal kill during summer. Cumulatively, these losses amount to 33% to 50% of the fawn population between June and November (Lavigne 1991a). By fall, net productivity in Maine typically ranges between 60 to 90 fawns per 100 does. Whenever doe losses during the course of the year exceed autumn production of female fawns, the deer population declines.

Food Habits and Nutrition

White-tailed deer are plant-eaters which, like moose, possess a specialized four-chambered stomach (rumen). Termed ruminants, animals possessing this type of digestive system are able to consume large quantities of food in a short time (Verme and Ullrey 1984). Ingested food remains in the rumen for 1 to 2 days, where a diverse array of bacteria and protozoa partially digest tough plant components. Ruminants aid in this digestion by engaging in cud-chewing long after the meal is eaten, usually while the animal is at rest in a secure location. It is generally true that larger ruminants, are able to thrive on lower quality vegetation. Hence, moose can thrive on a slightly coarser diet than deer, and large deer can utilize poorer quality forages than smaller deer (Putman 1988). When highly nutritious foods are unavailable, small deer, such as fawns fare the poorest.

White-tailed deer consume a huge number of different plants; their diet may exceed 500 different plant species in the northeast (Jacobson 1994). However, white-tails do not select all species equally. Deer tend to pick and choose, rarely restricting their daily intake to only one or a few plants. At any one place and time, deer will usually select the most digestible and nutritious plants currently available. Within plant species, deer will choose only that plant part (flower, leaf, seed, twig, root) which is most nutritious at that particular time of the year.

Seasonally, deer may concentrate on early growth of grasses, wild flowers and herbs, or emerging leaves in spring (Crawford 1982). During summer, tree, shrub, and herbaceous leaves and flowers may dominate the diet. When autumn's frosts arrive, deer will switch back to fall growth of grasses and herbs, but will also seek out soft or hard mast (berries, apples, acorns, or beechnuts), mushrooms, farm crops, even newly fallen leaves. Deer will continue to seek these high quality foods well into winter, if snow cover is not too deep. It is only when other, better quality foods, become unavailable that deer turn to dormant woody browse (twigs and buds of shrubs and trees) for a significant portion of their daily diet (Crawford 1982). Dormant twigs and buds are poorly digested by all deer (Mautz et. al. 1976). When restricted to these diets, deer will lose weight (Jenks 1986). Among all browse species, only the leaves of northern white-cedar can sustain deer in winter without causing serious weight loss. Generally, dormant browse only slows weight loss in deer, relative to eating nothing. Consequently, the amount of time deer are restricted to winter browse can affect survival of individual deer (Mautz 1978). Fawns restricted to diets of dormant browse

for more than 100 days are vulnerable to death by malnutrition (Severinghaus 1981). Larger deer can subsist longer, but they too have physiological limits to weight loss.

Winter Yarding and Related Survival Adaptations

One mechanism deer possess to counter the debilitating effects of woody browse diets in winter is to store body fat in autumn (Verme and Ozoga 1982). All deer naturally store body fat in the fall, when nutritious foods tend to occur in abundance. In the best deer ranges, individual deer may enter winter with 25% body fat (Huot 1982). Deer are considered to be in poor physical condition if their body fat level drops below 5% (Lavigne 1992). Physiologically, deer fat is highly mobile, being withdrawn whenever the number of calories taken in from browse cannot meet daily requirements for body warmth and movement. At such times, deer also may resorb their muscle tissue to provide calories (Torbit et. al. 1985). Maintenance of high quality summer and fall ranges is critical to deer survival during winter in Maine, because deer fatten better on high quality diets (Verme and Ozoga 1982).

Another important strategy deer utilize to survive winter is migration to winter ranges. Deer may travel as little as ½ mile or more than 25 miles to habitats which offer a survival advantage in winter (Lavigne 1991). In Maine, these winter ranges, or deer wintering areas (DWAs) ideally are mature coniferous forests whose deep, closed crowns intercept both snow and wind (Marston 1986). Consequently, deer are able to travel in shallower snow under the canopy of these forests (Hugie 1973). This in turn, reduces their energy loss in traveling to food sources, and may improve their chances of escaping predators (Mattfeld 1974). Most DWAs in Maine are located in riparian areas

along lakes, ponds, rivers and streams (Banasiak, 1964). Deer wintering areas may vary in size from less than 100 acres to nearly 20,000 acres (MDIFW unpubl. data).

Deer migrate to wintering areas in late fall or early winter, usually in response to accumulating snow cover. Persistent snow depths which exceed 10 to 14 inches, commonly trigger movements to DWAs, although below-zero weather can also induce yarding migrations among deer in late December or January (Lavigne 1991). Migration to winter range is traditional; fawns learn migration routes by following does (Tierson et. al. 1985). Individual sub-populations of deer show a great deal of fidelity to specific DWAs and summer range. Once the migration pattern is established, these deer normally return to the same locations year after year. Many DWAs in Maine have been used continuously by deer for 50 or more years (Lavigne 1991). Dispersal from deer winter ranges in March or April also is triggered by snow depth. Typically, when snow cover melts to less than a foot, deer begin migration to summer range.

While yarding (occupying wintering habitat), deer invoke a number of strategies that enhance survival (Moen 1976). In winter, northern deer use relatively small home ranges, and they tend to travel less than at other times of the year, thereby conserving energy (Tierson et. al. 1985). Physiological changes also occur at this time. During January and February, metabolic rate tends to slow, which lessens their demand for calories to maintain body functions (Silver et. al. 1969). In addition, deer innately reduce their intake of food (Verme and Ullrey 1984), thereby reducing their need to travel about to forage. Deer also take advantage of local topography. They can increase their comfort (and conserve energy) by bedding under shelter of low tree branches at night or by bedding and loafing in sunshine on south-facing slopes during

sunny days (Moen 1976). Sometimes, a short walk to the other side of a low ridge makes all the difference in the world on a cold and windy day.

Winter ranges comprise less than 25% of the land base in Maine; in some Wildlife Management Districts (Fig. 1), DWAs comprise less than 5% of summer range (Lavigne 1991). While yarding, wintering deer are concentrated at densities which are much higher than during summer. Wintering deer densities may range from as little as 20 deer /mi^2 to 350 or more deer /mi^2 in Maine. Aside from the fact that concentrated deer must compete with each other for scarce food resources, these wintering aggregations do offer some advantages for their survival. When concentrated, wintering deer share the considerable energetic cost of creating and maintaining trails in the snow (Mattfeld 1974). Once created, deer can move along hard-packed trails with relatively little energetic cost. This can be an advantage when deer are foraging for browse, or when trying to elude predators (Messier and Barrett 1985).

Acreage occupied by wintering deer varies both among years, and almost daily during the course of individual winters (Hugie 1973). The area they occupy is inversely related to snow depth. When snow is shallow, or when a crust allows deer to walk on top of the snow pack, wintering deer are able to travel widely, while taking advantage of forage at the periphery of their winter ranges (Lavigne 1976). As snow depths increase, deer restrict their travels to only the best quality shelter. A wintering aggregation of deer which occupies 2,000 acres of winter range when snow is only 10” and crusted, may be restricted to only 500 acres when they are belly-deep in 36” of powder snow, and are restricted to trails (Hugie 1973). Similarly, deer may range over a large portion of a riparian watershed during mild winters, but be restricted to just a portion of their historic

winter range during severe winters (Lavigne 1991). Finally, large populations of deer occupy a proportionately larger amount of wintering habitat than lower populations (Potvin et. al. 1981). As a result, the size of DWAs tends to shrink or expand in proportion to population size.

Forest stand size (acreage), development class (sapling, pole or sawlog), crown closure, and species composition (coniferous vs. deciduous trees) each have a marked impact on the quality of DWAs (Marston 1986). Large, uniform stands of timber are helpful to deer, but are not optimum. If mature (> 35 years old) and close-crowned (> 50% coniferous crown closure), conifer-dominated forest stands provide excellent mobility during snowy winters because the canopy intercepts and compacts snowfall. Hence, snow depths under closed coniferous (also known as softwood) forests may be 1/2 or less than snow depths in deciduous (also referred to as hardwood) forests (Richens and Lavigne 1978). Typically, these stands are deficient in young browse plants within reach of deer. Mature softwoods do, however, provide a substantial quantity of nutritious deer forage (litterfall) from the bits of leaves, twigs and arboreal lichens which are dislodged from the forest canopy by heavy winds, snow, or from the feeding activities of squirrels and porcupines (Hodgman and Boyer 1985). Litterfall may comprise as much as 50% of the winter foods available to deer in Maine (Ditchkoff 1994). On the other hand, large areas of closed-canopy softwood forest enable deer to develop an extensive system of trails. This trail system may be very important in enabling deer to elude predators such as coyotes and wolves (Mattfeld 1974; Messier and Barrette 1985).

At the other extreme, large tracts of young regenerating forest typically provide a substantial amount of browse, but they offer poor shelter from wind and snow. Indeed, during mild winters in which snow remains shallow, deer take full advantage of this food-rich habitat. However, these young, open forests provide no advantage to deer during periods of deep snow. In these stands, deer may expend more energy while traveling to food patches than they derive from that browse (Mattfeld 1974). Because snow depths in open canopy forests hinder deer movements, high energetic costs for deer living in these wintering areas can lead to high losses to malnutrition and predation.

Mature coniferous forests also offer thermal shelter for wintering deer (Moen 1976). Dense evergreen tree crowns pose a substantial barrier to chilling winds, and in a manner similar to a thermal blanket, such forests slow the loss of heat to the atmosphere. Hence, air within coniferous forests is calmer, and these habitats are warmer than air within deciduous forests, fields, or cut-over forests, which lack these barriers to heat loss (Hugie 1973). Thermal shelter slows the rate of heat loss in wintering deer (Moen 1976). The availability of this shelter can be critical to the survival of deer that have been weakened by pronounced under-nutrition during severe winters (Cheatum 1951).

In areas with characteristically severe winters, maintenance of wintering areas with high softwood crown closure, is critical to maintaining viable populations of deer (Marston 1986). The ideal wintering area would be one in which a network of mature softwood stands is interconnected along riparian areas, but well interspersed with smaller open-canopy patches of forest (Weber et. al. 1983). This fine-weave

arrangement of forest types would provide for movement throughout the winter range, as well as an abundance of forage a short distance from sheltered stands (Drolet 1976).

The effects of winter severity can have a substantial impact on annual deer survival (Chilelli 1988). During the past 30 years, annual winter losses have ranged from a negligible 3% to more than 35% of Maine's deer herd (Lavigne 1992). A series of severe winters with attendant high mortality can precipitate long-term population declines (as was the case in 1968-71), if deer losses to hunting and predation remain unchanged in subsequent years. Conversely, high survival resulting from successive mild winters can provide a tremendous boost to local populations. Not only do winters affect survival of deer experiencing that winter, but also the abundance and survival of fawns born that spring. Winter-weakened does produce smaller, weaker fawns, which usually fail to survive their first 48 hours of life (Verme 1977). Summer fawn losses tend to be higher following severe winters (Lavigne 1991a). This in turn, diminishes the number of young deer (recruits) available to replace annual losses.

During most winters, the weakest deer are the ones most prone to mortality. Typically, fawns comprise the most vulnerable segment of the population (Lavigne 1992). Their small body size, relatively high energy demands, subordinate place in the dominance hierarchy, and limited fat reserves place them at risk to malnutrition and predation losses (Verme and Ullrey 1984). Surprisingly, mature bucks are also susceptible to malnutrition in winter, because they nearly deplete all fat reserves during the autumn breeding season (Lavigne 1992). Mature bucks are prone to starvation losses whenever winter snows come early, and remain deep. Younger bucks, and does older than fawn, are the segment of the population which is the least vulnerable to

malnutrition. These individuals carry the highest fat reserves (Lavigne 1992), and are at the middle to the top in dominance when competing for winter forage (Ozoga 1972). Although predators such as coyotes, free-ranging dogs, and bobcats typically succeed at killing weak or debilitated deer, all deer are vulnerable to predation whenever mobility in snow (or on glare ice) is poor. Currently, deer losses to predation in winter greatly outnumber malnutrition losses during most winters in Maine (Lavigne 1992a).

The Concept of Ecological Carrying Capacity

White-tailed deer populations rarely remain stable over time. Stable populations will only occur when mortality is exactly balanced by recruitment of fawns into the herd. Deer populations will increase when fawn recruitment exceeds mortality of older deer. Conversely, herd declines occur when losses to the populations cannot be fully replaced by fawn production.

When favorable conditions for deer herd growth occur, deer populations will not grow indefinitely; nor does the growth rate in the population remain the same over time (McCullough 1979). Growing deer populations are limited by the amount and quality of food resources available in the environment. Habitats with a large amount of high quality deer forage can support higher deer populations than habitats with more a limited forage supply. Although they differ in the ultimate number of deer that can be supported, all deer herds exhibit the same pattern of population growth over time (Fig. 3).

White-tailed deer have evolved under intense predation pressure; their high reproductive potential is an adaptation to offset predation losses (McCullough 1979).

When reproducing at their genetic maximum, deer populations can sustain losses of nearly 50% (of does) per year. Reproductive potential sufficient to offset such high annual mortality, however, can occur only among extremely well-nourished deer. Even when mortality is held low (e.g., by man), deer populations do not increase at high rates indefinitely. Instead, reproductive rate progressively decreases as the herd becomes more abundant (McCullough 1979). Eventually, the herd becomes so large that population growth ceases entirely. Hence, population growth rate in deer is density-dependent, i.e. more deer means poorer reproduction and slower growth. The shape of this growth curve is depicted in Fig. 3. The “S” shape of this growth pattern reflects a progressive slowing in population growth as the herd changes from very scarce to very abundant in relation to carrying capacity.

At low numbers, most deer are well-nourished, and does produce offspring at nearly their genetic maximum (McCullough 1979). Later, herd growth slows, primarily because deer become progressively less well-nourished, and hence less productive, as abundance increases. Generally, the best deer foods are less abundant than lower-quality forages in most habitats. As deer abundance increases, they progressively over-utilize the best forages, and are then forced to consume an increasing amount of lower-quality forages. At relatively high density, deer are capable of eliminating many herbaceous and woody species from entire ecosystems (Waller and Alverson 1997). Hungry deer may cause substantial damage to agricultural crops, and ornamental plantings. They also may alter forest composition by suppressing palatable tree seedlings, while allowing unpalatable species to dominate regenerating forests or ground-level vegetation (deCalesta and Stout 1997).

Ultimately, deer populations which are allowed to grow unchecked, reach a maximum abundance at which they are severely impacting vegetation, and therefore their own nutrition and productivity. Severely malnourished does produce less than 1/3 the number of fawns as well-nourished does (McCullough 1979). At maximum abundance, does are only able to produce enough fawns to replace old-age losses, and other types of natural mortality (e.g., malnutrition and some diseases). At this point, population growth ceases, and the population stabilizes at its ecological carrying capacity (termed “K”; Fig. 3). Other components of the population curve depicted in Fig. 3 will be explained in later sections.

In addition to declining productivity, deer populations exhibit many other changes as the herd grows toward K carrying capacity. Declining diet quality also affects body size. Both skeletal growth and body weight are substantially less than genetic potential among undernourished deer (Banasiak 1964). Individual deer within populations at K may be 25 to 35 lb lighter than individuals in lower density herds (Lavigne 1998). Deer from populations at or near K also store less fat than better-nourished deer. When deer enter winter with low fat reserves, they are far more susceptible to winter mortality (Verme and Ozoga 1982).

Antler size also diminishes as deer become progressively undernourished (Rasmussen 1985). Particularly among young bucks (e.g., yearlings), antler growth is a physiological luxury. At the initiation of antler growth in April, a young buck’s first priority is to replace weight lost over winter, and to grow larger. Undernourished deer produce tiny, stunted antlers, compared to well-fed yearling bucks (Fig. 4). In deer, the diameter of the antler near the skull is a good index to the overall size of the antler. Well-

nourished yearlings may sport 5 or 6 point racks with an antler beam diameter (YABD) of nearly 1 inch (22 to 25 mm) or more (Fig. 4). At K, 1/3 of yearling bucks produce no antlers at all; those that can, produce short spikes averaging less than 1/2 inch (10 to 12 mm). In Maine, we use YABD as an index to the relative abundance of deer in relation to carrying capacity (Lavigne, in prep. (b)).

Additive vs Compensatory Mortality

Deer die from a wide array of causes: some are of natural origin, many others are from interactions with man. The impact of any one mortality factor on deer populations may be very different in various parts of the state. Moreover, mortality in a given population may vary dramatically between years, in response to fluctuations in winter severity or other elements of their environment. Mortality patterns may also change in response to short or long-term changes in carrying capacity, or due to changing deer abundance relative to carrying capacity.

It is useful to classify deer mortality into two broad types of losses: traumatic and chronic. Chronic mortality (often referred to as "natural" mortality) is that mortality which is due to factors which debilitate, rather than directly kill by injury or trauma (McCullough 1979). It includes deaths attributable to malnutrition, parasite burdens, some diseases, and the debilitating effects of old age (e.g., teeth too badly worn to properly chew browse). Some forms of chronic mortality are observed primarily among old deer. However, losses due to malnutrition can affect deer of all ages, including newborn fawns.

All other deer deaths may be termed traumatic mortality. These are losses directly caused by physical trauma, injury or virulent disease (McCullough 1979). Included here would be legal and illegal hunting, wounding loss, predation, drowning, accidental falls, and collisions with motor vehicles. Because they may kill individual deer regardless of physical condition, certain diseases (e.g., bluetongue and hemorrhagic disease) are considered traumatic losses, as well. Abnormally severe winters represent a specialized form of traumatic deer loss (catastrophic mortality; McCullough 1979). When wintering conditions are particularly severe and prolonged, a proportion of the deer population will be lost, regardless of the number or density of deer inhabiting a given deer wintering area. In this case, winter losses are density independent (Potvin et. al. 1977).

When deer populations are held well below I carrying capacity (Fig. 3), most deer are well-nourished, but relatively few individuals attain old age (McCullough 1979). Consequently, the incidence of chronic mortality is rare (left side of Fig. 5), and most deer losses are due to traumatic causes (e.g., the bullet, the bumper, and the fang). In deer populations below I, individual causes of traumatic losses are additive in their effect on total mortality within the population. In other words, increasing the hunting kill in a herd below I will cause total annual mortality to increase. In this instance, harvesting more deer one year will not result in a corresponding decrease in illegal kill or road-kill, for example, during that year. A more detailed explanation of I carrying capacity is presented in the next section.

As deer populations increase above I and approach K carrying capacity (Fig. 3), the mortality situation gets a bit more complicated. As the herd increases, individual

deer become progressively under-nourished. At the same time, a greater proportion of the population manages to survive; many approaching the maximum longevity for the species (McCullough 1979). Consequently, chronic mortality becomes increasingly more important as the herd approaches maximum abundance (right side of Fig. 5). When very near K, a substantial number of deer will die due to the complications of under-nutrition, and/or old age each year. Since these individuals will be lost to the population anyway, it does not matter if these deer are instead killed by predators, hunters, or lost to other traumatic losses. In this instance, culling the old, the weak, and the sick deer from the population does not add to total annual mortality. Rather, one form of mortality increases (e.g., predation or hunting) while the other simultaneously decreases (e.g., winter starvation). Hence, mortality in this situation is termed compensatory.

Harvest Concepts

Deer populations differ greatly in ability to sustain a hunter harvest, depending on the population's relationship to K carrying capacity. At K, deer are at their most numerous and most visible, but populations at K cannot sustain a sizable hunter harvest (McCullough 1979). When deer at K are hunted (or preyed upon, or subjected to road-kill, etc.) at levels beyond that which compensates chronic mortality, population density begins to decrease over time. At lower density, more forage is now available per deer. Hence, doe nutrition improves, fawn production increases, and a net surplus of deer then becomes available for population growth, or for additional harvest (Nielson et. al. 1997).

Fig. 6 depicts a generalized yield (harvest) curve for deer. Initially, the number of new individuals (fawns surviving their first 6 months) entering the population (net recruitment) increases steadily as the herd grows (McCullough 1979). However, recruitment tends to diminish after the herd reaches about 50% of K. From this curve, it is evident that maximum sustained yield (MSY or the maximum number of deer available for hunter harvest) occurs at 50 to 60% of K, well before deer become extremely abundant relative to carrying capacity. The point on the growth curve at which maximum sustained yield occurs is referred to as I carrying capacity (Fig. 3). One should also note that (except at I) we could sustain the same harvest from a highly productive, but low density herd (e.g., at 30% of K), as we could from a much more abundant, less well-nourished herd (e.g., at 70% of K; Nielson et. al. 1997).

Successful management of deer populations held below 50% of K is difficult. Deer losses from a wide array of causes, such as illegal hunting, road-kill, predation, accidents, and legal hunting are additive below I (McCullough 1979; Fig. 5). Increases in illegal kill rate, for example, will result in higher total losses, which may cause the herd to decline. When herds are held below I carrying capacity, the odds of inadvertently over-harvesting deer in any one year are high, which in turn, increases the likelihood the herd will decline.

Deer populations which grow above I, and toward K carrying capacity, become increasingly vulnerable to malnutrition losses, since undernourished deer enter winter with lower fat reserves (Verme and Ullrey 1984). As the herd approaches K, losses related to under-nutrition are to be expected during most winters, particularly among fawns. During most winters, mortality to starvation and predation can be particularly

high, since most deer from populations near K do not possess sufficient energy reserves to sustain prolonged periods of intense cold, poor mobility in snow, and lack of food (Severinghaus 1981). Where severe wintering conditions are the norm, deer populations, which are allowed to grow above 75% of K, will routinely exhibit repeated cycles of population crash and recovery over time.

In deer populations above I carrying capacity, autumn harvest of an appropriate number of deer will reduce subsequent competition among deer in wintering habitat. As a result, fewer malnutrition losses will occur during winters of normal or average severity.

The Concept of Maximum Supportable Population

The general concept of ecological carrying capacity (K), as described earlier, must be modified for deer near the northern limit of their range, as in Maine. Wintering conditions that force deer to congregate at higher densities in specialized habitats for several months will not allow deer full access to forage available on the entire range. In localities where the quantity of wintering habitat is limited, deer populations may never increase to the point of K carrying capacity on the entire matrix of deer habitat. Stated another way, in WMDs where deer must yard each winter, the amount and quality of winter range may set the upper limit to carrying capacity for deer, rather than the amount and quality of summer range alone. Only in areas in which deer are rarely restricted to wintering habitat, can populations increase towards ecological carrying capacity (K), as depicted in Fig. 3. Alternatively, deer populations may grow to K

carrying capacity in situations in which summer range is poor, and the winter range is sufficiently abundant to accommodate the population during normal winters.

Frequency of winters of sufficient severity to restrict deer to wintering habitat varies greatly among WMDs in Maine (Table 1). Generally, winter severity for deer progressively increases northwesterly, from the coast to northwestern Maine. Northernmost WMDs experience harsh wintering conditions nearly every year. Hence, overall carrying capacity in these districts is highly dependent on the amount and quality of wintering habitat. At the other extreme, severe winters are progressively rarer in WMDs 15 to 30; winters that force deer to yard tightly for 4 or 5 months may occur only once or twice per decade. It should be emphasized, however, that deer move to wintering habitat every winter throughout the state. During milder winters, deer utilize DWAs for shorter durations, and they range more frequently into non-wintering habitats to forage. Even on coastal islands in WMD 30, deer move into mature coniferous forests on the south side of islands in response to intense wind chill and/or snow cover.

To accommodate those (nearly universal in Maine) situations in which wintering habitat limits ultimate deer density, a new definition of carrying capacity is necessary. Termed Maximum Supportable Population (MSP), this is “the maximum number of deer that can survive in a WMD, given the current quantity (and quality) of wintering habitat available, and given average or normal winter severity for that WMD”. When deer density increases to the limit of MSP, utilization of woody browse in wintering habitat would become excessive. Depending on the relative amount of wintering habitat, however, browsing levels on summer range may remain low.

At MSP, over-browsing in wintering areas may lead to pronounced deterioration in physical condition among its inhabitants (Banasiak 1964). In addition, deer in over-crowded DWAs may begin to utilize nearby, less favorable habitat (MDIFW unpubl. data). Both situations would tend to increase winter mortality rates due to predation and malnutrition. This in turn would limit further population growth, despite the availability of high quality summer range. Over time, deer populations which have reached MSP would stabilize at this level, i.e. the carrying capacity of the winter range (Potvin and Huot 1983), rather than at K (Fig. 3). Depending on the relative quantity of wintering habitat available, deer populations at MSP may stabilize at densities which are above (MSP 2 in Fig. 3) or below (MSP 1 in Fig. 3) that point on the S-curve which results in maximum sustained harvest (I).

At MSP, buck fawns which survive winter may show evidence of reduced antler growth as yearlings. However, antler size may not diminish to extreme levels of stunting, if summer range is not also being over-browsed.

Competition with Moose and Snowshoe Hares

Deer may at times compete with moose and snowshoe hare for certain forages. Moose tend to select the leaves, buds, and twigs of tree and shrub seedlings and saplings during most of the year. Deer may depend on many of the same species at various times, particularly during winter (Pruss and Pekins 1992). Potential for competition between deer and moose for browse may be greatest in and near riparian areas (along the shores of rivers, streams, lakes and ponds). Most deer wintering areas are located in riparian habitats (Banasiak 1964), while moose tend to spend a great deal

of time feeding in and near these watercourses during summer (Morris, in prep.). High rates of browse removal by moose in summer or autumn could affect the amount of browse subsequently available to deer in winter. However, moose may prolong the amount of time during which saplings remain within reach of deer, because moose can reach higher and they are capable of "riding down" and breaking the tops of brittle saplings. This, in turn, may stimulate re-sprouting of hardwoods.

Snowshoe hare and deer eat similar foods during winter (Bookhout 1965). Although height of browsing obviously differs greatly between hares and deer on bare ground, deep snow can be a great equalizer for light-footed snowshoe hares. Because of dietary overlaps, any consideration of carrying capacity for deer must take relative abundance of moose and hares into account. Because of larger body size, an average moose would consume 3 to 5 times the amount of winter browse as an average deer. Consequently, one moose /mi^2 is equivalent to about 4 deer/mi^2 in browsing impact on trees and shrubs. This potentially exerts a large impact on relative carrying capacity for deer and moose. For example, an area which supports 5 deer and 4 moose /mi^2 may show the equivalent browsing effects of an area with >20 deer /mi^2. A population of 5 deer /mi^2 would have a negligible impact on vegetation. However, habitats sustaining the browsing equivalent of 20 deer /mi^2 may be very obviously undergoing heavy browsing.

Relative browse removal between deer and hares is less well quantified. However, impact of hare browsing on carrying capacity for deer may be significant only when hares are extremely abundant. Snowshoe hare populations tend to be cyclic, changing from extreme scarcity to extreme abundance over a 10 year period. This

cycle seems to be less pronounced near the southern limit of the species range (including Maine).

MANAGEMENT

Regulatory Authority

The Maine Legislature has ultimate regulatory responsibility for deer management. Through its statutory authority, the legislature has established the broad framework within which the Maine Department of Inland Fisheries and Wildlife (MDIFW) regulates deer populations, and their wintering habitats. In current practice, the Legislature delegates much of the operational responsibility for deer population management to MDIFW. Under this authority, MDIFW establishes deer season dates, and allocates Any-Deer permits through rulemaking under the Administrative Procedures Act. In other matters, such as protection and enhancement of deer wintering areas, MDIFW provides technical support to the Department of Conservation's Land Use Regulation Commission (LURC) for unorganized townships, or to the Department of Environmental Protection (DEP) for Maine's organized towns (Fig. 7). In the latter examples, MDIFW plays a supporting role in land-use regulation.

MDIFW today is granted considerable leeway in regulating deer harvests, but that has not always been the case. There is a long history of Legislative involvement in deer harvest regulation, reflecting the long-term importance of deer hunting to Maine people and to the state's economy (Table 2). The Legislature has been regulating deer hunting since 1830, in fact pre-dating the existence of the Department of Inland Fisheries and Wildlife by 20 years. Until recently (1983), most legislative actions involved shortening the length of either-sex deer hunting seasons. Over the years, the Legislature gradually increased the numbers and types of hunting restrictions by

imposing bag limits (first in 1873), creating hunting zones with differing season length (first in 1893), or establishing hunting license requirements (first in 1906 for nonresidents). Over this 168 year history, the Legislature enacted laws which helped define our changing concepts of fair chase in the recreational (vs. commercial) hunting of white-tailed deer. These included reductions and bans on the sale of venison, use of venison to provision logging camps, and outlawing pursuit at night or with dogs. Other laws were enacted to promote safety. These include bans on twilight hunting and "driving" of deer, as well as the requirement to wear blaze orange clothing during the firearms deer seasons (Table 2).

For a long time, the Legislature authorized only a general deer hunting season. In 1951, that changed when the first special archery season was established. Thirty years later (1981), black powder enthusiasts were granted their own deer season. In 1993, MDIFW was granted authority to conduct controlled hunts for deer, targeting populations of deer which were not being adequately controlled by recreational hunting seasons. Lastly, in 1997 (and 1998) the Legislature established an Expanded Archery Season (held in September) also to be used in areas where the Department has difficulty in controlling deer using firearms seasons. Currently, we offer 84 days of hunting opportunity (Fig. 8) for white-tailed deer.

Prior to 1973, the Legislature established deer season dates by statute two years in advance. Since 1973, the Legislature has delegated most of that regulatory authority to the Department (Table 2). The first step (1973) was to establish broad frameworks for maximum season length, with the provision that the Commissioner will shorten these seasons as necessary to protect the resource. Much later, the Legislature granted

authority to regulate the harvest of antlerless deer. This was accomplished provisionally in 1983-85 by authorizing MDIFW to establish hunting zones which differed in the number of either-sex hunting days allowed during the firearms deer season (Fig. 2). Beginning in 1986, MDIFW was granted long-term authority to establish Deer Management Districts (now Wildlife Management Districts; Fig. 1), and to regulate the harvest of does and fawns by issuing a variable quota of Any-Deer permits during the firearms and muzzleloader seasons. All of these season-setting activities are now promulgated annually by rule-making within the Department. All rule-making must conform to the Administrative Procedures Act. Under this act, the Commissioner and his Advisory Council vote on proposed rule changes (e.g. Any-Deer permit allocations) following public comment on proposals.

Habitat Management

We have long recognized the importance of deer wintering habitat to their survival in Maine (Gill 1957). Accordingly, the Department has considered the protection and enhancement of deer wintering areas (DWAs) to be an important role for our agency. In the 1950's and 60's, this role took the form of DWA identification and inventory, primarily in the northern 2/3 of the state. During this period, the Department (through the Wildlife Division) entered into cooperative agreements with a number of industrial timberland owners. These agreements were not legally binding, but nevertheless, were an effort to accommodate deer wintering area protection and enhancement into corporate timber harvest planning.

The ultimate fate of these early cooperative agreements is unclear, except to note that this method of protecting DWAs was supplanted within Maine's unorganized townships (Fig. 7) by more formal land-use zoning, when the LURC was established in 1973. When land-use zoning is practiced, Wildlife Division biologists first document and inventory deer wintering habitat in a given township. Qualifying habitats would then be proposed for designation as a Protected Fish & Wildlife (PFW) Zone. When all legally mandated procedures and landowner notifications were completed, the LURC could approve proposed PFWs or not, based on their merit. Once approved, landowners must comply with LURC-established standards for timber harvest, road or cottage development, and other uses in PFWs. Since 1973, a total of 190,000 acres comprising >200 deer wintering areas in Maine's unorganized townships has been placed in PFWs by LURC. This represents approximately 1.9% of the landbase in the unorganized townships, primarily in northern Maine, the western mountains, and the interior of Downeast Maine.

Until 1989, there were no statutes specifically enabling MDIFW to safeguard deer wintering habitat in Maine's organized towns (Table 2). In that year, the Maine Legislature passed the Natural Resource Protection Act (NRPA). Regarding deer, the NRPA mandated MDIFW to identify all existing high and moderate quality deer wintering areas. Our agency was also charged with defining a rating system for defining relative quality of DWAs, and then we were to propose a system whereby the Maine Department of Environmental Protection (MDEP) would regulate land-use practices in these protection areas. To date, we are in the process of identifying and rating deer wintering habitats in the organized towns of Maine (Fig. 7), where NRPA is targeted. As

to the regulation system, MDIFW is still debating whether this would be better accomplished using cooperative agreements, provision of financial incentives for local management by landowners, by land-use zoning (as with LURC), or a combination of these approaches.

During the past 4 or 5 years, MDIFW has renewed the cooperative agreement approach to safeguarding deer wintering habitat. Several industrial timberland owners are working with MDIFW to develop long-term management plans for timber cutting in currently occupied (and sometimes in historic) deer wintering habitat. In this context, historic DWAs are deer wintering areas which were used by deer during the 1960's or earlier, but which are no longer occupied by deer because of conflicting timber management practices, and/or the spruce budworm epidemic. These cooperative agreements involve relatively large acreages, which affords flexibility and predictability to timber planners, while providing for the enhancement of not only core DWAs, but also peripheral areas which deer rely upon for foraging. Most of those agreements are being developed in Maine's unorganized townships, and they will supplant land-use zoning under LURC, within the designated acreage. These areas, however, could revert back to zoning as PFWs under LURC, if either party dissolves the agreement. To date, MDIFW has negotiated long-term agreements protecting 68,000 acres of deer wintering habitat involving several major DWAs, primarily in northern Maine (MDIFW, unpubl. data). Progress toward negotiating other long-term DWA agreements is hampered by large-scale land sales in the industrial timberland of Maine during recent months.

Deer Population Management

Since 1975, deer population management has been guided by the Department's strategic planning process (Banasiak and Hugie 1975). A major output of this planning effort is the definition of clear goals and objectives for deer harvests, hunter success, and deer population. Included in these objectives are time guidelines for their achievement (Table 3). We regulate the doe and fawn harvest during the regular firearms and muzzleloader seasons to accomplish deer population goals and objectives (Fig. 2). We recognize the recreational value of deer hunting to many thousands of Maine people and visitors alike. Nevertheless, we also realize that regulation of legal hunting is our most reliable management tool for regulating deer populations.

Maine is a diverse state, encompassing a wide range in winter climate, land-use, topography, vegetation, and human settlement. Because of this, carrying capacity varies widely for deer. Moreover, there are regional differences in landowner tolerance for the negative impacts of deer. We believe that management of deer for the people of Maine is enhanced by dividing the state into management districts which reflect management capability (Fig. 1). As noted earlier, we have been regulating deer populations using one zoning system or another since 1893 (Table 2). The adoption of the 30 Wildlife Management District classification is the most recent refinement of this practice. As we had done with the 18 former Deer Management Districts (1986 to 1997) and the 8 Wildlife Management Units which preceded them (1975 to 1985), we will be establishing specific deer population, and wintering habitat goals and objectives for each of our 30 WMDs, as one product of this update of the Deer Strategic Plan.

Once these goals and objectives are established, MDIFW will regulate doe and fawn harvests to accomplish those objectives. During the initial years of strategic planning for deer (1975 to 1982), we were unable to regulate doe harvest sufficiently, when limited to shortening either-sex firearms seasons (Fig. 2). During 1980-82, we found that reducing the either-sex season from 3 to 2 weeks in the western mountains of Maine failed to achieve a desired reduction in doe harvest. Compression of the season also compressed hunting effort and exacerbated landowner conflicts. Later (1983-85), we demonstrated that combinations of bucks-only hunting and limited either-sex days can effectively reduce doe harvests, but this management practice failed to produce consistent results. On the negative side, the patchwork of bucks-only and varying either-sex days applied to four hunting zones in Maine caused many hunters to move to zones which offered more opportunity to kill antlerless deer. Variation in hunting effort caused by large-scale hunter movements contributed to unpredictable doe harvests, while exacerbating conflicts with land-owners and other hunters.

Our 3-year experiment with either-sex days as a means of regulating doe harvests led to two major advancements. In 1984, we established a uniform 4-week firearms deer hunting season throughout Maine. This season removed much of the incentive for hunters to “chase” open seasons for does from one end of the state to another. One advantage for southern Maine deer hunters: they gained 6 hunting days, since deer seasons in the south of Maine were formerly limited to only 3 weeks.

The other advancement was the development of the Any-Deer permit system. This harvest method enables all firearms hunters to pursue antlered bucks during any part of a long and stable hunting season. Within this framework, hunters who desire to

kill a doe or fawn must possess an Any-Deer permit, which is specific to one Wildlife Management District (WMD). This method permits great flexibility in regulating hunting pressure on does within individual WMDs. Permit issuance within any WMD may range from very conservative (bucks-only or no Any Deer permits) to very liberal (Any Deer permit issued to every hunter who applies). In this way, doe harvests can be reliably regulated to achieve population objectives within a given WMD. This method also has the advantage of allowing hunters long hunting seasons, while minimizing hunter shifts to adjacent WMDs. Since the firearm season on deer is 25 days, even the most ardent deer hunter has plenty of time to pursue deer at his/her own pace.

Since its inception in 1986, the Any-Deer permit system has proven to be a reliable method of regulating the doe harvest. During most years, doe harvests we've achieved under this system have consistently been within 5 to 10% of desired doe harvests (quotas). After gaining some experience in setting doe harvest quotas and issuing the requisite number of permits under the Any-Deer permit system, we have made substantial progress toward attainment of deer population goals and objectives.

We do not currently regulate the harvest of does and fawns during either archery season in Maine. The firearms and muzzleloading seasons attract 90% of hunting effort and account for 95% of antlerless deer harvests. Although the antlerless deer component of Maine's statewide archery season does reduce the potential allocation of Any-Deer permits to firearms hunters, bow-hunts currently do not affect these allocations to any significant degree.

Goals and Objectives

Since 1975, all updates of the Strategic Plan for Deer have had a common goal: to increase deer populations throughout Maine. In the 1975 and 1980 (Banasiak 1980) updates, however, we did not specify population objectives by which we could gauge successful attainment of population goals. Moreover, these earlier plans focused solely on specific harvest objectives which, if attained, would provide a certain level of hunting opportunity and success (Table 3). Such reliance on a fixed harvest ignored the possibility that achievement of harvest objectives (e.g., 34,000 deer/year) could contribute to population declines following severe winters. At the other extreme, removing a fixed yield of deer from a growing herd could lead to under-harvest, thereby squandering hunting opportunity.

Beginning in 1985, we shifted our focus toward attaining plan objectives in a hierarchical sequence (Table 3). Attainment of clearly stated population objectives became the first priority (Lavigne 1986). Desired deer population levels were phrased in the context of the relationship of the herd to its maximum supportable population (MSP). For the 1985, 1990, and 1996 updates of the deer plan, we sought to attain, and then to maintain the deer population at 50 to 60% of MSP in all WMDs. If this were achieved in all WMDs simultaneously, the statewide wintering population would approximate 270,000 to 330,000 deer, or 9 to 11 deer per mi^2 of habitat (Table 3).

Over the past 15 years, we have achieved a statewide wintering population (Fig. 9) of 255,000 deer (8/mi^2), which represents 46% of the maximum supportable population. At the end of the either-sex hunting era (Fig. 2), the wintering deer population numbered 160,000 (5.5 deer/mi^2). Greatest rate of growth in the statewide

herd occurred during 1983-85 (when southern WMDs were restricted to bucks-only hunting regulations), followed by 1994-97 (when the number of Any-Deer permits in some central and southern WMDs was sharply limited to accelerate population growth).

Current (1996 & 1997) deer population in relation to the population objective is presented by WMD in Table 4. We have attained the desired relationship to maximum supportable population (Fig. 10; 50-60% of MSP) in one-third of our WMDs (Fig. 1). Nearly all of these are located in the Western Mountains, the Moosehead Lake plateau, and their southerly foothills. An additional 10 WMDs are very close to target (45% to 47% of MSP); most of these occur in central and southern Maine.

Attainment of harvest objectives has been secondary to attainment of desired deer population size since 1985. As before, we are committed to providing as much deer hunting opportunity as can be allowed, while also achieving population objectives. However, we now recognize that optimum deer harvests can only be sustained after desired deer populations are achieved in each WMD. Since each 5-year update of the strategic plan called for increasing the state's deer population, using the legal harvest to achieve herd increases required a 15-year period of rather conservative deer harvests (Table 5).

During 1976-82 (either-sex years), deer harvests averaged (at 30,782 deer) near the lower acceptable range for harvest objectives (30,000 to 38,000) set for that period (Fig. 11). During that time, the deer population was declining, and hunting effort was increasing (as will be discussed later). At times, these harvests contributed to declining regional populations. During individual years, the statewide deer harvest deviated from the mean harvest objective (34,000 deer) by a range of -20% in 1979 to +11% in 1980

(Table 5). While we didn't know it then, harvest objectives established during 1976-82 generally exceeded the harvest which would stabilize the herd. Hence, harvests during the final years of either-sex hunting contributed to population declines.

During the years when we regulated doe harvest using bucks-only and limited either-sex days (1983-85; Fig. 2), deer harvests, statewide, averaged 21,527, or -29% to -43% below the mean harvest objective (Table 5). Harvests of this magnitude enabled the statewide deer population to increase.

Attainment of deer population objectives in all WMDs, could currently enable us to harvest 35,000 to 42,000 deer annually, given normal winter severity in any given year and WMD (Table 5). Since 1986, when the Any-Deer permit system was implemented, harvests were limited , at times to as little as one-half the harvest objective in order to facilitate herd growth. During the past 12 years, however, the disparity between actual vs. objective harvest has been steadily decreasing (Table 5).

Since 1919 (when mandatory deer registration began), peak deer harvest occurred during the late 1940's through the 1950's (Fig. 11), under either-sex deer hunting regulations. Attainment of our present objectives for deer abundance would enable us to return to harvests of similar magnitude (35,000 to 42,000 deer; Table 5), using the Any-Deer permit system. However, the relative contribution of antlered bucks vs. antlerless deer to total harvest would differ markedly today compared to the 1950's. During the 1950's, does and fawns contributed the most to total harvests (Fig. 12). Even during the 1970's, when buck harvests were declining (as were deer populations over-all), harvests of does and fawns remained rather consistent under either-sex hunting regulations (Fig. 12). Since 1983, antlerless deer harvests have been held to ½

or less of levels achieved during the either-sex hunting era. This reduction in antlerless deer harvest was essential for increasing Maine's deer population. As will be seen in the Population Assessment, the deer population increased between 1983 and 1997 in many WMDs.

One very desirable consequence of that achievement is that the harvest of antlered bucks also dramatically increased (Fig. 12). Record buck harvests were achieved in Maine during 1996 and 1997, exceeding those even of the "good old days" in the 1950's. Buck harvests today average 40% higher than those of the final 5 years of either-sex deer hunting (1978-82).

The final objective common to all updates of the Deer Strategic Plan is hunter success (Table 3). Hunting success objectives specified in each update of the Strategic Plan for Deer were set at 15% to 17%. Success rate is dependent on both the harvest achieved, and the number of hunters vying for the resource. Increasing deer populations can lead to increasing harvest, which in turn will lead to increased hunter success. However, declining participation in deer hunting can also lead to increasing success rate, if harvest remains stable or increases. Attainment of hunting success objectives specified in Table 3 must be interpreted in light of harvest size, and trends in hunter participation. The latter will be discussed in detail in the Use and Demand section.

Prior to 1985, we assumed that a deer hunter population of 200,000 was our "customer base". That assumption proved correct for the most part, although as many as 214,000 deer hunters participated in Maine's deer hunts during the early 1980's. For

1986-97, we projected that hunters would increase to a maximum of 220,000. That assumption proved wrong; deer hunters have actually declined since 1982.

Between 1976 and 1982, we achieved an average hunting success rate nearly identical to the objective for hunting success (15%). During most years since 1983, restrictive harvests resulted in success rates which were well below our objectives (Table 3). In 1997, hunter success slightly exceeded our current objective of 17%. However, that objective was met, in part, because the number of hunters competing for the allowable harvest of deer has been declining.

Statewide averages for hunter success rate mask the great variability in hunting success observed regionally, in Maine (Fig. 13). Hunting success was affected by regional differences in hunting weather, deer abundance, hunter density, and the number of Any-Deer permits we issued. The availability of tracking snow greatly increases local hunter effort and harvest. Driving rain or extremely dry woods exert the opposite effect. The number of deer encountered per outing likely increases with deer density, hence areas with abundant deer will generally yield higher success rate. On the other hand, deer in heavily hunted areas may be more wary than deer in more remote, less heavily hunted terrain. Hunters who are restricted to bucks-only regulations are typically less successful (8 to 12% success rate) than deer hunters who possess an Any-Deer permit (about 35% success rate). Hence, WMDs with liberal allocations of Any-Deer permits, typically support higher hunter success rate. Success rate among bow hunters usually varies between 5% and 10% in Maine, while that among black powder enthusiasts ranges from 3% to 6%.

Patterns of deer hunting success rate during 1997 among Maine's 30 WMDs are depicted in Fig. 13. Success rate ranged from a low of 3%, over-all, in WMD 3, to a maximum of 36% in WMD 24. Deer hunting success was above the statewide average of 17.5% in WMDs 7,15, 16, 17, 29, 21, 22, 23, 24, 25, and 30. Most of these are located in the central and southern part of the state (Fig. 1).

Projections

Estimates of deer population size, potential harvest, and hunter success which reflect current goals and objectives of the Deer Strategic Plan to be achieved by 2012 are presented by WMD in Table 6. Estimates of the amount of wintering habitat which is necessary to achieve and maintain objective populations are presented in Table 7. [Note: this section will be drafted when final objectives are known. Interim drafts will be presented, as needed, as the working group deliberates.]

HABITAT ASSESSMENT

Historical Perspectives

Habitat quality and winter climate interact to determine the distribution of white-tailed deer in Maine. Deer are not well adapted to foraging or eluding predators in deep snow, non-supporting crusts, and glare ice. As noted earlier, Maine is near the northernmost limit of deer distribution in the East. Long-term patterns of snow accumulation in winter largely determine whether deer populations can persist over time in this state. Consequently, there are winters during which the duration and depth of snow cover exceeds the physiological ability of deer to survive (Potvin and Huot 1983). At lesser extremes of winter severity, the availability of high quality wintering habitat provides a critical advantage for survival. Both climate and vegetative cover are continually changing in Maine. Some changes are clearly man-induced; others are completely beyond our control. Fourteen thousand years ago, glaciers covered all of Maine. At that time, and for thousands of years thereafter, habitat in Maine was completely unsuitable for white-tails (Banasiak, 1991). During the intervening centuries, climate in Maine alternately warmed and cooled over broad time intervals. Based on pollen deposition in Maine lakes, there were times when oak/hickory forests, similar to those in present-day Ohio and Tennessee, dominated forest cover in Maine. These forests are adapted to far warmer conditions than those presently typical of Maine. During these "warm spells", white-tailed deer were undoubtedly the dominant large herbivore throughout Maine (Banasiak 1991).

There were also periods when Maine's climate cooled markedly, compared to current climatic conditions. The period from AD 1200 to 1880 was known as the Little Ice Age. This 650-year "cold spell" was characterized by long, snowy winters (Gribbin and Lamb 1978). During this period cold-tolerant (boreal) forest cover increased in Maine. This combination of intense cold, deep snow cover, and boreal forest created a hostile environment for deer (Banasiak 1991).

At the time Maine was first colonized in the 1600's, white-tailed deer were restricted to the southern coastal plain, and along the lower reaches of the major river valleys (Stanton 1963). White-tails were absent east of Bar Harbor, and from all of interior and northern Maine. Moose and woodland caribou were the dominant large herbivores in much of the state during this period. The fact that early colonists routinely hunted moose in what is now Scarborough, Maine on 4 to 5 feet of snow in February, provides a clue as to how much more severe winter climate was for deer only a few hundred years ago.

Since the late 1800's, Maine's climate has been gradually warming (Banasiak 1991). This fact, along with the extirpation of the gray wolf (by the late 1800s), and large-scale changes in the forest due to logging, fire, agriculture, and development have enabled white-tailed deer to gradually expand to all parts of the state (Stanton 1963). Since colonial times, the local abundance of deer has been dependent on local variations in winter severity, availability of wintering habitat, quality of summer range, and mortality. Major factors influencing deer habitat are discussed below.

Logging activity has been on-going in parts of Maine for nearly 4 centuries (Stanton 1963). Aside from land clearing for agriculture, most logging prior to the mid

1800's was selective for large white pine. Later, logging practices intensified somewhat, as markets for spruce-fir saw timber developed. By the early 1900's, logging to support the emerging pulp and paper industry resulted in much greater utilization of forest resources, particularly for softwood (coniferous) species (Banasiak 1964). In the 1970's and 1980's, markets emerged for low-grade hardwood (deciduous) and softwood species, as wood-based electrical power generation and residential heating with wood gained in popularity (at least briefly).

For the past 30 years, timber removals have been a major influence on deer habitat in all parts of Maine (Griffith and Alerich 1996; Chilelli 1998). Depending on the scale and location of timber removals, habitat quality for deer could be either enhanced or reduced. High demand for softwoods for lumber and paper can place deer wintering habitat in jeopardy, if the coniferous canopy is thinned to the point where the forest no longer provides protection from wind chill and deep snow. Also, large-scale timber cutting operations may create a boom-or-bust cycle for deer forage, particularly when intensive timber removals create even-age stands over areas which exceed the home range of individual deer. Forests such as these may provide huge quantities of forage for deer (and moose) during initial re-growth, but they eventually become far less supportive after the forest grows out of reach, and the canopy closes overhead.

Wildfire has long been a factor influencing forest dynamics in Maine (Lorimer 1977). However, frequency of forest fires was probably greatest during earlier logging eras (Stanton, 1963). Individual fires exceeding 800,000 acres have occasionally occurred in the past 50 to 150 years (Banasiak 1964). During more recent times, fire suppression has been a priority in Maine. Since 1950, both the frequency and extent of

forest alteration due to wildfire has been reduced to only 1,000 to 5,000 acres annually (Gadzik et. al. 1998).

Tree mortality caused by defoliating insects periodically influences forest dynamics over large areas. Between 1975 and 1988, an irruption of the spruce budworm moth defoliated, weakened, and in places, killed entire stands of balsam fir and spruce. By the end of the infestation cycle, more than 8 million acres of spruce-fir forest had been affected to some degree (Irland et. al. 1988). Forests which experienced individual tree mortality decreased in average crown closure. Where balsam fir predominated, over-story crown closure was often reduced to the point where the entire stand regenerated. Insect-induced mortality to commercially important species such as balsam fir and spruce motivated many industrial land owners to salvage timber stands, where feasible. This led to accelerated timber harvesting beyond normal cutting schedules on many land ownerships during the mid 1970's and 1980's (Gadzik et. al. 1998).

Many deer wintering areas were subjected to reduced crown closure from balsam fir and spruce mortality, and related salvage cutting of timber. This certainly increased forage growth in the understory. However, energetic costs and predation may have increased among wintering deer when overstory canopy closure declined, and snow depths increased in budworm-damaged DWAs (Lavigne 1992a).

The spruce-budworm epidemic appears to be cyclic (Irland 1988). Prior to the 1975 outbreak, the last large-scale outbreak in Maine occurred in the early 1900’s. That outbreak also affected millions of acres of forest. Tree mortality from this earlier event likely set the stage for the 1970’s outbreak by creating a nearly even-aged spruce-fir

forest, after recovery from deforestation (Gadzik et. al. 1998). Large areas of even-age spruce and balsam fir, when mature, may be more susceptible to spruce-budworm infestation than smaller stands comprised of a diversity of age classes (Irland 1988).

Other insects, such as the gypsy moth, have defoliated varying amounts of hardwood forests in the southern part of Maine during recent times. These species can affect mast crops, but they usually do not affect canopy closure over the long-term. Since only hardwood species are affected, the impact of gypsy moth and brown caterpillar would be primarily limited to the summer range of deer.

Occasionally, extreme weather events can alter deer habitat over large areas (Stanton 1963). Hurricanes, such as the ones which struck Maine in 1938 and 1964, may damage forests over thousands of acres. Tornadoes also may demolish forest stands, but their frequency and relative impact area are typically small. The remarkable ice storms of January 1998 changed forest structure on over 2 million acres (predominantly in young hardwood forests) in central and coastal parts of Maine (Maine Forest Service 1998). During that event, freezing rain accumulated to a thickness of several inches on trees, causing widespread loss of branches and entire tops of susceptible trees. Soon after the storm, deer were provided with huge quantities of litterfall, greatly increasing available forage. In addition, many hardwood stands were opened to sunlight, which should increase understory vegetative growth.

Farmland, if interspersed with woodland, can greatly increase habitat quality for deer in Maine (Banasiak 1964). Regionally, some areas never have been farmed. These include large portions of WMDs 1, 2, 4, 5, 7, 8, 9, 10 and 19 (Fig. 1). Elsewhere, land clearing for agriculture has been an important factor influencing deer habitat since

colonial times. Records of the amount of land converted to farms are lacking prior to 1820. During the late 1800's, farmland was a far more dominant land-use than it is currently (Table 8). Between 1880 and 1910, as much as 1/3 of Maine was farmed. Many of our central and southern WMDs were, at one time, intensively cleared for agriculture. For example, >85% of Androscoggin Co. (portions of WMDs 15, 16, and 22) was farmed in the late 1800's (MDIFW unpubl. data). The peak of land clearing for agriculture in southern Maine (1880 to 1910) coincided with a time of very low deer populations in that part of the state. During the latter part of that period, deer hunting was closed in 10 of Maine's southernmost counties (Table 2). One may speculate that loss of wintering habitat coinciding with intensive land clearing for farms, may have contributed to low deer populations. It is also highly likely that hunting regulations at the time were inadequate to balance herd losses with fawn production.

Throughout the 1900's, both acreage and number of farms have declined in Maine. Much of this land has reverted to forest, although some has been developed. However, rate of loss of farms has stabilized since the 1970's (Table 8). Currently, 6% of Maine is used as farmland. This includes those portions of farm ownership in wood lots, as well as cleared land, and is based upon the USDA agricultural census of Maine (USDA 1997).

Most Maine cities and towns have been in existence for a long period of time; many pre-date statehood (1820). Maine may still be regarded as largely rural, compared to states to our immediate south. Nevertheless, parts of Maine have been undergoing certain types of development which affect deer habitat and population management. Beginning in the 1970's, development for dispersed housing intensified

in many parts of coastal and southern Maine. Southern Maine is not far from Boston and other large employment sources in eastern Massachusetts, making this part of Maine attractive for residential development. In addition, our state, particularly in coastal areas, has proven to be an attractive location for seasonal residences and tourism.

Many types of development are compatible with the adaptable white-tailed deer, as long as the developed site is not entirely paved over. One example would be a 500 acre old farm-woodland complex that is developed into a number of dispersed residences, interspersed with “green space” (field or forest). This scenario is akin to deer heaven: food (compliments of fertilized lawns and shrubbery), water, security cover (green space), and protection (firearm safety zones, posted land, etc) all occur in an area roughly the size of a deer's home range.

Current Habitat

Climate and topography largely determine the types of vegetation which can persist on the landscape (Boone 1997). Maine is currently a transition zone between two major forest types: Acadian and Eastern Deciduous (Mattfeld 1984). The Acadian forest is dominated by coniferous species, most notably balsam fir, spruce, and northern white cedar. The Eastern Deciduous forest is dominated by deciduous species such as sugar maple, yellow birch, and American beech, although white pine and eastern hemlock are important coniferous species in this broad forest type. The Acadian forest is adapted to a cool, moist climate, while the Eastern Deciduous forest occurs where more moderate climate prevails (Irland 1997).

The current distribution of Acadian vs. Eastern Deciduous forests in Maine is depicted in Fig. 14. The spruce-fir dominated Acadian forest predominates in northern, western, eastern, and along mid-coastal WMDs. The Eastern Deciduous forest, expressed as White Pine / Hardwood or Northern Hardwood forests, predominate in central and southern WMDs.

Of course, broad forest classifications such as these do not occur uniformly across the landscape. Local variations in soil drainage, microclimate, topography, land-use, prior timber harvest, and natural disturbances each may affect forest species composition and structure. For example, timber harvest or fire may open a closed-canopy forest, allowing sunlight to reach the forest floor. This may encourage shade-intolerant species such as aspen, birch, or red maple to become established for a time. These species are short-lived, however, and they will be replaced by shade-tolerant species such as sugar maple, yellow birch, spruce, or hemlock, which become established under the shade of short-lived tree species.

More detailed data describing current forests and other components of deer habitat in Maine were derived from the 1995 Forest Survey of Maine (Griffin and Alerich 1996; Chilelli 1998).

In this survey, areas of major forest types, and other land cover types were extrapolated from sampling in the field. Hence, all estimates are associated with a certain amount of error. Typically, error rates may increase when estimating habitat components which are uncommon, and when extrapolating to small areas, such as our 30 Wildlife Management Districts (Fig. 1). Despite some unavoidable inaccuracy, the

1995 Forest Survey of Maine provides considerable insight into current habitat conditions for deer in various locations in Maine.

Overall, Maine is 90% forested (Table 9); forested area ranges from a low of 60% in WMD 24, to 99% in WMDs 4, 5 and 8. Typically, Maine's unorganized towns (Fig. 6) tend to be the most heavily forested WMDs. Forests within organized towns tend to be more optimally interspersed with non-forested habitats, such as wetlands, idle and active agriculture, and developments.

Among softwood forest types, spruce-fir/cedar attains maximum percent of forested area in northern and eastern WMDs (Table 10). White pine/hemlock types, however, predominate among softwood types in southwestern WMDs. Tolerant hardwoods (sugar maple, beech, yellow birch) are well distributed throughout the state. These types tend to predominate in a few northern and several western Maine WMDs (Table 10). Intolerant hardwoods (aspen, birch, red maple, elm) average 15% of statewide forest types, but these types attain coverage of 20 to 25% of the forested area of several WMDs in the spruce-fir regions of northern, central, and eastern Maine (Table 10). Intolerant hardwoods such as red maple or aspen-birch often become temporarily dominant in spruce-fir forests after the softwood forest is cut, or killed by spruce-budworm. These sites generally revert back to spruce-fir forest within 60 to 70 years.

Maine forests are now dominated by poletimber (49%), with the remaining area nearly equally divided between seedling-sapling (27%) and sawtimer-large growth (24%; Table 11). Seedling-sapling stands average <5" diameter at breast height (DBH); saw timber averages $\geq$ 11" DBH; poletimber is intermediate. Although statewide estimates of the amount of forest by stand development class differ little for softwood

vs. hardwood forests, there are some important regional differences. Softwood forests in northern, western and eastern Maine WMDs tend to have a greater area currently in seedling-sapling regrowth than central and southern Maine softwood forests (Table 11). Conversely, WMDs with large areas in young forest also have correspondingly less softwood forest currently in sawtimber-large growth acreage. WMD 3 leads the pack in this regard, with 52% of its softwood forest area in seedling-sapling vs. 10% in sawtimber-large growth (Table 11). However, most other WMDs in the spruce-fir forest region of Maine (Figure 14) have >33% of their softwood forests in young growth.

Considering hardwood forests, most WMDs contain more area in sawtimber-large growth than is the case among softwood forests (Table 11). Several WMDs in the northern, western, and eastern timberlands, however, have 25 to nearly 50% of their hardwood forested area in seedling-sapling stages of forest development.

Since the early 1970's, spruce-fir forests have declined in overall area within Maine; most declines have come from the northern, western, and eastern WMDs. Many forest stands which had earlier been dominated by spruce-fir forest have regenerated (temporarily) into intolerant hardwood forests, following timber harvest and/or alteration by spruce-budworm. In addition to the loss in area of spruce-fir forest during the past 30 years, the net volume of spruce-fir timber, particularly sawtimber, has declined markedly. Models of future growth of Maine forests predict a shortage in spruce-fir timber, which would be at its worst around 2015 (Chilelli 1998). Current and projected shortages in these commercially valuable species will place increasing demands on those softwood forests, which now provide wintering habitat for deer. High demand for spruce-fir, hemlock and white pine has already exerted a major negative influence on

the amount of wintering habitat available for deer during the past 30 years. This topic will be explored in detail in a later section of the Habitat Assessment.

Many landowners practice chemical or mechanical thinning to accelerate re-growth of spruce-fir forests following timber harvest. Some landowners establish plantations, usually of coniferous species, often converting sites from predominantly hardwood to predominantly softwood forests. Each of these silvicultural practices are designed to increase the future availability of softwood fiber for the pulp and paper industry. Herbicide treatment, pre-commercial thinning, and plantation establishment has been practiced on 40,000 to 80,000 acres annually during the past decade (Maine Forest Service 1998a). These practices may reduce hardwood browse availability immediately after treatment. However, because hardwoods and herbaceous plants may become re-established in treated sites, browse may remain available within reach of deer over a prolonged period of time. Where practiced in deer wintering areas, herbicide and mechanical thinning may reduce the time required for a softwood stand to again provide winter shelter. Because they are essentially monocultures of one coniferous species, plantations are not likely to be as valuable as future wintering habitat for deer.

Wetlands of all types are habitats which are important to deer for food, security cover and water. In addition, many deer wintering areas at least partially encompass forested wetlands (Applegate and Lavigne 1995). Estimates of the amount of wetlands in Maine, based on the Forest Survey of Maine are probably unreliable (Table 9). Too few sample plots were placed in wetlands to reliably estimate the true acreage of this habitat type.

Active farmland also is likely under-estimated from Forest Survey data. Statewide estimates of agricultural land from the 1995 Forest Survey (3%) differ considerably from the 1997 Census of Agriculture estimate (6% of Maine's land area; USDA 1997). Unfortunately, the latter data source does not enable direct comparison of farmland acreage by WMD. However, Forest Survey estimates presented in Table 9 do reflect relative importance of agriculture among individual WMDs. Some of the highest percent of land area devoted to agriculture occurs in the northern farmland within WMDs 3 and 6 (each with 11% farmland). Value of this northern farmland for deer is diminished because it tends to be poorly interspersed with woodland, and it occurs where winters are the most severe in the state (Table 1). Northern Maine farmland is generally snow-covered from mid-November to late April or early May, annually. Hence, this habitat type is unavailable to deer during a large portion of the year.

Some other, more southerly WMDs have nearly as much land devoted to agriculture as WMDs 3 and 6 (Table 9). These WMDs, (e.g., districts 15, 16, 17, 20, 21, 22, 23, and 25), are comprised of 4 to 10% active farmland. Moreover, these farms tend to be smaller and more adequately interspersed with woodlands than are northern farms. Winters in these central and southern Maine WMDs are milder and of shorter duration (Table 1), thereby enabling deer to access agricultural forages over a longer period of the year. Within eastern WMDs, (districts 19, 26, 27, 28, and 29) between 2 and 5% of the WMD is devoted to active agriculture (Table 9). Much of this involves the cultivation of wild blueberries. From a habitat quality perspective, these agricultural lands are not as productive of quality forages for deer. Most commercial blueberry

growers actively manage their lands to reduce competition of grasses, shrubs and forbs to favor blueberries.

Maine differs greatly in the amount of land which is developed. Developments include cities, towns, residential suburbs, dispersed housing, cottage development, suburban malls and strip development, tourist attractions, gravel extractions, other mining, and roads. Since the 1970's, Maine has undergone increasing development pressures; much of this centered in southern and coastal sections. Since 1990, rates of land-use conversion to development have probably slowed somewhat, compared to the pace development had attained in the 1980's.

Current estimates from the Forest Survey of Maine suggest that only 4% of Maine is developed. As noted before, this is probably an under-estimate, but these figures do enable valid comparison among WMDs (Table 9). Developed land is most prevalent in south-coastal WMDs. The 5 most heavily-developed WMDs are districts 24 (26% developed), 21 (23% developed), 16 (13% developed), and districts 23 and 25 (each at 12%). Development area in our southernmost WMD 20 is probably significantly under-estimated (7% of land area) by the Forest Survey of Maine.

For this assessment, deer habitat is calculated as the sum of all land cover types except development. As noted before, deer can and will thrive in certain types of developed land. Hence, estimates of the amount of deer habitat which exclude developments will under-estimate actual occupied deer habitat. The problem is being able to distinguish which developments will always support deer, and which will not. Since it is very difficult to control deer populations in heavily developed areas (posted land, safety zones, firearms discharge bans) it is tempting to administratively ignore

deer within developed parts of Maine. However, our greatest deer-people conflicts occur in developed areas. Ignoring deer management challenges in this part of the state is not a viable option. Even when excluding development, at least 96% of Maine would be considered deer habitat. Among WMDs, deer habitat ranges from 74% of the land area in WMD 24 to nearly 100% of our northern, western and east-central WMDs (Table 9).

On an area basis, our WMDs range from 276 mi^2 of deer habitat in WMD 24 to 2,041 mi^2 of habitat in WMD 8. Our 30 WMDs average 973 mi^2, although the area of our coastal island district 30 cannot yet be calculated. Statewide, 29,179 mi^2 of our 30,441 mi^2 of land area is classified as deer habitat.

Deer Wintering Area Inventory

Wildlife Division biologists have been documenting the location of deer wintering areas since the 1950's. Prior to 1990, most of this effort was focused in the unorganized towns of Maine (Fig. 7). During the past decade, deer wintering area inventories have been conducted, statewide, when wintering conditions were appropriate. In most situations, area occupied by deer was evaluated only when deer were severely restricted by deep snow. Hence, winter range estimates are probably substantially lower than estimates that would be derived when deer are ranging more widely across the landscape.

To date, most towns have been inventoried (at least from aerial surveys) for deer wintering area (DWA) locations. However, we do not know if all wintering areas have

been mapped, nor are we able to effectively monitor loss of, or new occupation of deer wintering habitat.

Acreage occupied by wintering deer was calculated from DWA inventory maps which were entered onto the Department's Geographic Information System (GIS). The resulting estimates of the area and spatial distribution of DWAs reflect a composite snapshot of winter range use during severe winters over the past 15 to 20 years (Krohn et. al. 1998).

Statewide, deer wintering habitat comprises roughly 750,000 acres, or 4% of total deer habitat (Fig. 15). As a rule, central and southern Maine WMDs tend to possess a greater amount of deer winter range than northern and eastern WMDs. The top 5 WMDs in proportion of total deer habitat area comprised of wintering habitat are: districts 23 (14%), 22 (11%), 16 (10%), 25 (10%), and 17 (8%). The districts comprised of the least proportion in winter range include: districts 29 (1.5%), 19 (1.5%), 14 (1.5%), 6 (1.8%), and 3 (2%).

Spatial distribution of DWAs also varies within the state (Fig. 16). Deer wintering areas tend to be sparsely interspersed within northern, western, and eastern WMDs. Moreover, there is a tendency for wintering areas to be large and interconnected in several northern Maine WMDs. In central Maine, deer wintering areas tend to be abundant, widely interspersed, and relatively small, individually. In aggregate, there were 2,870 individual DWAs in our GIS database, as of 1998.

Deer wintering habitat comprised 10 to 15% of total deer habitat in northern, western, eastern, and parts of central Maine during the 1950's to the early 1970's (Banasiak 1964, Lavigne 1991). Area occupied by deer during that time in southern

parts of Maine were less well documented. However, it is unlikely that DWAs comprised less area than more northerly locations. In aggregate, there were more than 4,000 individual DWAs occupied by deer during the 1950's (Banasiak 1964).

Area occupied by wintering deer has clearly declined during the past 30 years. The actual amount of historic DWA which is now unoccupied by deer may never be accurately calculated. The empirical data from comparison of GIS vs. earlier reports suggest we've lost 2/3 of our wintering habitat, statewide (12% vs. 4% of total habitat). Declines in wintering habitat acreage are probably greatest within the Acadian forest (spruce-fir region), i.e., northern, western, and eastern WMDs (Fig. 14).

Excessive timber removal within, and surrounding, deer wintering areas is the most widely-accepted cause of DWA removal from the landscape. Many DWAs may have been cut prior to their identification and protection by MDIFW. Many others, however, may have deteriorated when the spruce-budworm epidemic caused extensive coniferous tree mortality. Budworm damaged forests rendered large areas of former wintering habitat unsuitable for wintering deer; the resulting loss of coniferous canopy prevented MDIFW from placing these sites under LURC protective zoning. Whatever the cause of DWA loss, these sites will again be favorable to deer, if and when, mature coniferous forests dominate the former (or historic) DWA site, and depending on forest management practices.

Carrying Capacity for Deer

Ecological (K) carrying capacity was estimated for each WMD and statewide, based upon forage potential of the summer range (Lavigne, in prep. (c)). Forest and

other habitat features detailed in Tables 9 to 11 provided the basis for estimation of K carrying capacity. Generally, WMDs in which agriculture and/or young forests were prevalent rated high in ability to sustain deer during spring through autumn.

Overall, Maine could support 1.85 million deer (63 deer /mi^2), if K were to be attained in all WMDs simultaneously (Table 12). Among WMDs, K ranged from 54 deer /mi^2 (WMD 27) to 80 deer /mi^2 (WMD 3).

Maximum Supportable Population (MSP) was estimated using procedures modified from Lavigne (1991). MSP is an estimate of the maximum number of deer that can survive in a WMD, given the current amount of wintering habitat, and given average or normal levels of winter severity. Habitat acreage is estimated indirectly, based on: 1. physical condition indices (e.g., yearling antler diameter); 2. winter severity index (WSI); and 3. optimum stocking density of deer while using winter range (Lavigne 1991; Lavigne in prep.).

The maximum number of deer that could be supported by existing wintering habitat, given winters typical of the 1990's (Table 1) is nearly 552,000 deer, statewide (Table 12). At MSP, the statewide deer population would, when on summer range, average 19 deer /mi^2. MSP varies considerably among WMDs, because of: 1. variations in quantity of winter range available to deer; and 2. extreme variation in relative severity of winter. Among WMDs, maximum supportable population ranges from 5 deer /mi^2 (WMD 3) to 61 deer /mi^2 on summer range (WMD 24).

As noted in the Management section of this report, the population objective we set in 1985 was to increase the deer population to 50 to 60% of MSP in each WMD by the year 2002. If attained in each WMD, the statewide population would approximate

270,000 to 330,000 deer, or an average of 10 deer /mi^2 while on summer range. Corresponding densities among our 30 WMDs would range from nearly 3 deer /mi^2 in WMD 3, to 34 deer /mi^2 in WMD 24 (Table 12).

It is instructive to speculate what deer densities we could potentially attain, if Maine had more area in high quality wintering habitat. For example, is it feasible to allow deer populations to grow to the limit of K carrying capacity? Given the reality that sufficient wintering habitat must be available to accommodate 1.8 million deer, this option is not realistic. When deer must use wintering habitat during average or severe winters, 42% of our deer habitat base must be in wintering area to accommodate the herd at K (Table 12). It is unlikely that this quantity of mature coniferous-dominated forest ever existed in Maine during the past 250 years or more (Stanton 1963).

A more modest option is worth considering. How many deer could Maine support in good condition (i.e., 50% of MSP), if we regained the quantity of wintering habitat that likely existed during the 1950's? Assuming that the percent of total deer habitat in wintering habitat ranged from 10% in northern and eastern WMDs, 15% in central Maine WMDs, and 20% elsewhere, an average of 14% of Maine would be in wintering habitat (Table 12). This would approximate 2.6 million acres of wintering habitat as Maine's historic winter deer range. One may only speculate whether that much wintering habitat actually did exist during the 1950's and 1960's. However, 14% of total habitat in winter range is in line with estimates from Banasiak's (1964) assessment of winter range in Maine, and from other locations across the northern range of white-tailed deer (Lavigne 1991).

With 14% of Maine as winter range, we could potentially winter more than 585,000 deer, statewide. This population would average 20 deer /mi^2, statewide, and would range from 10 to 33 deer /mi^2 among WMDs (Table 12). Although similar in overall density to the herd level at current MSP, this potential population would be in excellent physical condition. The potential population, at 50% MSP, would not occur at excessive densities in wintering areas, unlike populations at MSP. Accordingly, the potential population would not be subjected to high risk of malnutrition, as would the herd at MSP. Does within a herd at this potential population size would be more productive than does from the herd at MSP. Therefore, the higher productivity and growth of this potential population, at 50% MSP, would allow a greater harvest than at MSP, given our current amount of wintering habitat.

Projections

Carrying capacity for deer in Maine during the next 10 to 15 years will depend on the fate of existing winter range, and the rate of forest succession within historic wintering areas which had been cut (or opened naturally by spruce-budworm). Commercial demand for spruce, fir, hemlock, and pine is expected to remain high. Moreover, supply of spruce and fir sawlogs and pulpwood is expected to continue to decline until about 2010 over large areas of northern, western and eastern Maine (Gadzik et. al. 1998). The potential for conflict between softwood removal vs. maintenance of high-quality shelter for wintering deer is likely to intensify when spruce and fir demand exceeds supply. Lack of supply of softwood products in the industrial timberlands of Maine may result in more intensive management of softwood forests

within deer wintering areas in central and southern WMDs outside the primary range of spruce-fir forests (Fig. 14). However, the diverse private land ownership patterns which characterize Maine's organized towns (Fig. 7) may dampen actual rates of softwood timber removals from deer wintering areas.

Deer wintering habitat will remain vulnerable to commercial and residential development. Southern and coastal WMDs will receive the most development pressure. Over-all, carrying capacity for deer will decline in proportion to DWA loss to development.

The degree to which MDIFW succeeds in obtaining meaningful cooperative agreements with landowners for the long-term protection and improvement of deer wintering habitat may well spell the difference between achieving a net gain in available wintering habitat vs. a net loss in northern, western, and eastern WMDs over the next 15 years. If softwood timber harvest intensifies within deer wintering areas in central and southern WMDs, it may be desirable to develop a cooperative deer wintering protection program there as well.

It is unlikely that the quality or quantity of summer range for deer will change significantly during the next 10 to 15 years. Continued development pressures will likely result in an increase in conversion of forested and agricultural habitat to dispersed housing and more intensive development. To the degree that this development increases, negative impacts will be focused on loss of hunting opportunity and increased difficulty in maintaining deer at tolerable levels in developments. These problems will likely remain greatest in southern and coastal WMDs.

POPULATION ASSESSMENT

Historical Perspectives

Little is known of deer population size in Maine prior to the 1950s. Much of what we do know, was gleaned from anecdotes in earlier reports, such as sporting journals, railroad shipping reports, and early reports of MDIFW (Stanton 1963).

It is unlikely that deer were very abundant during early colonial times in Maine. Restricted to coastal and riparian habitats at a time when winter climate was severe, deer populations may have been limited by predation from aboriginal man, wolves, bobcats, black bears, and mountain lions (Stanton 1963; Banasiak 1964).

During the 1800's however, logging and land clearing opened Maine's forests at a time when winter climate began to moderate. During this time, also, wolves and mountain lions were extirpated from Maine, leaving man as the only important predator on deer older than newborn fawns. This reduction in non-human predators persisted from the late 1800's to the 1960's, when the eastern coyote expanded into Maine. Therefore, the stage was set for periodic cycles of deer population increases to very high relative numbers, followed by abrupt crashes, usually after severe browsing damage had occurred (Banasiak 1964). These boom and bust cycles were not synchronized around the state. Rather, they occurred primarily where hunting effort by man was light, such as in the large roadless expanses of northern, western, and eastern interior Maine. Many of these cycles had a periodicity of 30 to 35 years. For example, times of extreme deer abundance were noted in northern Maine around 1900, and again in the mid 1930's, and yet again in the early 1960's. Each population crash

seemed to be precipitated by severe winters; each was associated with extreme browsing damage and malnourished deer (Stanton 1963). We know that prior to the herd crash in the north in 1963, yearling buck antlers averaged 1/2" in diameter (12 mm YABD) (vs. 3/4" or 18 mm today); they averaged 88 lb. dressed weight (vs. 120 lb. today). From all indications, the deer population in the remote woodlands of northern Maine was existing at >80% of maximum supportable population. Winter surveys of the time documented excessive browsing in wintering areas; and biologists noted high annual losses to malnutrition (predominantly young deer) prior to the crash in 1963 (Banasiak 1964).

Other boom to bust cycles in deer abundance occurred in eastern Maine (Stanton 1963). The first one was noted in the 1860's; the last peak occurred in the late 1940's.

In addition to reduction in predation pressure, and availability of increased forage supplies following successive waves of logging activity, access to the woodlands of Maine for sport hunting has played a role in regulating deer abundance since colonial times. Prior to the 1970's, access to deer hunters was very restricted in northern, western, and eastern WMDs (Fig. 1). Traditionally, most forest products were transported to mill sites by water (Stanton 1963). Beginning in the 1960's, the emphasis shifted from river driving to trucking of timber to mill sites in Maine. Prior to 1975, road access to many parts of Maine was very limited, by today's standards. Earlier sport hunters often traveled two or more days by boat, airplane, or buckboard into remote hunting grounds. Limited access prior to the 1970's undoubtedly resulted in negligible

impact on northern, western and interior eastern Maine deer populations (Banasiak 1964).

In the more settled parts of central, southern, coastal, and northeastern Maine, intensive land clearing, more extensive road access, a larger hunter force, and rather liberal bag limits all combined to more closely regulate deer populations during earlier times, despite the loss of competition from most natural deer predators. However, extremes in deer abundance sometimes were noted in these more populous regions of Maine between 1850 and the 1950's (Banasiak 1964). As noted earlier, Maine's 10 southernmost counties were closed to all deer hunting during a period of extreme deer scarcity. Later, deer were sufficiently abundant in many central Maine towns during the 1940's to warrant investigating means of reducing crop damage (Kittams 1941).

Recent Times

During the past 30 to 40 years, many changes have occurred which have had dramatic effects on deer populations in Maine. Forests changed from predominately maturing pole-stage to increasingly younger stands. The spruce budworm outbreak and intensified timber harvests have improved summer range for deer, while also reducing the winter carrying capacity for deer in large areas of the state. Intensified timber harvesting, following the 1975 ban on river-driving of wood products, prompted industrial land-owners to develop thousands of miles of logging roads. This network of roads reaches into virtually all of Maine's formerly remote woodlands. Today, road access for hunting is comparable among all of Maine's WMDs (Fig. 17); few deer now reside farther than a mile or two from a gravel or paved road in Maine. Hunting effort

can now impact nearly all deer (and moose) populations, if adequate access is allowed by landowners.

At the same time that forests were changing, a new predator emerged in Maine. The eastern coyote became firmly established during the late 1960's in western Maine. Within 15 years, coyotes were distributed in all Maine towns (Hilton 1992). We have documented that coyotes do prey on deer, and when the deer population is well below MSP, most losses to coyote are additive to hunting, illegal hunting, road-kill, and other traumatic losses among deer (Lavigne 1992). Although coyotes will readily kill old, sick or debilitated deer, there are typically few such individuals at current population levels in Maine. Superb opportunists, coyotes are able to successfully prey upon healthy deer of all ages, particularly in winter. There is evidence that predation rates by coyotes are higher in deer wintering areas which have been reduced in area, opened, and/or fragmented by logging, and/or the effects of spruce budworm. Hence, the effects of coyote predation would be minimized during normal winters, if deer had access to high quality wintering habitat (Lavigne 1995).

Given its food habits, the eastern coyote fills the niche vacated by the eastern timber wolf, at least with regard to predation on white-tailed deer (Lavigne 1995). During early summer, coyotes join a long list of predators which compete for newborn fawns (Long et. al. 1998). This list also includes black bears, red fox, bobcats, fisher, and domestic dogs. Although deer fawns also die from causes related to maternal under-nutrition, accidents and illegal kill, it is likely that coyote predation contributes to a higher total mortality rate among fawns today than was evident during the "pre-coyote" era. Prior to the arrival of coyotes in the 1950's, summer loss rate among fawns

averaged 30% statewide. During the past 20 years, these rates have increased to 45% (Lavigne 1991a). No other factors (i.e., illegal kill, road kills, inadequate nutrition of does, bear population size, etc.) have changed sufficiently to account for this increase in fawn loss rate. Recent increases in fawn mortality represent a net loss in new recruits to Maine's deer population; therefore, allowable harvest for does must be kept lower. This also increases the likelihood of over-harvest at times when other doe losses increase unexpectedly (e.g., severe winters).

In addition to increased pressure from natural predation, Maine's deer population experienced higher pressure from hunting from 1960 to 1988. As will be noted in the Use and Demand Section, hunter numbers, and over-all hunting effort increased during this period, resulting in higher removal rates among does. Along with increasing hunter effort, our continued use of either-sex hunting regulations to manage deer populations probably contributed to deer population declines between 1970 to 1982. Following severe winters (e.g., 1978 and 1982), harvests of adult does under either-sex hunting regulations actually increased, thereby adding to all other doe losses for the year, which cumulatively exceeded production of fawns.

Another factor which greatly influenced population dynamics of deer in Maine during the past 30 to 40 years is the severity of winter weather. During the late 1960's through 1982, winters cooled, became longer, and snowier in Maine (Banasiak 1991). Compared to the preceding decade, and subsequent decades, the 1970's were stressful times for wintering deer, as indicated by our winter severity index (WSI; Fig. 18). Considering the physiological challenges to deer posed by deep snow and intense cold over long periods, the rigors of most 1970's winters were a major factor influencing

deer survival in Maine. During the worst of these winters (1971), we lost 35% of our wintering herd in western and northern Maine.

The cumulative impact of severe wintering conditions during the 1970's must be interpreted in light of ongoing changes in deer wintering habitat, timber harvesting on summer ranges, emergence of the coyote, improved hunter access, increasing hunting effort, and the effects of an increasing human population (road-kill, illegal-kill, etc.). It is doubtful that we could have succeeded in increasing Maine's deer populations to the degree we have, if winters hadn't moderated during the 1980's and 1990's (Fig. 18).

Illegal deer kill is a long-standing drain on both the deer resource and MDIFW's financial and personnel commitments. Deer losses to illegal hunting are additive to most other losses to the deer population, i.e. the magnitude of the illegal deer kill directly reduces the allowable harvest to law-abiding hunters. Though poorly quantified, the unreported illegal kill of deer may approximate 10,000 to 15,000 deer, or 1/2 the legal harvest of deer in Maine (Lavigne 1995; Vilkitis 1971). Locally, illegal kill may contribute to deer population declines, or it may impede population recovery (Banasiak and Lavigne 1983). Sources of illegal kill include night hunting, out of season hunting, failure to register deer killed in season, and false registration of deer killed by another hunter. Some of these illegal kills are reported in the registered harvest. The illegal kill estimate presented above includes only those which remain unreported.

Deer killed in collisions with motor vehicles also represent an additive loss to Maine's deer population, and hence they reduce allowable harvest. The number of road-kills varies seasonally (peaks in June and November), regionally, and annually. During the past 15 years, reported mortality of deer from collisions with motor vehicles

has more than doubled, from 1,800 (in 1982) to >5,600 deer (in 1998). Trends in road-kills have generally paralleled those for deer populations as a whole. However, regional differences in road density (Fig. 17), traffic volume, and intensity of urban/suburban development, each influence the relative risk of collision to local deer. Many deer mortalities to motor vehicle collisions are never reported. Hence, the figures for deer losses to motor vehicles cited above under-estimate the true magnitude of these losses to the deer population.

As noted in the Habitat Section, the amount of developed land increased during the past 30 years. Deer remain and thrive in developed areas, but controlling deer populations using traditional hunting techniques becomes increasingly difficult. Firearms hunting frequently is banned in developed areas for safety reasons. In many other residential developments (and an increasing number of other properties), individual landowners may post their land against trespass by hunters. Where access to recreational hunting with firearms is restricted, deer populations in Maine have increased dramatically during the past two decades. In many such areas, increased problems between deer and residents (shrubbery damage, road-kills, Lyme Disease) have prompted MDIFW to explore more innovative means of controlling deer populations. These include controlled hunts, sharpshooting, crop damage permits, and expanded archery hunting opportunities.

Deer Population Size

The HARPOP model (Lavigne 1989) was used to estimate statewide deer populations from 1957 to the present (Fig. 9). This model requires deer harvest, and

several attributes of population age structure derived from the 5,000 to 7,000 deer, which biologists examine during the hunting season. Although considered adequate for monitoring deer population change over large areas, this model will tend to over-estimate deer abundance during times when hunting removal rate is increasing. Moreover, since HARPOP is harvest-dependent, actual populations will be under-estimated in WMDs in which large areas are closed to hunting due to firearm ordinances, statutory hunting bans, or intensive posting against trespass.

Between 1957 and 1997, Maine's wintering deer population fluctuated between 265,000 and 140,000 deer (Fig. 9). Populations generally declined between 1957 and 1982. Since that time, Maine's wintering deer population has slowly increased. Major influences on deer populations described earlier are readily apparent in population trends for the late 1960's and 1970's. Periods of apparent recovery in statewide populations around 1980 are the result of 3 mild winters (1979-81). Actual populations were probably over-estimated by this model in 1980, since deer were more vulnerable to harvest during a particularly snowy firearm season. Harvest that year (37,250) was ≈ 5,000 deer more than normal; this inflated the population estimate by ≈ 40,000 deer, statewide.

Population increases since 1982 have been achieved in large part, because legal harvests of does have been closely regulated, as noted in the Management Section. Since 1983, annual harvests of adult does have been held to ½ or less the number of does harvested during the final years of either-sex hunting (1976-82). Close attention to balancing doe losses with fawn production, particularly following severe winters, has

enabled MDIFW to consistently increase deer populations wherever hunting exerts a major influence on deer population growth.

We have been most successful in achieving deer population increases in central and southern Maine WMDs, as is illustrated in Table 13. In many southern Maine WMDs, deer populations have doubled since 1982, many increasing by as much as 10 deer /mi^2 (Table 13). In these areas, does were under intense hunting pressure when deer of either-sex regulations were in place. Since habitat and winters generally remained favorable, deer populations responded favorably to reduced doe mortality achieved under the Any-Deer permit system, and the bucks-only regulations which preceded the permit system.

Deer inhabiting most northern, western, and eastern WMDs have not fared so well since 1976 (Table 13). In many of these WMDs, deer populations initially responded to reductions in doe harvest, but then later declined. Others have been steadily declining since 1976. WMDs in which populations have declined since 1976 all are located in the spruce-fir region of Maine (Fig. 14); they encompass the majority of Maine's industrial timberland ownership. There, population declines are likely related to the progressive loss of deer wintering habitat, and reduction in quality of remaining DWAs since the early 1970's. The real value of the harvest reduction we imposed in northern, western, and eastern WMDs since 1982, lies in reducing the rate of decline in deer populations following severe winters. Winter mortality surveys in this part of Maine suggests that winter losses were nearly twice as high during the 1980's and 1990's, than they were in the earlier 1970's, despite similar levels of winter severity (MDIFW, unpubl. data). Failure to compensate for these increased herd losses by reducing

hunting mortality would have precipitated larger declines in deer population in northern and eastern WMDs. Had winters during the past 15 years remained as severe as those of the 1970's (Fig. 18), northern and eastern Maine's deer population would be lower still.

Prior to the 1997 hunting season, nearly 300,000 deer inhabited the fields, forests and suburbs of Maine (Table 14). Regionally, pre-hunt density ranged from less than 2 deer /mi^2 in northern WMD 3 to at least 38 deer /mi^2 in heavily developed WMD 24. Among adult (yearling and older) deer, does outnumbered bucks by 141: 100; this ratio varied regionally from nearly equal doe: buck ratios in WMD 5, to 185 does: 100 adult bucks in WMD 24. Generally, southern and central Maine WMDs have a slightly higher ratio of does per buck in the pre-hunt population than elsewhere (Table 14). This reflects our success in achieving meaningful reductions in over-all doe mortality, and was a prerequisite for achieving population increases.

During 1997, fawn recruitment (autumn) averaged 82 fawns: 100 does, statewide (Table 14). This level of recruitment enabled does to sustain an over-all mortality rate of 27%. Fawn recruitment is higher than the statewide average in central and southern WMDs. In many of these WMDs, recruitment varied between 80 and 96 fawns: 100 does during 1997. Recruitment is apparently much lower (more frequently affected by under-nutrition of does, and lack of buffer prey in early summer) in northern, western and eastern WMDs, ranging from 58 fawns: 100 does to 81 fawns: 100 does during 1997. Because recruitment of fawns is lower, allowable mortality among adult does in northern, western, and eastern WMDs must also remain lower. In northern and western Maine, severe wintering conditions often contribute to over-all doe mortality which

exceeds losses allowable by fawn recruitment. This often required a complete ban on hunting of does in order to minimize population declines.

During 1997, 19,660 antlered bucks were taken, statewide, from the pre-hunt population by legal hunting. This represented a hunting mortality rate of 23% of the pre-hunt buck population (Table 14). Removals of bucks by hunting varied from 14% to 16% of pre-hunt buck populations in northern WMDs, to as much as 30% to 40% in more southerly WMDs. Hunting removal rate among antlered bucks is directly related to hunting pressure; impacts of hunting pressure on availability of mature bucks will be explored in detail later in this section.

During 1997, 7,319 adult does and 4,173 fawns (both sexes) were legally harvested statewide in Maine (Table 14). Harvest among does was negligible in northern and eastern WMDs, which were restricted to bucks-only hunting during the firearm season on deer. There, only 1 to 4 does were removed from the pre-hunt herd for every 100 antlered bucks taken (Table 14). Within central and southern WMDs, doe (and fawn) harvests were more liberal, averaging 25 to 65 adult does per 100 bucks. Limited harvests in northern Maine represented only 1% or 2% of allowable total losses to does, while more liberal harvests in the south accounted for as much as 50% of total allowable losses. Despite these great differences in doe harvest rate, our objective was to achieve slow herd growth in all WMDs during 1997. Differences in doe harvest among WMDs during 1997 reflect the relative contribution of hunting vs. other losses (illegal kill, predation, accidents, etc.) to total mortality of does around the state.

During 1997, the post-hunting population totaled 254,000 deer statewide. This population was calculated by subtracting the legal deer harvest (31,152), and the

unreported illegal kill and wounding loss estimates (12,000+), from the pre-hunt population. Therefore, wintering densities varied from 1.6 deer per mi^2 in WMD 3, to 30 deer per mi^2 in WMD 24 (Table 14). It should be noted that wintering densities in the better deer ranges of central and southern Maine now approximate 20 to 30 deer/mi^2. Deer at this level of abundance can begin to impact forest regeneration, and intensify conflicts with farmers, landowners and motorists. However, deer in these areas generally have not yet reached our stated population objective of 50 to 60% of MSP (Table 4). Achievement of that objective would lead to populations of 30 to 40 deer/mi^2 in some central and southern Maine WMDs (Table 12). We currently have no consensus on whether to limit deer population growth to address complaints of deer damage (social carrying capacity), or to allow the herd to reach biological MSY (50 to 60% of MSP).

Since 1976, subtle changes have occurred for certain attributes of Maine's deer population. Some reflect changes in deer abundance; others reflect changes in mortality. Since 1976, our antlered buck population has been getting slightly younger, while our doe population has been getting older. This trend is seen from the change in the frequency of yearling bucks, and yearling does in the harvest over the years (Table 13). A high percentage of yearlings in the harvest is associated with a correspondingly low percentage of older deer (Lavigne 1993). When averaged for large areas over many years, these yearling percentages reflect annual mortality rates among yearling and older deer in the population (Severinghaus and Maguire 1955).

Statewide, yearling buck frequency increased from 34% in 1976-82 to 41% in 1990-96 (Table 13). Not all WMDs experienced this change, but the majority did.

Overall buck mortality has increased during the past 22 years; increases in hunting effort during this period are clearly implicated. Among does, the opposite trend has occurred. Yearling percentages in the doe harvest have declined from 31% during 1976-82 to 27% during 1990-96 (Table 13). Moreover, reductions in yearling doe percentage are greater in areas in which doe harvest restrictions have led to greatest increases in deer population (central and southern WMDs). Wherever the herd has responded favorably to harvest restrictions since 1982, yearling doe percentages (and overall doe mortality rates) have decreased the most, to the biological minimum of ≈20% in some central WMDs (Table 13). This suggests that does in southern and central WMDs are surviving longer than was the case in 1976-82 when either-sex hunting regulations were enacted. One positive outcome of greater longevity in does is that does now produce more offspring during their lifetime than they formerly could. This, in turn, increases net reproductive output in the population, and potentially increases the number of bucks available for harvest.

The interaction between increasing buck mortality and decreasing doe mortality in Maine has inevitably led to changes in pre-hunt sex ratios among adults (Table 13). During the final years of either-sex hunting, adult (yearling and older) sex ratios were more nearly balanced, averaging 110 adult does: 100 adult bucks, statewide (Table 13). During the initial years of doe harvest restrictions (1983-89), the sex ratio widened to 137 adult does: 100 adult bucks. More recently (1990-96), there were 152 adult does: 100 adult bucks among deer in Maine's statewide herd. During all periods, regional deer populations, which were declining, tended to exhibit nearly balanced population

sex ratios. This reflected our failure to materially reduce overall doe mortality by reducing hunting mortality.

The change in adult sex ratios from 110 to 152 adult does: 100 adult bucks in the pre-hunt population between 1976 and 1996 was not a negative event from a population dynamics perspective. Maintaining a higher proportion of older does in the herd contributed to higher annual fawn recruitment between 1976 and 1997. This in turn, probably contributed to desired herd increases, and ultimately increased the availability of bucks for harvest (Fig. 12).

Between 1976 and 1996, recruitment of fawns into the herd improved from 71 to 83 fawns: 100 does, statewide. Between-period increases in fawn recruitment were positively correlated with population growth in central and southern Maine WMDs (Table 13). In addition, those WMDs exhibiting the highest adult doe: adult buck ratios, also exhibited the highest recruitment rates (Table 13).

The relatively high proportion of mature (4+ years old) bucks in Maine deer harvests has long attracted both resident and non-resident deer hunters to the Maine woods. If a buck survives to age 4 or older, there is an excellent chance he would possess a set of antlers considered trophy-quality by most hunters. Bucks may also attain maximum weight by this age, hence mature bucks are very likely to be near or over the magical 200 lb. mark, eviscerated.

Since 1976, the percentage of mature bucks in Maine's statewide buck harvest has changed from 25 to 35% in 1976-82 to 18 to 23% during 1990-97 (Fig. 19). Despite this, however, the actual number of mature bucks in the statewide harvest has remained stable.

Declines in the proportion of the buck harvest comprised of mature individuals are a consequence of higher over-all mortality rates bucks experienced between 1976 and 1997. Recall changes reported earlier in yearling buck frequency. In most cases, these higher apparent rates of mortality among antlered bucks are at least partially attributable to increases in hunting effort which occurred between 1976 and 1997 (Fig. 20). Reasons for increased deer hunting effort will be detailed in the Use and Demand section. The proportion of mature bucks in the statewide harvest was inversely correlated with overall hunting effort for deer between 1976 and 1997 (Fig. 21). This relationship was also evident from regional comparisons of hunting effort vs. availability of trophy bucks in the harvest (Fig. 22).

Maintenance of relatively stable numbers of mature bucks (Fig. 19) in the harvest in the face of increasing buck mortality rates was possible only because over-all buck populations were increasing between 1976 and 1997. Since 1976, harvests of antlered bucks increased by nearly 50% (Fig. 12), while overall deer populations increased by nearly 60% (Fig. 9).

There is much regional variation among WMDs in the percent of the buck harvest comprised of mature bucks (Fig. 23). Generally, those WMDs which experience highest hunting effort, support the lowest proportion of mature bucks in the harvest. Hence, lightly hunted WMDs in northern, western, and eastern parts of Maine tend to support buck harvests with a greater proportion of mature individuals. In these areas, however, low overall deer densities (Table 13) limit the number of mature bucks which are available for pursuit by hunters. A better balance between proportion of the herd comprised of mature bucks vs. overall deer abundance currently occurs in central and

southern WMDs (Fig. 24). Although more heavily hunted, WMDs in this part of the state support higher over-all deer populations, and they contribute more mature bucks empirically, to the harvest. In terms of the number of mature bucks contributed to the mean annual statewide harvest of 3,472 mature bucks during 1990-97, the leading 5 WMDs were: WMD 17 (424/yr), WMD 23 (302/yr), WMD 11 (231/yr), WMD 5 (190/yr), and WMD 16 (174/yr). Two of these occurred in the more favorable habitats of northern Maine; the remainder were in the central part of the state. When the mature buck harvest is adjusted for the relative size of our 30 WMDs, the top producers of mature bucks during 1990-97 all occur in central and southern Maine. WMD 23 leads here, with 33 mature bucks harvested per year for every 100 mi^2 of deer habitat. Other leading producers of mature bucks in recent years includes WMD 17 (31/yr/100 mi^2), WMD 16 (24/yr/100 mi^2), WMD 24 (20/yr/100 mi^2) and WMDs 13, 25 and 26, each yielding 18/yr/100 mi^2.

Population Projections

Changes in deer population during the next 15 years will depend upon changes in availability of wintering habitat, the relative severity of winters, and the magnitude of doe losses (to all causes) in relation to recruitment. Doe loss rates will, in part, be dependent upon the harvest regulations we promulgate. Access to recreational hunters will be an important determinant of deer population growth in central and southern WMDs. How we choose to meet the challenges of deer population regulation in developed areas of Maine will have a major impact on deer population size and growth.

Within the spruce-fir region of Maine (Figure 14), deer populations could increase if winters continue to moderate, or if the amount and quality of wintering habitat improves during the next 15 years.

USE AND DEMAND ASSESSMENT

Historical Perspectives

Little is known regarding the number of people who participated in deer hunting prior to the 1920's in Maine. It is safe to say, however, that many hunters during the 1800's and earlier, hunted deer for their contribution to food larders, and for financial gain, rather than for recreational enjoyment. Hunting of deer as a recreational activity gradually evolved in the late 1800's (Stanton 1963). As sport hunting grew in popularity, a code of ethics gradually evolved, governing hunter behavior and rules of fair chase. This evolution in hunter behavior while afield continues, even today.

Nonresident deer hunters were required to purchase a Maine deer hunting license beginning in 1906 (Table 2). Maine began requiring residents to purchase licenses, and to legally register their kill in 1919 (Table 15). Initially, hunting licenses were good for the life of the hunter, but these were revoked in 1930 in favor of annual licensing.

Between 1930 and the end of World War II, the number of deer hunters in Maine fluctuated between 80,000 and 95,000, statewide (Table 15). During the next 15 years, the ranks of deer hunters swelled by another 50,000, as young adults of the World War II generation (born 1920 to 1945) entered the hunter pool. By 1960, Maine's deer hunters numbered 150,000 (Table 15).

Prior to the 1960's, deer outnumbered deer hunters by a considerable margin. This circumstance led to considerable hunter satisfaction, since deer sightings and success rate tended to remain high (Banasiak 1964). Moreover, low hunter density,

especially given our long hunting seasons (Fig. 8), minimized individual hunters' perceptions of overcrowding and excessive competition. Hunter success rate between 1930 and 1960 fluctuated between 17 and 30%, statewide (Table 15). In more remote parts of Maine during this period, reported hunter success exceeded 50%, when deer were particularly abundant.

During these early times, regulations allowing harvest of deer of either-sex were generally appropriate. Low hunter numbers relative to the size of the deer population required liberal harvests to control deer population growth. This was particularly true considering there were no wild predators available which would be capable of seriously limiting deer population growth.

Beginning in 1960, our nation's largest generation, The Baby Boom Generation (people born between 1946 and 1970), began to enter the hunting pool in Maine. Despite the gradual loss of deer hunters from earlier generations, Maine's deer hunting fraternity grew by more than 50,000 by the mid 1970's (Table 15). By the late 1970's, 200,000 resident and nonresident hunters were competing for a share of the deer resource. Collectively, deer hunters were spending 1.5 million days afield by the mid 1970's.

For the first time in Maine's modern history, deer hunters outnumbered their quarry by the early 1970's. Since the 1960's, just as new hunters were bolstering the ranks of more veteran Maine hunters, the deer population was plummeting from 260,000 to 140,000 wintering deer (Fig. 9). Despite continuation of rather liberal hunting regulations throughout the 1970's (Fig. 8), Maine's burgeoning hunter was

experiencing difficulty in finding and killing deer. Between 1960 and 1975, deer hunting success dropped from 25% to 15% or less (Table 15).

Recent Times

During the 1970's, an increasing hunting population that was experiencing lower harvests and reduced success led to a considerable amount of unfulfilled demand for a quality deer hunting experience. This in turn, led to hunter demands for higher deer populations, but it also led to demands for expanded hunting opportunities.

Since 1975, hunting opportunity progressively expanded (Table 2; Fig. 8), as MDIFW and the Maine Legislature lengthened existing, or added new hunting seasons. These changes were made largely to placate vociferous interest groups, who were competing for deer hunting opportunities. In 1977, a residents' only Saturday was added to the firearms season on deer. In 1981, black powder enthusiasts received their own season. At this point, archers, regular gunners, and primitive firearms enthusiasts each had their share of the opportunity pie (Fig. 8). In 1984, the firearms season was lengthened by a week in southern Maine, thereby creating a uniform firearm season, statewide. In 1990, land-owners were given preference in the allocation of Any-Deer hunting permits. In return for keeping their land open to deer hunting (at least by permission only), qualifying landowners gained an edge over other hunters competing for the limited opportunity to pursue does and fawns during the firearms seasons. In 1995, black powder hunters successfully lobbied for a second week of deer hunting, effectively doubling the length of their special season. Finally, in 1997, bowhunters were given the privilege to hunt deer in limited areas under a separate license with a

separate limit. This was the first time multiple bag limits were allowed for deer hunting in Maine since 1925. Between 1975 and 1997, deer hunting opportunity expanded from 48 to 84 days, although for most of these years, hunting opportunity was 59 days annually (Fig. 8).

For the remainder of the either-sex hunting era (1976-82) the number of deer hunters continued to increase in Maine. By 1982, Maine deer hunters (residents and nonresidents combined) reached a maximum of 214,000 (Fig. 25). For the 1976-82 period as a whole, an unprecedented 207,000 people were annually vying for a share of the deer resource in Maine (Table 15).

Since 1982, the number of people pursuing deer in Maine has been declining (Fig. 25). Between 1983-89, an average of 200,000 hunters pursued deer in Maine, representing a net loss of 14,000 deer hunters since the peak in 1982. This loss of deer hunting participants cannot be explained solely by declines in the number of nonresident deer hunters. Their numbers have fluctuated within a fairly narrow range of 25,000 to 40,000 license holders since the early 1970's; nonresidents' participation in deer hunting in Maine parallels that for residents.

One is tempted to speculate that the precipitous drop in deer hunters we observed during the years in which we promulgated bucks-only seasons with either sex-days (1983-85; Fig. 2), was due solely to hunter dissatisfaction with more restrictive hunting regulations. Undoubtedly, some of this loss of participation occurred. However, dissatisfaction over the change to bucks-only hunting regulations cannot explain all of the decrease in deer hunting participation which occurred since 1982.

The ranks of deer hunters also continued to drop during the initial two years of the Any-Deer permit system (1986 and 1987). Then, a partial recovery in deer hunters occurred during 1988 and 1989, suggesting Maine deer hunters were adjusting to these relatively restrictive hunting regulations.

For the remainder of the Any-Deer permit years (1990-97) there has been an uninterrupted decline in hunting participation for deer in the State of Maine (Fig. 25). The uniformity of each year's decline suggests the decline is systematic, and may be attributable to changing demographics in Maine's human population as a whole. This possibility will be explored in more detail in the Hunter Projection section. During 1990-96, hunting participation had dropped to an average of 190,500 people (Table 15). By 1997, fewer than 178,500 active deer hunters remained in Maine; this represents a decrease of more than 28,500 participants in deer hunting in only 15 years.

Trends in hunting effort (cumulative number of days spent hunting deer by all hunters combined) since 1976 do not exactly parallel trends in hunter numbers (Fig. 25). Maine's deer hunters have apparently taken advantage of increased opportunities to hunt deer, which had materialized since the mid-1970's (Fig. 8). Data from hunter surveys in Maine reveal that the number of days spent hunting deer progressively increased from about 8 days/hunter in 1976-82, to more than 11 days/hunter in 1996 (MDIFW unpublished data; Phillips et. al. 1989; Boyle et. al. in prep.).

Despite declining hunter numbers, overall hunting effort for deer increased from 1.6 million hunter-days in 1976 to more than 2.2 million hunter-days in 1988 (Fig. 25). The largest increase in hunting effort occurred after the firearms season was

lengthened in 1984. Since 1988, hunting effort has dropped to 1.9 million hunter-days, more closely matching the declining trend in hunter numbers.

Hunting effort is not distributed equally among Maine's four deer hunting seasons (Fig. 26). Participants in the regular firearms season are, by far, the most numerous. This long-standing season attracted 176,500 hunters in 1997; firearms hunters contributed 92% (1.72 million days) of the total hunting pressure on deer that year. A distant second in contributing to Maine's overall deer hunting effort, the 10,500 hunters, participating in the October archery season collectively expended 115,000 days bowhunting for deer (6% of total effort). Participants in Maine's late muzzleloading season are nearly as numerous (9,300 hunters) as October archers, but black powder hunters expended far less effort (43,500 days), contributing less than 2% of total effort expended hunting deer in 1997 (1.9 million days). In its fledgling year, the September archery season attracted 1,400 hunters (Fig. 26). Effort per hunter is unknown, but total effort is certainly less than 1% of totals for 1997.

Hunter distribution and deer hunting effort vary a great deal regionally within Maine (Table 16). Generally, hunting pressure has traditionally been highest in central and southern Maine WMDs, where the majority of Maine people reside. Although as much as 25% of the annual deer harvest is taken by resident deer hunters who traveled away from their home WMD, the majority of our residents tend to hunt quite close to home. Nonresident deer hunters tend to be more mobile, traveling to areas that appeal to their interests. These interests frequently focus on maximizing their odds of encountering a trophy-age buck in relatively uncrowded hunting areas. Consequently,

many nonresidents choose northern, western, and central Maine WMDs for their hunting experience.

Hunting effort varies 10-fold between the more remote northern Maine WMDs, which averaged less than 20 hunter-days/mi^2/year, and some southern WMDs, in which deer were subjected to more than 200 hunter-days/mi^2/year during 1990-97 (Table 16). With hunter densities approaching 20 hunters /mi^2 /year in parts of Maine, the potential for landowner conflicts with hunters is greatest in central and southern WMDs. However, a major advantage of our long seasons is that hunters are free to hunt to the degree they desire, while choosing to avoid those seasons or days within seasons which attract “crowds”. Perceptions of crowding and the level of hunter-landowner conflicts would likely be far worse if Maine deer hunting seasons were compressed into much shorter time frames, as in some other states.

Increases in hunting effort noted at the statewide level between 1976 and 1997 (Fig. 25), generally were shared among most of Maine’s 30 WMDs (Table 16). Rates of increase in effort since 1976, however, were greatest in central and southern WMDs. Eastern Maine WMDs (districts 19, 27, 28, and 29) probably experienced a net loss of hunters and hunter-effort between 1976 and 1997.

Because hunter numbers were increasing (Fig. 25) at a time when deer populations were declining (Fig. 9), over-all hunting success declined during the final years of the either-sex hunting era in Maine (Table 15). During this time, success rates ranged from 12.9 to 17.7 (a snowy season in 1980), while averaging 14.9% for the seven-year period (1976-82; Table 15). During the transition years between either-sex hunting and the Any-Deer permit era (1983-89), hunting success for deer dropped even

further, averaging only 11.9%. Whether regulations were either-sex days or Any-Deer permits, few firearms hunters had the opportunity to pursue does and fawns between 1983 and 1989. In addition, large-scale recovery in deer numbers had not yet taken place. Despite a relatively large increase in hunting effort, hunter success varied between 9.5% and 14.9% statewide between 1983 and 1989 (Table 15).

Since 1990, overall deer hunting success has generally increased (Table 15). Although part of this is attributable to our success in increasing the deer population, the apparent increase in hunting success also is due to the steady decline in the number of hunters competing for a share of Maine's allowable deer harvest (Fig. 25). Between 1990 and 1996, statewide deer hunting success increased from 13% to nearly 16%. In 1997, 17.5% of Maine's deer hunters tagged a white-tail.

Hunter success rate varies for each type of deer season we offer. Hunter success is typically highest during the regular firearm season, averaging more than 17% during 1997. However, hunter success during this season largely depends on the relative number of Any-Deer permits we issue. Success rate among Any-Deer permittees ranged between 28 and 40% during 1986-97. Some of this apparent success is due to the practice of "buddy hunting" in which an Any-Deer permittee (illegally) tags an antlerless deer killed by another hunter (who did not possess an Any-Deer permit). Among hunters restricted to bucks-only hunting during the regular firearms season, hunting success varied from 6 to 16%, depending largely on the abundance of deer in a given WMD. Statewide success rate for bucks-only hunters averaged 11% during the regular firearms season, during 1997. Consequently, overall hunter success in a given WMD would be near 10% if firearm hunters were restricted to

bucks-only, or it would exceed 20% if hunters had access to a large number of Any-Deer permits. A return to either-sex hunting regulations today, given current deer abundance and hunter participation, would result in success rates approaching 25% -- for a short time.

During 1990-97, bowhunters who participated in the statewide archery season on deer (during October) experienced a success rate ranging from 5 to 9%; average success rate for this period was 6%. Archers who participated in the expanded bow season during September in 1997 fared considerably better. Success rate for this hunt, which was limited to WMDs 24 and 30, was 18%. These WMDs support the highest deer densities of any area in Maine (Table 13).

Among all hunter-groups, black powder enthusiasts are the least successful in tagging a deer. Success rates resulting from our late muzzleloading season on deer varied between 3 and 6% since 1990, and averaged 5%.

Projected Hunter Participation

In 1985, we anticipated that demand for deer hunting experiences would continue to increase through the year 2000 (Lavigne 1986). Our harvest and success rate objectives were contingent upon satisfying demand from 220,000 deer hunters by the year 2000 in Maine. As noted earlier, that level of growth in deer hunting participation has not materialized.

Rather than gaining, Maine has been losing deer hunters at a rate of roughly 2,400 hunters per year since 1990 (Fig. 24). How long this trend will continue is

uncertain at this time. If the cause for this decline is changing demographics, we may stand to lose thousands more deer hunters in the next 15 years.

The 1996 deer hunter survey yielded data on the date of birth among Maine's current population of deer hunters (Boyle et. al., in prep), which was used to analyze participation rates among the four generations of hunters currently pursuing deer in Maine. These demographics also allowed projections into the future, assuming current age-specific participation rates.

During 1996, deer hunters in Maine ranged from 10 to 93 years of age. They represented four generations; i.e. Pre World War II, World War II, Baby Boomers, and Generation X. By far, Baby Boomers were the most numerous generation, and they contributed the most hunters per year-class (i.e., 3,500 people born in 1950, 3,500 born in 1951, etc.). One disturbing trend was that we were recruiting new hunters (Generation X) to the hunting pool at only one-third the rate (about 1,200 per year-class) of Baby Boomers.

Examination of year-class frequencies among older hunters revealed that hunters began to drop out of the hunting pool at accelerating rates after age 50 to 55. Although World War II generation hunters averaged 2,400 people/year-class when around 50 years of age, their participation rate declined to about 1,800/year-class between age 50 to age 70. After that, participation rate dropped precipitously to about 800/year-class or less.

Since 1990, the progressive loss of deer hunters in Maine may simply have been due to the fact that fewer young hunters were being recruited than were dropping out from among the older generations of hunters.

During the next 15 years, all Pre World War II generation hunters will be gone. World War II generation hunters, who have seen the best and the worst of deer hunting times come and go in Maine, will be exiting the hunter population at a high rate. During the next decade and a half, Baby Boomers will remain the most numerous hunter group, but the oldest of these hunters will begin to drop out, as they enter their 50's and 60's. By the year 2012, Baby Boomers will not yet have attained 70 years of age. By 2012, Generation X hunters will mature as young adults (some approaching middle age); the next generation (born after 1995, and as yet unnamed) will represent our pool of young hunters (recruits).

Assuming that current rates of participation among various age-classes of hunters continues, we stand to lose an additional 25,000 deer hunters by the year 2012. At that time, deer hunters (resident and nonresident combined) may number about 155,000 (Table 17) in Maine. Although more tenuous, projections beyond 2012 suggest an even sharper drop in hunter participation. Between 2012 and 2025, most Baby Boomers will have completely left the hunting scene in Maine to younger generations. Unless participation rates among post-Baby Boom Generation hunters increase dramatically, the ranks of Maine deer hunters will fall to less than 100,000 by the first quarter of the 21st century. At that time, not only will Maine's deer hunters be fewer in number, they will also average much older than the current population of deer hunters.

Non-Consumptive Use

Few people fail to thrill at the sight of a deer, whether that encounter takes place in the deepest woodland or the backyard. Although solid data detailing rates of deer

watching in Maine are lacking, non-consumptive use of wildlife is an important benefit to sharing our environment with wild animals. In addition, wildlife watching likely contributes a great deal of revenue to Maine's economy (Teisl and Boyle 1998). During recent years, the practice of supplemental feeding of deer has increased dramatically, adding a new dimension (and new challenges for MDIFW) to wildlife viewing among both hunters and non-hunters in Maine.

Most people, however, recognize that there is a limit to the tolerance of the white-tails' impacts, when deer change from a source of joy to one of nuisance. When deer populations are high, landowners eventually reach a point where they no longer tolerate loss of expensive shrubbery, agricultural crops, or forest re-growth. Somewhere, there is a balance between the desire to observe deer, and tolerance of their negative impacts. Different communities, as well as individuals, vary in their relative tolerance for deer in their lives. Quite often, tolerance levels change when individuals are, for the first time, directly involved with an incident of over-browsing, damage to self and property from a collision with deer, or from the perception that they are at greater risk of contracting Lyme Disease.

In previous updates of the Strategic Plan for Deer, we did not set specific objectives addressing Maine citizens' desire for non-consumptive use of deer. However, our selection of 50% to 60% of maximum supportable populations WMD as the population target in each WMD did represent a compromise between maximum viewing opportunities (a herd near ecological carrying capacity or K) and conflicts with land owners.

We now know that in southern Maine WMDs, achieving 50% of MSP may result in a deer herd which causes more negative impacts (road kills, plant damage, risk of Lyme Disease) than land owners will tolerate. Unfortunately, we have no direct, broad-based measure of landowner tolerance for deer which could guide us in setting population objectives for the next 15 years.

SUMMARY AND CONCLUSIONS

The white-tailed deer is a widely distributed herbivore which successfully inhabits a wide array of habitats from the equator in South America to the edge of the boreal forest in southern Canada. White-tailed deer interact with their habitat in a density-dependent manner. At relatively low densities, deer are able to obtain an abundance of high quality forages. With increasing deer abundance, intensifying foraging causes shifts in the abundance and diversity of better quality foods. At extreme density, deer exert serious impacts on natural and man-dominated environments. Because diet quality declines with increasing deer abundance, physical condition and reproductive rate decline as well. Ultimately, ecological carrying capacity (K) is attained, when deer reach a tenuous balance between limited availability of forage, and reproductive output.

In regions such as Maine, the quantity and quality of wintering habitat may limit deer populations. Where deep snow and intense cold force deer to occupy favorable wintering habitat for months on end, the relative quantity of wintering habitat may limit deer at a density (maximum supportable population or MSP) which is far below the carrying capacity of summer range alone (K).

Currently, 96% of Maine is considered deer habitat; this excludes developed parts of the state. In practice, even a portion of Maine's developed land is habitable and currently occupied by deer. Forestland dominates the habitat base, comprising 94% of the deer habitat in Maine. Compared to earlier decades, there currently is a relatively high proportion of regenerating forest stands in the state, particularly in northern, eastern and western areas, which comprise the spruce-fir forest region of Maine.

Considering the abundance of regenerating forests, combined with other forage-rich habitat types, such as wetlands and farmland, it is likely that summer carrying capacity for deer is higher today than was the case 30 to 40 years ago. Estimates of K, based only on summer range, vary from 55 to 80 deer per mi^2 among Wildlife Management Districts (WMDs) in Maine, or roughly 1.8 million deer statewide (60 deer/mi^2). There is an insufficient quantity of wintering habitat to accommodate this population (at K) when severe winters cause deer to seek favorable wintering habitats.

Moreover, there is evidence suggesting that the quantity and quality of deer wintering habitat in Maine has been declining during the past 30 years. This trend appears to have been particularly acute in the spruce-fir region of northern, eastern and western Maine. Estimates of winter range utilization by deer suggest that wintering habitat quantity may have declined by >50% since the late 1960's. Central and southern WMDs appear to have fared better than eastern and northern WMDs in retaining deer wintering habitat. Estimates for the latter WMDs suggest as much as 80% of historically known deer wintering areas have been rendered unusable by deer due to excessive timber harvesting, and/or degradation of the overstory by the spruce-budworm outbreak of 1970-88.

The 1986 update of the white-tailed deer strategic plan called for attainment of 50% to 60% of maximum supportable population (MSP) in each Wildlife Management District by 2002. MSP, given current quantities of wintering habitat in Maine, approximates 550,000 deer, statewide. Therefore, if 50% to 60% of MSP were to be attained in all WMDs, Maine would support a wintering herd of 270,000 to 330,000 deer. Estimates of deer density at 50 to 60% of MSP through this period vary from nearly 3

deer /mi^2 to 37 deer /mi^2 among WMDs. Central and southern Maine WMDs, by far, can support more deer in winter than WMDs elsewhere.

Potential carrying capacity, if historical (pre-1970) quantities of wintering habitat were currently available in all WMDs, was calculated to describe the current magnitude of habitat limitations due to loss of deer wintering habitat. Depending on location in Maine, historical amounts of wintering habitat ranged from 10 to 20% of total habitat for deer among WMDs. Southern and central Maine WMDs traditionally, and still do, contain greater acreage of wintering habitat. Maximum supportable population in Maine, if all WMDs currently were at historical levels of deer wintering habitat is estimated to be 1 million deer, statewide. Under this scenario, our population objective (55% of MSP) would translate to 590,000 deer, or 287,000 more deer than can actually be supported today.

Since 1970, our agency has worked with the Land Use Regulation Commission (LURC) to place 200 deer wintering areas comprising 200,000 acres (1.9% of the land base in unorganized towns) into protective land-use zones. More recently, MDIFW has been actively negotiating long-term agreements with corporate landowners to ensure protection and enhancement of deer wintering habitats. These cooperative agreements currently encompass 68,000 acres in both unorganized and organized towns in Maine. In addition, MDIFW is actively working to identify, and to implement, acceptable methods of protecting important deer wintering habitats in all of Maine's organized towns.

Since 1983, our focus in deer population management has been to regulate the harvest of antlerless deer in order to achieve deer population increases specified in the

1985 Strategic Plan for Deer. To date, the statewide deer population has increased from 160,000 to 255,000 deer. We have been more successful in achieving significant population increases in central and southern WMDs, than elsewhere. Currently, we have achieved the population objective (50 to 60% of MSP) in 10 of 30 WMDs; most of these 10 are located in the lower portion of northern Maine (western mountains, foothills, Moosehead Lake region). We are very near 50% of MSP in an additional 10 WMDs, all located in central and southern Maine.

To achieve deer population increases (and at times, to slow herd declines in the north and elsewhere), we have reduced antlerless deer harvests to 50% or less of the number of does and fawns formerly taken during either-sex hunts during 1978-82. During most years since the either-sex era, we have regulated doe and fawn harvests using WMD-specific allocations of Any-Deer permits. Harvests allowed in Maine during 1983 to 1997 were reduced by 4,000 to 8,000 antlerless deer to achieve herd increases.

Annual harvests of adult bucks have increased by nearly 50% since 1976-82. Distribution of buck harvests among WMDs, and annual trend in buck harvest paralleled that for over-all deer populations between 1983-97. There was a slight decline in the proportion of mature bucks in the harvest during the past 20 years, reflecting a decrease in antlered buck survival during this time period. It is likely that this change in adult buck survival is related to increased hunting pressure on the deer population. Interestingly, the number mature bucks harvested has remained relatively stable. Overall increases in the size of the buck population have more than compensated for the slight increase in average mortality rate of bucks. During 1996 and 1997, we achieved all-time record buck harvests (19,601 and 19,660 antlered bucks). During the

final years of the either-sex hunting era (1976-82) mean harvest of antlered bucks was 12,800.

The number of hunters vying for available deer hunting opportunity in Maine increased steadily between 1960 and 1982, attaining an all-time high of 216,000 deer hunters by 1982. Participation in deer hunting began to decline in Maine beginning in 1983. Except for a few years during the late 1980's, hunter numbers have progressively declined, reaching 178,000 hunters in 1997. Both resident and nonresident deer hunters declined, with nonresidents comprising about 15% of the total deer hunter pool. The steady decrease in hunters since 1982 may be attributable to changing demographics in the hunter population. We are simply not recruiting young people into the hunting population at high enough rates to offset losses of older hunters. As a result, the total number of deer hunters decreased rather systematically each year, since 1990.

Despite declining hunter numbers, hunting effort per deer hunter has been increasing since 1976. During the past 25 years, average days spent hunting per individual deer hunter has increased from 8 to more than 11 days per year. In this time interval, we have progressively increased deer hunting opportunity by lengthening existing seasons, adding new deer hunting seasons, and increasing bag limits in limited areas (1997 &1998 only). Hunters apparently have taken advantage of these new deer hunting opportunities in Maine.

Because effort per hunter has increased, overall hunting pressure during Maine's deer seasons has increased by nearly 40% since 1976. During the final years of the either-sex hunting era (1976-82), statewide deer hunting effort averaged 1.5 million

hunter-days. During 1988, hunting pressure reached an all-time high of 2.2 million hunter-days. Since that time, effort has declined to 1.9 million hunter-days, primarily in response to the cumulative effects of annual decreases in hunters. Based upon current trends in deer hunting participation, deer hunters may decrease to 155,000 people in Maine by the year 2012.

Non-consumptive use of deer, primarily deer watching and supplemental feeding are largely undocumented in Maine. However, both activities are perceived to be gaining in popularity. Selection of population objectives in 1986 involved the need to strike a balance between providing maximum deer viewing opportunities vs. maximum harvest opportunities in various parts of Maine. We now know that management for maximum harvest opportunities in central and southern parts of the state may lead to undesirable levels of conflict with landowners.

Maine may be divided into 3 parts, each presenting different challenges and opportunities for deer management. In a large portion of the spruce-fir region, wintering habitat limits opportunities for increasing either deer harvest or viewing opportunities. Real progress in achieving deer population increases there will depend on our success in increasing the amount and quality of wintering habitat for deer. How we manage moose in this region will also affect our ability to increase the deer population, since moose and deer may compete for many of the same winter forages.

In more southerly and coastal sections of Maine, continued urban/suburban sprawl has led to a situation where deer are not currently being limited by hunting (or natural predators). Deer populations in these suburban (and in some island) environments are much higher than those called for in our population objectives. It is in

these areas that firearm discharge bans, high rates of posted land and safety concerns, largely preclude firearms hunting. Hence, deer harvests are low in relation to the harvests needed to maintain local deer populations at appropriate levels. Overcoming this problem will require implementation of more innovative deer hunting opportunities, while fostering a much closer working relationship between municipalities and the Department.

In the remainder of Maine, our current habitat base is adequate to maintain a substantial deer population for the enjoyment of hunters and wildlife watchers alike. The greatest challenge here is to maintain deer populations which are compatible with other land-uses, to regulate harvests sufficiently to prevent population declines, and to ensure that the current amount of wintering habitat remains available, when needed.

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Table 1. Frequency distribution of winters by winter severity rating during 1973-74 to 1997-98 by Wildlife Management Districts in Maine.

Wildlife Management District	Severity Rating: Total WSI Range:	Number Of Winters Mild <60	Moderate 60-74	Severe 75-89	Very Severe 90		1973-1997 Mean Severity Rating	1973-1997 Mean WSI Value
1		1	3	7	14	25	very severe	93
2		1	3	7	14	25	very severe	93
3		2	2	8	13	25	very severe	90
4		2	0	12	11	25	severe	88
5, 6		2	5	9	9	25	severe	84
7		4	8	9	4	25	severe	77
8		3	5	9	8	25	severe	82
9		2	12	5	6	25	severe	75
10		4	11	7	3	25	moderate	71
11		4	12	4	5	25	moderate	71
12		10	9	4	2	25	moderate	64
13		8	10	6	1	25	moderate	68
14		5	7	7	3	25	moderate	71
15		15	8	3	1	25	mild	59
16		13	11	3	1	25	moderate	61
17		8	9	5	0	25	moderate	64
18		13	4	3	0	25	mild	59
19		19	3	3	0	25	mild	56
20		20	3	2	0	25	mild	52
21		15	7	3	0	25	mild	56
22		17	5	3	0	25	mild	56
23		18	5	2	0	25	mild	57
24		19	5	1	0	25	mild	50
25		20	5	0	0	25	mild	53
26		18	5	2	0	25	mild	55
27, 28		17	5	3	0	25	mild	56
29		17	5	3	0	25	mild	54
30								
Statewide		8	12	5	0	25	mild	65

1999/assessments/deer/freq distrb 97-98

Table 2. Maine deer management history: 1830-1998.

Year	Statutes and Regulations
1830	First restrictions on deer hunting; season set at September 1 through December 31, no bag limit.
1840	Season extended to November 1 through June 30.
1848	Season changed to July 1 through February 28.
1853	Season reduced to September 1 through January 15.
1870	Season reduced to October 1 through January 15.
1873	First bag limit, three deer per hunter per year.
1883	Sale of venison limited to three deer per hunter per year; exporting of venison outlawed.
1886	Hunting deer with dogs outlawed.
1893	Eight southern counties closed to deer hunting; other such closures between 1894 and 1902.
1895	Bag limit reduced to two deer per hunter per year.
1900	Season reduced to October 1 through December 15; special license required to sell venison.
1903	All Maine counties again open to deer hunting.
1906	Nonresidents required, for the first time, to purchase licenses for deer hunting annually.
1907	Hunters in York and Cumberland Counties restricted to one antlered buck apiece - the first "bucks only" law; in effect in 1907 and 1908.
1913	Southern Maine restricted to one deer per hunter, October 1 through November 30 season.
1914	Some counties restricted to October 15 opening, or to hunting only during November, between 1914 and 1922.
1916	Taking of deer for provisioning logging camps outlawed.
1919	Mandatory deer registration began; residents required to purchase "good for life" license; nonresidents still required to purchase annual license.
1921	Modified buck law (two deer per hunter, one must be antlered buck) in effect in northern and eastern Maine; in effect in 1921 and 1922.
1923	Most counties closed during first two weeks of October; season closings varied from November 30 to December 15 between 1923 and 1938, maximum was eight weeks.
1925	Bag limit set at one deer of either sex, statewide.
1929	Legislature authorized payments to farmers for crop damage by deer; law repealed in 1951.
1930	All hunters required to purchase annual hunting licenses, except landowners hunting on their own land.
1939	Basic two-zone (north and south) system established, allowing five to six weeks of hunting in the north, four weeks in November in the south. In effect through 1970, except for a three- zone system from 1960 through 1962 and a four-zone system from 1963 through 1966.
1951	First special archery season, October 1 through October 15, Franklin and Oxford Counties only.
1967	Deer hunters required to wear fluorescent orange clothing during regular firearm season in southern and central Maine. Later required statewide.
1971	Deer drives outlawed. Land Use Regulation Commission (LURC) established, biologists begin inventory of important wintering areas for LURC protection. Last week of season closed as an emergency measure, the only time this has been done. Also in 1971 (and through 1972), season was set at five weeks in the north, three weeks in the south.
1973	Northern zone season shortened to four weeks (still three weeks in southern zone). Commissioner given authority to set annual deer seasons within a framework - the fifth Monday preceding Thanksgiving through the Saturday following Thanksgiving (seasons previously set every two years by legislature).
1977	Legislature provided that Saturday before regular firearm season be open for resident hunting only.
1980-82	Regular firearm season on deer shortened to two weeks in the "western mountain" portion of southern zone. Elsewhere in southern zone, season length remained three weeks and northern zone remained four weeks.

Table 2. Maine deer management history: 1830-1998 (continued).

Year	Statutes and Regulations
1981-82	Experimental muzzleloader season established by Legislature for three days following the end of regular firearm season. Law sunset in 1982.
1982	Legislature altered the deer season framework to include the fifth Saturday preceding Thanksgiving to November 30. Therefore, closing date of deer season no longer tied to Thanksgiving weekend.
1983-85	Legislature granted Department the authority to create hunting districts and to restrict the harvest of antlerless deer to increase deer populations. Authority sunset in 1985 and did not allow use of "doe permits". The late muzzleloader season resumed in 1983, continues to present.
1983	Southern zone divided into western, eastern, and central districts. Harvest restricted to deer with antlers 3" or larger in the former two districts while any deer was legal in the latter. Season length remained three weeks in all districts of southern zone. Any deer was legal during the four week northern zone season.
1984	Uniform four week season established, statewide. Any deer was legal in the northern zone throughout the season. In the southern zone, only deer with antlers 3" or larger were legal throughout the season in the western and eastern districts while in the central district hunters were restricted to deer with antlers 3" or greater for first three weeks with any deer legal the last week.
1985	Season length unchanged from 1984. Harvest restrictions in all districts of southern zone unchanged from 1984. Northern zone restricted to deer with antlers 3" larger first 3 weeks with any deer legal last week. Legislature granted Department permanent authority (effective 1986) to create hunting districts and to regulate the harvest of antlerless deer including the use of "doe permits". Permanent muzzleloader season established by Legislature effective 1985 for 6 days following the end of regular firearm season on deer.
1986-95	Season length unchanged from 1984. Seventeen (18 after 1990) Deer Management Districts (DMDs) established to manage deer. Variable quota doe harvests within DMDs accomplished using Any-Deer permits valid for regular firearm and special muzzleloader seasons. Deer of either-sex legal for Any-Deer permittees and archers during special archery season.
1989	The Natural Resources Protection Act (NRPA) is passed. It mandates MDIFW to support MDEP in protecting and enhancing deer wintering habitat in Maine's organized townships.
1993	Legislature granted Department authority to implement controlled deer hunts after the close of muzzleloader season to January 31st annually, or as needed. Location of hunt area, weapon type, hunter selection, bag limits, quotas and composition of the kill to be determined by Commissioner as needed.
1995-96	Legislature granted Department authority to implement an additional 6 days (maximum of 12 days) of primitive firearm hunting during the special muzzleloader season which follows the regular firearm season. Commissioner may specify in which DMDs this season extension will be allowed.
1997-98	Legislature granted Department authority to establish an early archery season (September 6 through the 30th in 1997). Either-sex season has separate limit from other deer season; targets parts of Maine where access to firearm deer hunters limits deer harvest capability.
1998	Department implements a new zoning system for hunting regulations. Individual districts, termed Wildlife Management Districts (WMDs) total 30, statewide. WMDs would replace former 18 Deer Management Districts (DMDs) in use since 1986.

Table 3. Comparison of objective vs. achieved deer population, harvest, and hunting success rate in Maine, during 1976 to 2012.

Period	Wintering Deer Population		Deer Harvest			Hunting Success Rate (%)	
	Objective[a]	Achieved	Objective[b]		Achieved	Objective[e]	Achieved
			Range	Mean			
1976-82	Unspecified	160,000 to 215,000	30,000 to 38,000	34,000	30,782	15	14.9
1983-85	Unspecified	169,000 to 204,000	30,000 to 38,000	34,000	21,527	17	11.7
1986-89	270,000 to 330,000	199,000 to 229,000	35,000 to 42,000	38,000	25,409	17	12.3
1990-96	270,000 to 330,000	198,000 to 256,000	35,000 to 42,000	38,000	27,054	17	14.2
1997	270,000 to 330,000	255,000	35,000 to 42,000	38,000	31,152	17	17.5
2001[c]	270,000 to 330000		35,000 to 42,000	38,000		17	
2012[d]							

[a]Population objective since 1986 has been a wintering population ranging between 50 and 60% of MSP (maximum supportable population). Based upon recent trends in carrying capacity (1996-97), that range approximates 275,000 to 330,000 deer.

[b]For 1976 to 1985, harvest objectives were pre-selected for 5-year intervals, assuming a fixed yield from the available deer population. For 1986 to 1997, the harvest objective assumes a fixed yield of antlered bucks, and that harvest of does and fawns which stabilizes the population, when the herd ranges between 50 and 60% of MSP.

[c]Target year for attainment of deer population objectives specified in the 1986, 1990, and 1996 updates of the White-Tailed Deer Strategic Plan.

[d]Target year for attainment of deer population objectives for this (1998) update of the White-Tailed Deer Strategic Plan.

[e]During 1976 to 1985 success rate objective assumed 200,000 deer hunters, that for 1986-2001 assumed 220,000 deer hunters.

1999/assessment/deer/drcomp-objvsach

Table 4. Post-hunt deer population during 1996 and 1997 in relation to maximum supportable population (MSP) in Maine, by Wildlife Management District.

Wildlife Management District	Mean YABD (mm)			Post Hunt Deer / Mi^2			Pooled Post-Hunt Pop'n as % MSP[a]	Projected Post-Hunt Pop'n Size at				Projected Post-Hunt Pop'n Density / Mi^2 at		
	1996	1997	Pooled	1996	1997	Pooled		MSP	50% of MSP	60% of MSP	Pooled 96-97	MSP	50% of MSP	60% of MSP
1	18.3	17.4	17.9	5.5	5.9	5.7	42	19,271	9,636	11,619	8,079	13.6	6.8	8.2
2	16.6	17.9	17.3	2.7	2.5	2.6	47	6,468	3,293	3,881	3,043	5.5	2.8	3.3
3	18.6	18.6	18.6	2.0	1.6	1.8	36	4,655	2,328	2,793	1,669	5.0	2.5	3.0
4	17.0	18.3	17.7	5.0	4.1	4.6	43	20,961	10,579	12,538	8,970	10.7	5.4	6.4
5	16.8	18.1	17.5	7.6	6.3	7.0	45	24,071	12,035	14,504	10,692	15.6	7.8	9.4
6	19.2	18.9	19.1	2.8	3.3	3.1	31	13,780	6,890	8,267	4,225	10.0	5.0	6.0
7	**16.4**	**15.9**	**16.2**	**7.3**	**7.4**	**7.3**	**55**	**18,128**	**9,132**	**10,904**	**10,022**	**13.3**	**6.7**	**8.0**
8	**16.5**	**16.8**	**16.7**	**6.0**	**4.3**	**5.1**	**51**	**20,410**	**10,205**	**12,246**	**10,519**	**10.0**	**5.0**	**6.0**
9	**15.8**	**16.4**	**16.1**	**3.0**	**2.7**	**2.9**	**56**	**4,930**	**2,465**	**2,939**	**2,730**	**5.2**	**2.6**	**3.1**
10	**16.8**	**15.3**	**16.0**	**4.0**	**3.8**	**3.9**	**57**	**6,025**	**3,012**	**3,633**	**3,469**	**6.8**	**3.4**	**4.1**
11	17.6	17.9	17.8	5.5	5.6	5.5	43	21,325	10,662	12,828	9,267	12.8	6.4	7.7
12	**16.0**	**15.5**	**15.8**	**10.5**	**9.6**	**10.1**	**58**	**16,304**	**8,152**	**9,745**	**9,394**	**17.4**	**8.7**	**10.4**
13	**16.8**	**16.9**	**16.9**	**12.8**	**13.7**	**13.3**	**50**	**15,029**	**7,515**	**9,040**	**7,484**	**26.6**	**13.3**	**16.0**
14	**15.8**	**17.3**	**16.6**	**8.5**	**7.4**	**8.0**	**52**	**12,228**	**6,114**	**7,305**	**6,331**	**15.4**	**7.7**	**9.2**
15	**16.6**	**16.4**	**16.5**	**15.8**	**16.5**	**16.2**	**53**	**30,478**	**15,239**	**18,326**	**16,085**	**30.6**	**15.3**	**18.4**
16	17.2	16.9	17.1	19.0	19.3	19.2	48	28,720	14,360	17,232	13,766	40.0	20.0	24.0
17	16.9	17.3	17.1	22.0	22.1	22.0	48	62,425	31,213	37,483	30,083	45.8	22.9	27.5
18	**16.3**	**17.0**	**16.7**	**7.8**	**7.9**	**7.8**	**51**	**19,890**	**10,010**	**11,960**	**10,249**	**15.3**	**7.7**	**9.2**
19	17.9	17.9	17.9	2.6	2.8	2.7	42	7,462	3,731	4,431	3,138	6.4	3.2	3.8
20	17.5	17.6	17.5	10.4	10.8	10.6	45	14,184	7,092	8,534	6,385	23.6	11.8	14.2
21	17.3	17.2	17.2	13.4	14.4	13.9	47	14,445	7,222	8,686	6,799	29.6	14.8	17.8
22	17.4	17.8	17.6	18.2	21.3	19.8	44	23,445	11,723	14,067	10,291	45.0	22.5	27.0
23	17.1	17.5	17.3	26.0	25.6	25.8	47	56,822	28,463	34,052	23,551	54.9	27.5	32.9
24	16.9	18.0	17.5	25.3	29.7	27.5	45	16,864	8,446	10,129	7,589	61.1	30.6	36.7
25	17.4	18.5	18.0	12.5	12.8	12.6	41	14,859	7,454	8,906	6,108	30.7	15.4	18.4
26	17.2	17.5	17.3	20.0	19.1	19.6	47	25,812	12,937	15,475	12,103	41.7	20.9	25.0
27	17.1	17.3	17.2	8.6	9.3	9.0	47	15,605	7,843	9,396	7,305	19.1	9.6	11.5
28	17.1	18.1	17.6	3.4	4.3	3.9	44	7,387	3,735	4,399	3,207	8.9	4.5	5.3
29	19.0	19.2	19.1	4.0	5.9	5.0	31	7,841	3,945	4,724	2,408	16.1	8.1	9.7
30	unknown	unknown												
Statewide				8.8	8.7	8.7	46	549,824	275,431	330,043	254,961	18.8	9.4	11.3

[a]Maximum supportable population (MSP) is the number of deer that can be sustained by the existing summer and winter range. MSP is equivalent to K carrying capacity only where winters are extremely mild, or where a surplus of high quality wintering habitat exists in a region where summer range quality for deer is poor. MSP is estimated from mean antler beam diameter of yearling bucks (YABD), i.e. YABD is inversely correlated with % MSP.

1999/assessment/deer/pthntdrpop

Table 5. Comparison of objectives vs. achieved deer harvests at the statewide level in Maine, during 1976-1998.

Year	Objective Harvest		Achieved Harvest	Deviation from Mean objective Harvest (%)[1]
	Range	Mean		
1976	30,000-37,000	33,500	29,965	-11
1977			31,430	-6
1978			29,002	-13
1979			26,821	-20
1980	30,000-38,000	34,000	37,255	11
1981			32,167	-5
1982			28,834	-15
1983			23,799	-29
1984			19,358	-43
1985			21,424	-37
1986	35,000-42,000	38,000	19,592	-48
1987			23,729	-38
1988			28,056	-26
1989			30,260	-20
1990			25,977	-32
1991			26,736	-30
1992			28,820	-24
1993			27,402	-28
1994			24,683	-35
1995			27,384	-28
1996			28,375	-25
1997			31,152	-18
1998			28,241	-26
1976-82			30,782	-9
1983-89			23,745	-34
1990-96			27,054	-29

[1] Objective harvest is the harvest level which may be expected when deer population objectives for the planning period have been achieved in all Wildlife Management Districts. Any harvest within +/- 10% of this harvest objective would be considered "on target." This harvest objective should not be confused with the annual harvest objective, which is the harvest needed to achieve specific herd growth strategies for that particular year. Annual harvest objectives are intended to facilitate herd growth toward the target population objective for the planning period.

1999/assessment/deer/drdvhvst.lwp

Table 6. Deer population, harvest, and hunter success objectives to be achieved in Maine by 2030, by Wildlife Management Districts.

Wildlife Management District	Population Target (% of MSP)[a]	Wintering Population Size at Target[b]		Allowable Harvest[c]	Potential Hunting Success Rate[d]
		Number	Number/Mi^2	At Target	% At Target
1	55	14,150	10	1,100	64
2	55	11,750	10	900	59
3	55	9,300	10	800	25
4	55	19,600	10	1,350	51
5	55	15,450	10	950	37
6	55	13,800	10	1,350	23
7	55	13,650	10	1,100	43
8	55	20,400	10	1,800	36
9	55	9,500	10	850	33
10	55	8,850	10	850	28
11	55	16,650	10	1,450	25
12	55	14,050	15	1,450	38
13	55	8,500	15	900	38
14	55	11,900	15	1,250	37
15	48	14,950	15	2,300	26
16	50	14,350	20	2,450	28
17	43	27,250	20	4,500	29
18	55	19,500	15	2,150	26
19	55	17,500	15	1,650	38
20	62	9,000	15	2,100	23
21	51	7,300	15	1,850	24
22	44	10,400	20	2,100	26
23	32	18,250	20	3,050	25
24	25	4,150	15	1,050	24
25	49	7,250	15	1,400	20
26	43	11,150	18	1,650	25
27	55	12,250	15	1,350	34
28	55	12,400	15	1,100	51
29	55	7,300	15	650	41
30	15	3,000	15	1,200	50
Statewide Sum		383,550	13	46,650	30

[a] Percent of Maximum Supportable Population, ie. the maximum number of deer that can survive in that WMD, given the amount of wintering habitat available in 2030.

[b] Assumes area of deer habitat in WMD will be same as area in 1997.

[c] Yield of bucks, given current rates of hunting effort for bucks. Harvest among antlerless deer is that number which stabilizes the population when at target.

[d] Assumes hunter density approximates those listed in Table 17. Success rates above 25% are probably not feasible. WMDs with potnetial success >25% require an influx of hunters to achieve harvest potential.

Table 7. Amount of wintering habitat required to support target population objectives, by Wildlife Management Districts in Maine, by 2030.

Wildlife Management District	Target Wintering Population[a]		Optimum Stocking in Wintering Habitat		Projected Wintering Conditions[b]		Wintering Habitat Required			
	Number of Deer	Deer/Mi^2 Habitat	Deer-Days Use	Maximum Wintering Density (Deer / mi^2)	WSI	Yarding Period (Days)	Acres/ Deer	Total Acres	Total Mi^2	Percent of WMD
1	14,150	10	15,000	110	88	135	5.8	82,070	128	9.0
2	11,750	10	15,000	120	87	125	5.3	62,275	97	8.2
3	9,300	10	15,000	125	84	120	5.1	47,430	74	7.9
4	19,600	10	15,000	110	85	135	5.8	113,680	178	9.1
5	15,450	10	15,000	125	79	120	5.1	78,795	123	8.0
6	13,800	10	15,000	125	79	120	5.1	70,380	110	8.0
7	13,650	10	15,000	135	73	110	4.7	64,155	100	7.3
8	20,400	10	15,000	120	79	125	5.3	108,120	169	8.3
9	9,500	10	15,000	140	71	105	4.5	42,750	67	7.1
10	8,850	10	15,000	160	70	100	4.3	38,055	59	6.7
11	16,650	10	15,000	160	70	100	4.3	71,595	112	6.7
12	14,050	15	15,000	160	70	100	4.0	56,200	88	9.4
13	8,500	15	15,000	160	70	100	4.0	34,000	53	9.4
14	11,900	15	15,000	160	70	100	4.0	47,600	74	9.3
15	14,950	15	15,000	160	70	100	4.0	59,800	93	9.3
16	14,350	20	15,000	160	70	100	4.0	57,400	90	12.5
17	27,250	20	15,000	160	70	100	4.0	109,000	170	12.5
18	19,500	15	15,000	160	70	100	4.0	78,000	122	9.4
19	17,500	15	15,000	160	70	100	4.0	70,000	109	9.3
20	9,000	15	15,000	160	70	100	4.0	36,000	56	9.3
21	7,300	15	15,000	160	70	100	4.0	29,200	46	9.4
22	10,400	20	15,000	160	70	100	4.0	41,600	65	12.5
23	18,250	20	15,000	160	70	100	4.0	73,000	114	12.5
24	4,150	15	15,000	160	70	100	4.0	16,600	26	9.4
25	7,250	15	15,000	160	70	100	4.0	29,000	45	9.3
26	11,150	18	15,000	160	70	100	4.0	44,600	70	11.3
27	12,250	15	15,000	160	70	100	4.0	49,000	77	9.4
28	12,400	15	15,000	160	70	100	4.0	49,600	78	9.4
29	7,300	15	15,000	160	70	100	4.0	29,200	46	9.4
30	3,000	15	15,000	160	70	100	4.0	12,000	19	UNK
Statewide Sum	383,550	13						1,700,000	2,658	9.1

[a] Population to be achieved and maintained by the year 2030, as set forth in Table 6.

[b] For WMDs 1 to 11, assumes winters between 1999 and 2030 will average the same level of severity as those from 1980-98. For WMDs 12 to 30, assumes some winters will approximate WSI of 70 (moderate to severe conditions), thereby requiring sufficient winter carrying capacity for moderately restrictive yarding conditions spanning 100 days. See Table 12.

2000/assessment/deer/target popobj

Table 8. Farmland acreage in Maine,1820-1997.

Year	Number of farms	Sq. mi. land in farms	Percent of total land in farms[a]
1820	31,019	--	--
1850	46,760	7,117	24
1860	55,698	8,950	30
1870	59,804	9,122	31
1880	64,309	10,239	34
1890	62,013	9,656	32
1900	59,299	9,844	33
1910	60,016	9,839	33
1920	48,277	8,478	28
1930	39,006	7,250	24
1940	38,980	6,598	21
1950	30,358	6,534	21
1959	17,360	4,816	16
1969	7,791	2,750	9
1978	6,775	2,344	8
1982	7,003	3,294	7
1987	6,269	2,098	7
1992	5,776	1,966	6
1997	5,810	1,893	6

a) Total land in farms includes farm woodlots

1999/assessments/deer/farm acre 1820-1997

Table 9. Percent of total area within Wildlife Management Districts in Maine comprised by major land cover categories, 1995[a].

Wildlife Management District	Land Cover Category					Deer Habitat[b]		Land Area (mi^2)
	Forest	Wetlands	Idle Farmland	Active Farmland	Developed	Percent	Mi^2	
1	97	2	2	<1	<1	99.8	1,417	1,420
2	97	1	1	<1	1	98.8	1,176	1,190
3	84	<1	1	11	4	96.4	931	966
4	99	1	<1	<1	<1	99.8	1,959	1,963
5	99	1	<1	<1	<1	99.6	1,543	1,549
6	83	1	3	11	3	97.2	1,378	1,417
7	96	<1	1	1	2	97.8	1,363	1,393
8	99	1	<1	<1	<1	99.4	2,041	2,054
9	96	1	<1	<1	3	96.8	948	979
10	92	5	<1	1	1	98.7	886	898
11	92	2	<1	3	2	98.0	1,666	1,700
12	88	2	<1	4	6	94.1	937	996
13	95	<1	<1	4	2	98.3	565	575
14	96	2	1	<1	1	99.5	794	798
15	88	3	1	4	4	96.0	996	1,038
16	75	<1	2	10	13	86.9	718	826
17	86	2	<1	7	5	95.3	1,363	1,430
18	91	2	<1	2	5	95.1	1,300	1,367
19	96	1	<1	2	1	99.1	1,166	1,176
20	85	1	<1	8	7	93.0	601	646
21	71	2	<1	5	23	77.6	488	629
22	83	<1	<1	7	10	90.5	521	576
23	78	3	<1	8	12	88.2	913	1,035
24	60	11	<1	3	26	73.8	276	374
25	75	3	<1	9	12	88.0	484	550
26	86	1	3	5	5	94.6	619	654
27	85	4	<1	2	9	91.2	817	896
28	90	4	<1	6	<1	99.6	828	831
29	88	1	2	4	5	94.9	487	513
30							unknown	unknown
Statewide[c]	90	2	1	3	4	95.9	29,179	30,441

[a]Based on the 1995 Forest Inventory of Maine
[b]All land cover categories, except developed
[c]Excludes WMD 30 and the sanctuary portion of Baxter State Park

1999/assessment/deer/percent land cover

Table 10. Percent of total forest area within Wildlife Management Districts in Maine by forest type classes, 1995[a].

Wildlife Management District	Forested Area (mi^2)	Percent of WMD Forested Area in:			
		White Pine/ Hemlock[b]	Spruce-Fir/ Cedar	Tolerant[c] Hardwoods	Intolerant[d] Hardwoods
1	1,373	0	54	32	14
2	1,155	0	31	49	20
3	814	0	51	28	21
4	1,946	1	53	38	8
5	1,531	1	59	33	7
6	1,178	1	39	37	23
7	1,338	0	37	49	14
8	2,028	0	39	45	16
9	939	1	28	57	14
10	824	12	27	41	20
11	1,572	5	48	33	14
12	877	16	17	56	11
13	544	5	13	61	21
14	765	4	36	53	7
15	911	34	2	53	11
16	617	14	8	57	21
17	1,235	6	33	34	27
18	1,244	15	42	28	15
19	1,124	16	49	24	11
20	548	36	0	51	13
21	448	23	0	63	14
22	480	14	0	74	12
23	806	10	29	43	18
24	224	16	15	59	10
25	413	25	27	33	15
26	563	7	42	27	24
27	762	7	50	21	22
28	746	5	43	37	15
29	454	0	63	16	21
30	unknown				
Statewide	27,458	7	37	41	15

[a]Based on the 1995 Forest Inventory of Maine
[b]Includes Red and Jack Pine stands
[c]Includes Oak/Pine, Oak/Hickory, and Northern Hardwood stands
[d]Includes Elm/Ash/Red Maple and Aspen/Birch stands

1999/assessment/deer/percent total forest

Table 11. Percent of forested area by stand development class and stand type among Wildlife Management Districts in Maine, 1995[a].

Wildlife Management District	Softwood-Dominated Stands[b]				Hardwood-Dominated Stands[b]				All Forests			
	Forested Area (mi^2) Growth	Percent of Area in: Seedling-Sapling	Poletimber	Sawtimber-Large	Forested Area (mi^2) Growth	Percent of Area in: Seedling-Sapling	Poletimber	Sawtimber-Large	Forested Area (mi^2) Growth	Percent of Area in: Seedling-Sapling	Poletimber	Sawtimber-Large
1	735	41	33	26	638	30	27	43	1,373	36	30	34
2	355	36	47	17	800	18	33	49	1,155	23	37	40
3	414	52	38	10	400	26	48	26	814	39	43	18
4	1,050	38	40	22	896	30	26	44	1,946	35	34	31
5	927	33	42	25	604	18	13	69	1,531	27	31	42
6	470	41	53	6	708	26	50	24	1,178	32	51	17
7	497	39	56	5	841	18	60	22	1,338	26	58	16
8	805	33	54	13	1,223	27	37	36	2,028	29	44	27
9	271	32	39	29	668	22	52	26	939	25	48	27
10	320	14	60	26	504	23	40	37	824	20	48	32
11	835	24	59	17	737	42	41	17	1,572	32	51	17
12[d]	290	7	68	25	588	18	52	30	877	14	57	29
13[d]	102	16	64	20	441	15	55	30	543	15	57	28
14[d]	306	38	48	14	459	23	39	38	765	29	43	28
15[d]	331	6	26	68	580	10	73	17	911	9	56	35
16[d]	134	6	62	32	484	28	52	20	617	23	54	23
17	485	20	63	17	750	33	55	12	1,235	28	58	14
18	714	25	55	20	530	43	40	17	1,244	33	48	19
19	738	37	54	9	386	36	41	23	1,124	37	50	13
20[d]	196	<1	35	65	352	16	69	15	548	10	57	33
21[d]	104	<1	59	41	344	24	66	10	448	18	65	17
22[d]	69	<1	25	75	411	25	50	25	480	22	47	31
23[d]	314	7	77	16	492	19	68	13	806	14	72	14
24[d]	68	15	51	34	156	7	47	46	224	9	48	43
25[d]	214	9	43	48	200	18	57	25	413	13	50	37
26[d]	275	15	61	24	287	20	69	11	563	18	65	17
27	434	16	68	16	328	19	62	19	762	17	65	18
28	357	29	58	13	389	49	38	13	746	39	47	14
29	288	34	60	6	166	23	77	<1	454	30	66	4
30	unknown											
Statewide	12,096	28	51	21	15,363	25	47	28	27,458	27	49	24

[a]Based on the 1995 Forest Inventory of Maine.
[b]Includes white pine, hemlock, red pine, jack pine, spruce-fir, and northern white-cedar dominated stands
[c]Includes Oak/Pine, Oak/Hickory, Elm/Ash/ Red Maple, Maple/Beech/Birch, and Aspen/Birch dominated stands
[d]Percent of forest in youngest development classes probably is biased low due to inadequate sampling in the field. Accordingly, percentages of other classes are probably over-estimated.

1999/assessment/deer/percent forested area

Table 12. Wintering habitat requirements of deer populations in Maine at varying population levels, by Wildlife Management District, 1986-97.

Wildlife Management District	Wintering Population Per Mi^2				WinteringHabitat Required[a] (Mi^2)				Required Wintering Habitat As Percent of Total Deer Habitat			
	K[b]	Potential[c]	MSP[d]	1986-2000 Target[e]	K	Potential	MSP	1986-2000 Target	K	Potential	MSP	1986-2000 Target
1	66	12	14	7.5	848	142	96	96	60	10	7	7
2	59	12	6	3.1	575	118	30	30	49	10	3	3
3	80	16	5	2.8	594	93	20	20	64	10	2	2
4	64	10	11	5.9	1,136	196	87	87	58	10	4	4
5	62	13	16	8.6	762	154	106	106	49	10	7	7
6	76	11	10	5.5	835	138	60	60	61	10	4	4
7	57	15	14	7.4	571	136	74	74	42	10	5	5
8	60	11	10	5.5	1,014	204	93	93	50	10	5	5
9	58	14	5	2.9	387	95	19	19	41	10	2	2
10	60	13	7	3.8	357	89	22	22	40	10	3	3
11	63	14	13	7.1	705	167	79	79	42	10	5	5
12	59	24	18	9.6	346	141	56	56	37	15	6	6
13	60	26	24	13.2	212	85	52	52	38	15	9	9
14	60	22	15	8.5	298	119	42	42	38	15	5	5
15	58	32	31	16.9	361	199	105	105	36	20	11	11
16	73	32	40	22.0	328	144	99	99	46	20	14	14
17	67	32	46	25.2	571	273	214	214	42	20	16	16
18	63	24	16	8.5	512	195	69	69	39	15	5	5
19	59	21	6	3.5	430	175	26	26	37	15	2	2
20	63	31	24	13.0	237	120	49	49	39	20	8	8

Table 12 (Continued). Wintering habitat requirements of deer populations in Maine at varying population levels, by Wildlife Management District, 1986-97.

Wildlife Management District	Wintering Population Per Mi^2				WinteringHabitat Required[a] (Mi^2)				Required Wintering Habitat As Percent of Total Deer Habitat			
	K[b]	Potential[c]	MSP[d]	1986-2000 Target[e]	K	Potential	MSP	1986-2000 Target	K	Potential	MSP	1986-2000 Target
21	62	32	30	16.3	189	98	50	50	39	20	10	10
22	66	33	45	24.8	215	104	81	81	41	20	16	16
23	72	32	55	30.2	411	183	195	195	45	20	21	21
24	66	33	61	33.7	114	55	58	58	41	20	21	21
25	70	32	30	16.9	212	97	51	51	44	20	11	11
26	60	32	42	23.0	232	124	89	89	37	20	14	14
27	54	31	19	10.6	276	163	54	54	34	20	7	7
28	66	29	9	4.9	342	166	25	25	41	20	3	3
29	55	29	16	8.9	167	97	27	27	34	20	6	6
30	NA											
Totals												
Per Mi^2	63	20	19	10.4	12,385	4,070	2,028	2,028	42	14	7	7
Deer →	1,850,000	587,500	551,750	303,000	7,900,000	2,600,000	1,300,000	1,300,000	← Acres			

[a]Wintering habitat requirements assume an optimal stocking level of 15,000 deer-days and maximum density of 170 deer/mi^2 of wintering habitat. Depending on average winter severity in each WMD, wintering acreage requirements range from 4.0 to 5.7 acres/deer. Unless winters are normally more severe, minimum acreage requirements are based on a Winter Severity Index value of 70, which is equivalent to a yarding period of 90 to 95 days at moderate severity.

[b]K denotes the maximum biological carrying capacity, in this case, based on the quality of summer range for deer.

[c]Potential Carrying Capacity is the number of deer which can be maintained in good condition (approx. 55% of MSP), given quantities of wintering habitat which had occurred in Maine during the past 30 to 50 years (or more recently in central and southern WMDs).

[d]MSP is the maximum number of deer that can survive in a WMD, given the current amount of wintering habitat, and given average or normal winter severity.

[e]Target population set during the 1986, 1991 and 1996 updates of the Strategic Plan for Deer. These populations represent 50 to 60% of the maximum supportable population (MSP) that may be sustained, given current quantity and quality of wintering habitat available in each WMD.

Table 13. Trends in selected deer population attributes by Wildlife Management District (WMD) in Maine 1976-1996.

	Wintering Population per Square Mile of Habitat			Percent Yearlings in the Antlered Buck Harvest			Percent Yearlings in the Adult Doe Harvest			Adult Does per 100 Antlered Bucks In the Pre-hunt Population			Fawn per 100 Adult Does in the Pre-hunt Population		
WMD	76-82	83-89	90-96	76-82	83-89	90-96	76-82	83-89	90-96	76-82	83-89	90-96	76-82	83-89	90-96
1	8.4	6.1	4.9	26	32	37	27	15	27	91	102	110	80	76	57
2	7.9	4.6	2.4	28	32	39	24	17	17[b]	91	102	116	63	73	56[b]
3	2.9	2.3	1.2	26	36	50	22	26	n/a	96	111	149	71	90	69[b]
4	4.3	5.7	4.8	25	31	32	25	20	16[b]	96	103	102	78	84	55[b]
5	6.2	7.5	6.2	33	31	27	29	19	15[b]	105	106	103	86	82	56[b]
6	3.0	2.7	2.3	26	35	42	24	27	24	96	112	134	74	89	72[b]
7	3.8	6.3	7.3	34	27	36	22	23	17	101	103	115	57	86	57
8	2.7	4.7	5.3	39	30	36	23	23	16	116	103	115	60	86	62
9	4.1	3.7	3.2	32	31	36	28	27	28	99	113	115	68	74	56
10	4.0	4.9	3.5	38	34	32	22	28	21	117	108	106	72	73	64
11	6.2	8.2	5.3	31	33	28	27	25	14[b]	108	109	117	72	69	42[b]
12	4.2	6.3	8.8	33	34	37	21	24	23	102	126	144	62	83	76
13	5.8	8.5	10.9	40	34	38	26	29	20	119	117	141	69	84	75
14	5.5	7.0	7.9	29	33	33	21	21	19	108	113	130	57	73	56
15	5.2	7.2	14.0	43	43	48	30	28	22	120	137	179	82	87	94
16	8.4	9.2	15.9	38	43	44	33	28	19	100	137	164	80	91	93
17	13.3	16.2	20.1	29	39	42	28	23	19	112	139	170	79	96	92
18	6.6	8.0	7.0	31	31	34	29	28	15	96	107	121	62	81	84
19	5.0	3.7	2.4	31	37	36	30	24	26	92	118	124	76	61	80
20	6.2	6.9	9.0	46	44	51	25	31	28	117	127	163	61	85	86
21	5.2	8.2	10.7	48	53	59	39	34	30	120	139	176	76	98	87
22	9.5	9.8	14.6	43	43	50	56[b]	40	22	113	128	179	81	89	89
23	13.4	16.4	21.0	37	40	42	34	27	20	97	132	170	68	93	97
24	13.2	14.8	22.5	45	51	57	35	33	27	115	138	188	88	85	96
25	8.8	7.6	9.9	46	42	45	40	32	26	117	117	155	77	68	81
26	11.2	10.1	14.5	40	42	47	32	19	21	112	129	182	78	74	96
27	7.7	6.7	6.9	30	24	38	29	27	26	108	127	130	44[b]	75	80
28	5.3	3.3	2.8	26	24	36	29[b]	25[b]	25[b]	105	116	124	70[b]	61[b]	82[b]
29	5.7	3.7	3.1	25	30	27	43[b]	25[b]	25[b]	105	115	125	70[b]	60[b]	80[b]
30[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statewide	6.2	6.9	7.6	34	37	41	31	27	27	110	137	152	71	83	82

[a]Population attributes cannot be estimated for this district
[b]Estimates biased by low sample size

Table 14. Deer population and deer harvest in Maine during 1997, by Wildlife Management Districts (WMDs).

Wildlife Management District	Registered Deer Harvest						Harvest per 100 Adult Bucks		Harvest per 100 Sq. Mile Habitat	
	Adult Buck	Doe	Fawn Buck	Fawn Doe	Antlerless Deer	All Deer	Adult Does	Antlerless	Adult Bucks	All
1	525	6	2	1	9	534	1	2	37	38
2	176	3	0	0	3	179	2	2	15	15
3	111	1	1	0	2	113	1	2	12	12
4	412	10	2	1	13	425	2	3	21	22
5	486	21	3	2	26	512	4	5	31	33
6	332	13	1	1	15	347	4	5	24	25
7	533	64	33	14	111	644	12	21	39	47
8	544	73	21	12	106	650	13	19	27	32
9	159	31	9	7	47	206	19	30	17	22
10	212	49	17	8	74	286	23	35	24	32
11	560	98	33	22	153	713	18	27	34	43
12	548	137	40	34	211	759	25	39	58	81
13	475	219	60	51	330	805	46	69	84	142
14	391	117	26	24	167	558	30	43	49	70
15	1,322	609	212	177	998	2,320	46	75	133	233
16	1,191	635	182	162	979	2,170	53	82	166	302
17	2,502	1,289	371	346	2,006	4,508	52	80	184	331
18	742	188	62	54	304	1,046	25	41	57	80
19	204	8	2	2	12	216	4	6	17	19
20	775	504	150	134	788	1,563	65	102	129	260
21	908	534	197	170	901	1,809	59	99	186	371
22	1,103	493	164	108	765	1,868	45	69	212	359
23	1,913	907	290	248	1,445	3,358	47	76	210	368
24	921	545	176	150	871	1,792	59	95	334	649
25	623	258	58	55	371	994	41	60	129	205
26	955	292	72	61	425	1,380	31	45	154	223
27	526	117	38	26	181	707	22	34	64	87
28	202	7	0	2	9	211	3	4	24	25
29	161	7	3	0	10	171	4	6	33	35
30[2]	148	084	47	29	160	308	57	108	-	-
Statewide	19,660	7,319	2,272	1,901	11,492	31,152	37	58	67	107

[1]Sex/age data were corrected for errors in the deer registrations.
[2]Area of deer habitat in WMD 30 has not been determined.

1999/assessment/deer/drpop drhvst

Table 14. Deer population and harvest in Maine during 1997, by Wildlife Management Districts (WMDs) con't.

Wildlife Management District	Pre-hunt Population Size 1997 Adult Buck	Adult Doe	Fawn Buck	Fawn Doe	Total	Pre-hunt Total per Sq. Mi. Habitat	Post-hunt Population Size 1997 Adult Buck	Adult Doe	Fawn Buck	Fawn Doe	Total	Post-hunt Total per Sq. Mi. Habitat
1	3,236	3,659	1,218	1,087	9,200	6.5	2,590	3,548	1,155	1,032	8,325	5.9
2	1,108	1,319	404	361	3,192	2.7	891	1,280	383	342	2,896	2.5
3	459	683	274	245	1,661	1.8	323	660	260	232	1,475	1.6
4	3,273	3,484	1,086	970	8,813	4.5	2,766	3,392	1,037	926	8,121	4.1
5	3,977	4,097	1,277	1,140	10,491	6.8	3,379	3,979	1,218	1,087	9,663	6.3
6	1,541	2,014	830	741	5,126	3.7	1,132	1,935	790	706	4,563	3.3
7	3,956	4,289	1,496	1,335	11,076	8.1	3,301	4,119	1,409	1,258	10,087	7.4
8	3,470	3,817	1,351	1,206	9,844	4.8	2,801	3,635	1,271	1,134	8,841	4.3
9	1,043	1,138	385	343	2,909	3.1	848	1,075	358	319	2,600	2.7
10	1,420	1,436	516	461	3,833	4.3	1,160	1,344	478	427	3,409	3.8
11	3,936	3,988	1,348	1,204	10,476	6.3	3,248	3,778	1,254	1,120	9,400	5.6
12	3,152	4,087	1,512	1,350	10,101	10.8	2,478	3,841	1,409	1,258	8,986	9.6
13	2,536	3,378	1,553	1,386	8,853	15.7	1,952	3,064	1,439	1,285	7,740	13.7
14	2,433	2,707	829	740	6,709	8.5	1,952	2,511	757	676	5,896	7.4
15	4,311	7,811	3,961	3,537	19,620	19.7	2,685	6,937	3,602	3,216	16,440	16.5
16	4,121	6,454	3,307	2,953	16,835	23.4	2,656	5,580	2,987	2,667	13,890	19.3
17	8,790	15,018	6,585	5,880	36,273	26.6	5,712	13,229	5,916	5,282	30,139	22.1
18	3,630	4,473	1,985	1,772	11,860	9.1	2,717	4,136	1,837	1,640	10,330	7.9
19	1,077	1,383	592	528	3,580	3.1	826	1,334	566	505	3,231	2.8
20	2,135	3,465	1,574	1,405	8,579	14.3	1,181	2,806	1,334	1,191	6,512	10.8
21	2,176	3,821	1,817	1,622	9,436	19.3	1,059	3,105	1,517	1,355	7,036	14.4
22	3,145	5,493	2,670	2,384	13,692	26.3	1,788	4,779	2,398	2,141	11,106	21.3
23	6,561	11,130	5,410	4,830	27,931	30.6	4,208	9,841	4,903	4,378	23,330	25.6
24	2,307	4,264	2,117	1,891	10,579	38.3	1,174	3,535	1,838	1,641	8,188	29.7
25	1,993	2,991	1,375	1,227	7,586	15.7	1,227	2,608	1,243	1,109	6,187	12.8
26	3,135	5,573	2,709	2,419	13,836	22.4	1,960	5,090	2,528	2,257	11,835	19.1
27	2,516	3,249	1,528	1,364	8,657	10.6	1,869	3,027	1,433	1,279	7,608	9.3
28	1,200	1,521	643	574	3,938	4.7	951	1,473	618	551	3,593	4.3
29	1,083	1,105	508	453	3,149	6.5	885	1,065	487	435	2,872	5.9
30[a]												
Statewide	83,720	117,847	50,860	45,408	297,835	10.2	59,719	106,706	46,425	41,449	254,299	8.7

[a]Data are not available to estimate population attributes.

1999/assessment/deer/drpop drhvst Part II

Table 14. Deer population and harvest in Maine during 1997, by Wildlife Management Districts (WMDs) con't.

Wildlife Management District	Pre-hunt Population Ratios: Adult Does Per 100 Adult Bucks	Pre-hunt Population Ratios: Anterless Per 100 Adult Bucks	Pre-hunt Population Ratios: Fawns Per 100 Adult Does	Mortality Rates: Legal Hunting Mortality (% of Pre-hunt Population): Adult Buck	Adult Doe	Fawn	All-cause Allowable Doe Mortality (%)	Adult Doe Mortality as % of All-cause Allowable Mortality
1	113	184	63	16	<1	<1	23	1
2	119	188	58	16	<1	<1	22	1
3	149	262	76	24	<1	<1	26	2
4	106	169	59	13	<1	<1	22	1
5	103	164	59	12	<1	<1	22	2
6	131	233	78	22	1	<1	27	2
7	108	180	66	14	2	1	24	6
8	110	184	67	16	2	1	24	8
9	109	179	64	15	3	2	23	12
10	101	170	68	15	3	2	24	14
11	101	166	64	14	3	2	23	11
12	130	220	70	17	3	3	25	14
13	133	249	87	19	7	4	29	22
14	111	176	58	16	4	3	22	20
15	181	355	96	31	8	5	31	25
16	157	309	97	29	10	6	31	32
17	171	313	83	29	9	6	28	31
18	123	227	84	20	4	3	28	15
19	128	232	81	19	1	<1	28	2
20	162	302	86	36	15	10	29	50
21	176	334	90	42	14	11	30	47
22	175	335	92	35	9	5	30	30
23	170	326	92	29	8	5	30	27
24	185	359	94	40	13	8	31	41
25	150	281	87	31	9	4	29	30
26	178	341	92	31	5	3	30	17
27	129	244	89	21	4	2	30	12
28	127	228	80	17	1	<1	27	2
29	102	191	87	15	1	<1	29	2
30[a]								
Statewide	141	256	82	23	6	4	27	22

[a]-Data are not available to estimate population attributes.

1999/assessment/deer/drpop drhvst Part III

Table 15. Summary of deer harvest and effort data statewide in Maine during 1919 to 1998.

Year	Registered Deer Kill	License Holders			Estimated Actual Hunters[1]	Hunter-Days Effort[2] (Millions)	Success Rate[3] (%)	Kill/1,000 Hunter-Days	Number Unsuccessful Hunters[5]
		Resident	Nonresident	Total					
1919	5,784	3,043							
1920	5,829	3,109							
1921	8,861	3,074							
1922	7,628	3,142							
1923		3,021							
1924		3,494							
1925	8,379	3,355							
1926		3,619							
1927	8,112	3,375							
1928	9,061	3,803							
1929	11,708	4,276							
1930	13,098	70,596	4,355	74,951	63,708	0.51	20.6	25.6	50,610
1931	14,694	91,743	4,215	95,958	81,564		18.0		66,870
1932	15,465	103,961	3,535	107,496	91,372		16.9		75,907
1933	18,935	99,519	3,476	102,995	87,545		21.6		68,610
1934	13,284	92,747	3,628	96,375	81,919		16.2		68,635
1935	19,726	98,633	3,716	102,349	86,997	0.70	22.7	28.2	67,271
1936	19,134	99,030	4,156	103,186	87,708		21.8		68,574
1937	19,197	92,927	5,055	97,982	83,284		23.1		64,087
1938	19,363	93,308	5,155	98,463	83,694		23.1		64,331
1939	19,187	92,920	5,070	97,990	83,292		23.0		64,105
1940	22,201	94,024	5,677	99,701	84,746	0.68	26.2	32.6	62,545
1941	19,881	99,521	6,115	105,636	89,791		22.1		69,910
1942	22,591	99,014	5,447	104,461	88,792		25.4		66,201
1943	24,408	102,411	7,191	109,602	93,162		26.2		68,754
1944	21,708	102,176	8,329	110,505	93,929		23.1		72,221
1945	24,904	102,343	11,478	113,821	96,748	0.77	25.7	32.3	71,844
1946	31,728	113,189	17,576	130,765	111,150		28.5		79,422
1947	30,349	101,520	11,906	113,426	96,412		31.5		66,063
1948	35,364	106,809	17,458	124,267	105,627		33.5		70,263
1949	35,051	138,467	16,348	154,815	131,593		26..6		96,542
1950	39,216	144,349	16,612	160,961	136,817	1.09	28.7	36.0	97,601
1951	41,370	145,872	19,777	165,649	140,802		29.4		99,432
1952	35,471	145,928	23,974	169,902	144,417		24.6		108,946
1953	38,609	146,031	23,265	169,296	143,902		26.8		105,293
1954	37,379	148,258	24,427	172,685	146,782		25.5		109,403

Table 15. Summary of deer harvest and effort data statewide in Maine during 1919 to 1998 (continued).

Year	Registered Deer Kill	License Holders			Estimated Actual Hunters[1]	Hunter-Days Effort[2] (Millions)	Success Rate[3] (%)	Kill/1,000 Hunter-Days	Number Unsuccessful Hunters[5]
		Resident	Nonresident	Total					
1955	35,591	145,087	24,925	170,012	144,510	1.16	24.6	30.7	108,919
1956	40,290	146,151	23,505	169,656	144,208		27.9		103,918
1957	40,142	151,295	24,039	175,334	149,034		26.9		108,892
1958	39,393	151,511	23,227	174,738	148,527		26.5		109,134
1959	41,735	151,469	24,061	175,530	149,201		28.0		107,466
1960	37,774	157,650	25,744	183,394	155,885		24.2		118,111
1961	32,747	147,182	25,687	172,869	146,939	1.18	22.3	27.8	114,192
1962	38,807	150,877	25,889	176,766	150,251		25.8		111,444
1963	29,839	147,205	28,518	175,723	149,365		20.0		119,526
1964	35,305	153,212	30,034	183,246	155,759	1.22	22.7	28.9	120,454
1965	37,282	152,665	33,143	185,808	157,937		23.6		120,655
1966	32,160	166,612	32,259	198,871	169,040		19.0		136,880
1967	34,707	165,847	33,464	199,311	169,414		20.5		134,707
1968	41,080	171,098	36,119	207,217	159,557	1.15	25.7	35.7	118,477
1969	30,409	167,267	38,622	205,889	158,535	1.15	19.2	26.4	128,126
1970	31,750	177,373	41,707	219,080	168,692	1.23	18.8	25.8	136,942
1971	18,903	159,044	38,480	197,524	154,666	1.11	12.2	17.1	135,763
1972	28,698	151,916	29,764	181,680	140,857	1.27	20.4	22.5	112,159
1973	24,720	165,036	32,920	197,956	149,143	1.23	16.6	19.5	124,432
1974	34,667	177,088	33,364	210,452	162,952	1.14	21.3	29.5	128,285
1975	34,675	188,847	35,929	224,776	182,285	1.46	19.0	24.0	147,610
1976	29,965	203,095	30,136	233,231	196,437	1.57	15.3	19.1	166,472
1977	31,430	206,956	30,208	237,164	199,590	1.60	15.7	19.6	168,160
1978	29,002	211,135	33,112	244,247	204,933	1.65	14.2	17.6	175,931
1979	26,821	214,310	34,127	248,437	207,286	1.68	12.9	16.0	180,465
1980	37,255	217,294	34,520	251,814	210,724	1.70	17.7	21.9	173,469
1981	32,167	224,308	33,332	257,640	215,485	1.74	14.9	18.5	183,318
1982	28,834	223,324	35,263	258,587	216,285	1.75	13.3	16.5	187,451
1976-82	**30,782**	**214,346**	**32,957**	**247,303**	**207,249**	**1.67**	**14.9**	**18.4**	**176,467**
1983	23,799	215,034	35,104	250,138	209,091	1.69	11.4	14.1	185,292
1984	19,358	208,710	34,551	243,261	203,273	1.92	9.5	10.1	183,915
1985	21,424	212,187	32,880	245,067	204,304	1.94	10.5	11.0	182,880
1986	19,592	197,089	34,175	231,264	192,469	2.02	10.2	9.7	172,877
1987	23,729	194,333	36,406	230,739	190,822	2.00	12.4	11.8	167,093
1988	28,056	200,806	39,988	240,794	197,903	2.21	14.2	12.7	169,847
1989	30,260	204,115	42,785	246,900	203,723	2.14	14.9	14.1	173,463

Table 15. Summary of deer harvest and effort data statewide in Maine during 1919 to 1998 (continued).

Year	Registered Deer Kill	License Holders			Estimated Actual Hunters[1]	Hunter-Days Effort[2] (Millions)	Success Rate[3] (%)	Kill/1,000 Hunter-Days	Number Unsuccessful Hunters[5]
		Resident	Nonresident	Total					
1983-89	**23,745**	**204,611**	**36,556**	**241,167**	**200,226**	**1.99**	**11.9**	**11.9**	**176,499**
1990	25,977	200,127	40,117	240,244	197,932	2.10	13.1	12.4	171,955
1991	26,736	203,303	39,251	242,554	199,389	2.12	13.4	12.5	172,653
1992	28,820	207,200	39,635	246,835	193,669	2.17	14.9	13.3	164,849
1993	27,402	206,846	38,600	245,446	191,636	2.17	14.3	12.6	164,234
1994	24,683	203,691	36,941	240,632	186,449	2.13	13.2	11.6	161,766
1995	27,384	199,688	35,458	235,146	183,183	2.11	14.9	13.0	155,799
1996	28,375	196,502	35,490	231,992	180,953	2.08	15.7	13.7	152,578
1990-96	**27,054**	**202,480**	**37,927**	**240,407**	**190,459**	**2.13**	**14.2**	**12.7**	**163,405**
1997	31,152	195,372	35,498	230,870	179,527	2.06	17.4	15.1	148,375
1998[5]	28,241	196,077	35,563	231,640	179,713	2.07	15.7	13.6	151,472

[1]License buyers who did not hunt deer were estimated from respondents of Department's Game Kill Questionnaires, 1971-83, and the 1984, 1987 and 1996 hunting surveys. Data for earlier years were estimated assuming 15% non-deer hunters, overall, after Gill (1966), Banasiak (1964b) and Banasiak (1964a).

[2]Data for 1971-82 were derived from annual Game Kill Questionnaire. Data for earlier years assumes 8.1 hunting days for residents and 6.5 hunting days for nonresidents after Gill (1966) and Banasiak (1964). Data for 1983 to 1997 were derived from the 1984, 1987 and 1996 hunting surveys.

[3]Success rate derived as (registered kill/estimated actual hunters) X 100.

[4]Unsuccessful hunters estimated as (estimated actual hunters - registered kill).

[5]License sales are preliminary. This leads to a slight under-estimate of hunters and a slight over-estimate of success rate.

Table 16. Estimates of the number of deer hunters, effort and success rate in Maine by Wildlife Management District, 1976 to 1996.

Wildlife Management District	Deer Hunters			Deer Hunters Per Mi^2 Habitat			Hunter-Days Effort Per Mi^2 Habitat			Average Deer Harvest			Success Rate		
	1976-82	1983-89	1990-96	1976-82	1983-89	1990-96	1976-82	1983-89	1990-96	1976-82	1983-89	1990-96	1976-82	1983-89	1990-96
1	2,100	2,000	2,100	1.4	1.3	1.4	11	13	15	642	595	539	31	30	26
2	1,900	1,800	1,900	1.6	1.5	1.6	13	15	17	615	326	198	32	18	11
3	4,300	3,800	3,900	4.6	4.1	4.2	37	45	48	311	215	105	7	6	3
4	4,600	3,000	3,200	2.0	1.5	1.7	16	15	17	590	657	591	13	22	18
5	4,000	3,000	3,200	2.6	2	2.1	21	20	21	808	735	550	20	25	17
6	8,300	6,900	7,200	6.0	5	5.2	48	56	61	530	387	282	6	6	4
7	4,700	3,100	3,200	3.4	2.2	2.3	27	23	25	654	471	751	14	15	24
8	8,300	6,000	6,200	4.0	2.9	3.0	32	29	32	809	738	868	10	12	14
9	3,800	3,200	3,100	4.0	3.4	3.3	32	32	34	456	299	263	12	9	8
10	4,700	3,800	3,700	5.3	4.3	4.2	43	38	40	509	446	300	11	12	8
11	9,900	7,300	7,100	6.0	4.4	4.3	48	45	47	1,483	1,479	850	15	20	12
12	6,200	4,800	4,700	6.6	5.1	5.0	53	50	55	702	439	759	11	9	16
13	4,100	3,000	2,900	7.3	5.3	5.2	59	53	57	645	489	689	16	16	23
14	5,800	4,200	4,100	7.3	5.3	5.2	59	55	60	706	647	665	12	15	16
15	14,400	11,400	10,700	14.5	11.5	10.8	117	115	125	1,471	906	1,979	10	8	18
16	10,800	12,000	10,700	15.1	16.7	14.9	122	166	174	1,538	1,152	1,703	14	10	16
17	18,000	19,700	19,200	13.2	14.5	14.1	106	144	163	3,778	3,510	4,027	21	18	21
18	11,200	11,100	10,200	8.6	8.5	7.8	69	85	89	1,475	1,333	965	13	12	9
19	5,300	5,900	5,300	4.6	5.1	4.6	37	51	52	703	497	215	13	8	4
20	10,900	11,800	11,400	18.1	19.6	19.0	146	195	220	1,302	754	1,321	12	6	12
21	9,200	10,000	9,500	18.7	20.4	19.4	151	203	231	816	803	1,403	9	8	15
22	8,900	10,300	9,800	17.0	19.7	18.8	137	196	223	1,275	999	1,302	14	10	13
23	14,500	15,200	14,800	15.9	16.6	16.2	128	165	187	3,236	2,578	2,817	22	17	19
24	5,300	5,600	5,300	19.1	20.2	19.1	154	201	228	983	782	1,299	19	14	25
25	8,400	9,200	8,800	17.4	19.1	18.2	140	190	213	1,166	828	817	14	9	9
26	7,300	8,400	8,200	11.9	13.7	13.3	96	137	156	1,438	960	1,014	20	11	12
27	5,300	5,400	4,900	6.6	6.7	6.1	53	67	72	1,037	450	475	20	8	10
28	3,900	3,000	2,700	4.6	3.6	3.2	37	36	38	575	177	134	15	8	5
29	2,900	2,100	1,900	6.0	4.5	4.0	48	45	47	378	123	94	13	6	5
30	NA	NA	NA	NA	NA	NA	NA	NA	NA	98	69	155	NA	NA	NA
Statewide	207,249	200,226	190,500	7.1	6.9	6.5	57	68	69	30,782	23,745	27,054	15	12	14

1999/assessment/deer/drhnt by WMD

Table 17. Projected hunter distribution, and deer hunting effort expected to occur in Maine by 2012, by Wildlife Management District.

Wildlife Management District[a]	Deer Hunters	Hunters Per Mi^2 Habitat	Hunter-Days effort Per Mi^2 Habitat[b]
1	1,710	1.1	14
2	1,528	1.3	17
3	3,154	3.4	44
4	2,634	1.4	18
5	2,592	1.7	22
6	5,859	4.2	55
7	2,586	1.9	25
8	5,049	2.4	31
9	2,555	2.7	35
10	3,021	3.4	44
11	5,772	3.5	46
12	3,818	4.1	53
13	2,388	4.2	55
14	3,375	4.2	55
15	8,714	8.8	114
16	8,745	12.1	157
17	15,630	11.4	148
18	8,287	6.3	82
19	4,315	3.7	48
20	9,287	15.4	200
21	7,698	15.8	205
22	7,958	15.3	199
23	12,004	13.2	172
24	4,288	15.5	202
25	7,175	14.8	192
26	6,696	10.8	140
27	4,022	5.0	65
28	2,155	2.6	34
29	1,580	3.2	42
30	unknown	unknown	unknown
Statewide	155,000	5.3	69[c]

[a] Assumes quantity of deer habitat between 1997 and 2012 is unchanged.
[b] Distribution of hunters among WMDs assumed unchanged between 1997 and 2012. Also assumes days deer hunting effort per hunter will increase by 1.5 days by 2012 to 13 days/hunter/year.
[c] Total deer hunting effort would approximate 2.0 million hunter-days.

1999/assessment/deer/projdrhvst

Table 18. Summary of objective vs. current deer population, wintering habitat, harvest, and hunter success.

Wildlife Management	Percent of MSP		Wintering Deer/mi^2		Wintering Habitat (% of WMD)		Harvest to Stabilize		Hunter Success Rate %	
District	Current	Target	Current	Target	Current	Target	Current	Target	Current	Potential[a]
	1997		1997		Known	Required	1997		1990-96	
1	42	55	5.7	10	3.0	9.0	651	1,100	26	64
2	47	55	2.6	10	2.2	8.2	218	900	11	59
3	36	55	1.8	10	1.8	7.9	129	800	3	25
4	43	55	4.6	10	1.9	9.1	543	1,350	18	51
5	45	55	7.0	10	2.6	8.0	641	950	17	37
6	31	55	3.1	10	1.4	8.0	438	1,250	4	23
7	55	55	7.3	10	2.9	7.3	789	1,100	24	43
8	51	55	5.1	10	2.1	8.3	762	1,800	14	36
9	56	55	2.9	10	2.1	7.1	236	850	8	33
10	57	55	3.9	10	3.2	6.7	330	850	8	28
11	43	55	5.5	10	5.5	6.7	829	1,450	12	25
12	58	55	10.1	15	2.4	9.4	943	1,450	16	38
13	50	55	13.3	15	3.3	9.4	817	900	23	38
14	52	55	8.0	15	1.1	9.3	610	1,250	16	37
15	53	48	16.2	15	3.2	9.3	2,485	2,300	18	26
16	48	50	19.2	20	9.5	12.5	2,335	2,450	16	28
17	48	43	22.0	20	8.7	12.5	4,904	4,500	21	29
18	51	55	7.8	15	7.4	9.4	1,158	2,150	9	26
19	42	55	2.7	15	1.2	9.3	236	1,650	4	38
20	45	62	10.6	15	5.1	9.3	1,519	2,100	12	23
21	47	51	13.9	15	4.7	9.4	1,780	1,850	15	24
22	44	44	19.8	20	10.8	12.5	2,250	2,100	13	26
23	47	32	25.8	20	14.2	12.5	3,902	3,050	19	25
24	45	25	27.5	15	1.9	9.4	2,027	1,050	25	24
25	41	49	12.6	15	9.5	9.3	1,221	1,400	9	20
26	47	43	19.6	18	5.7	11.3	1,720	1,650	12	25
27	47	55	9.0	15	1.9	9.4	737	1,350	10	34
28	44	55	3.9	15	2.0	9.4	250	1,100	5	51
29	41	55	5.0	15	1.0	9.4	212	650	5	41
30	UNK	UNK	UNK	15	UNK	UNK	UNK	1,200	UNK	50
Statewide	-	-	8.7		4.0	9.1	34,672	46,650	14	30

[a]Success Rates above 25% are probably not feasible. WMDs with potential success >25% require an influx of hunters to achieve harvest potential.

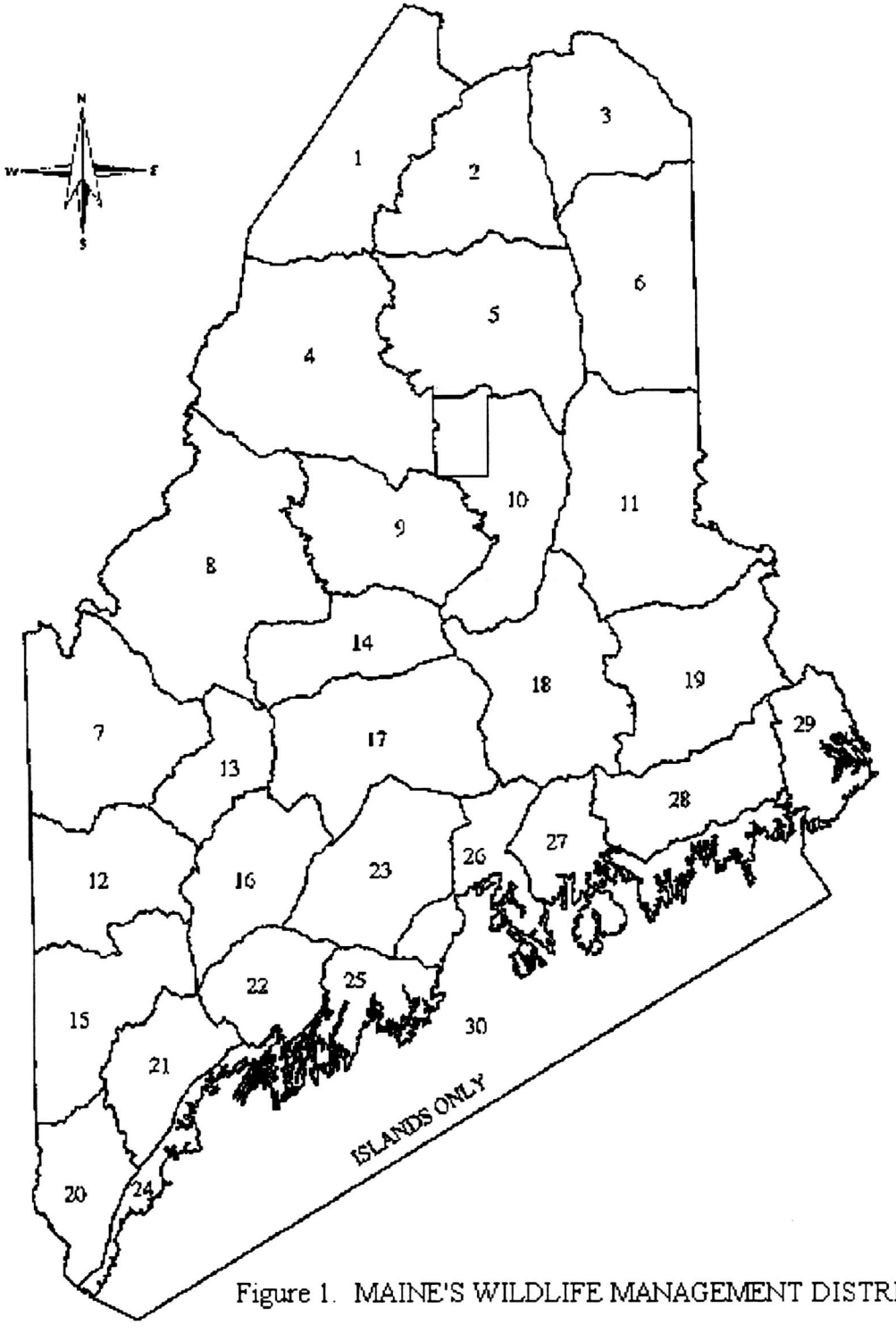


Figure 1. MAINE'S WILDLIFE MANAGEMENT DISTRICTS

MDIFW WMD'S

FIGURE 2. DEER HUNTING REGULATIONS DURING MAINE'S REGULAR FIREARMS AND MUZZLELOADER SEASONS

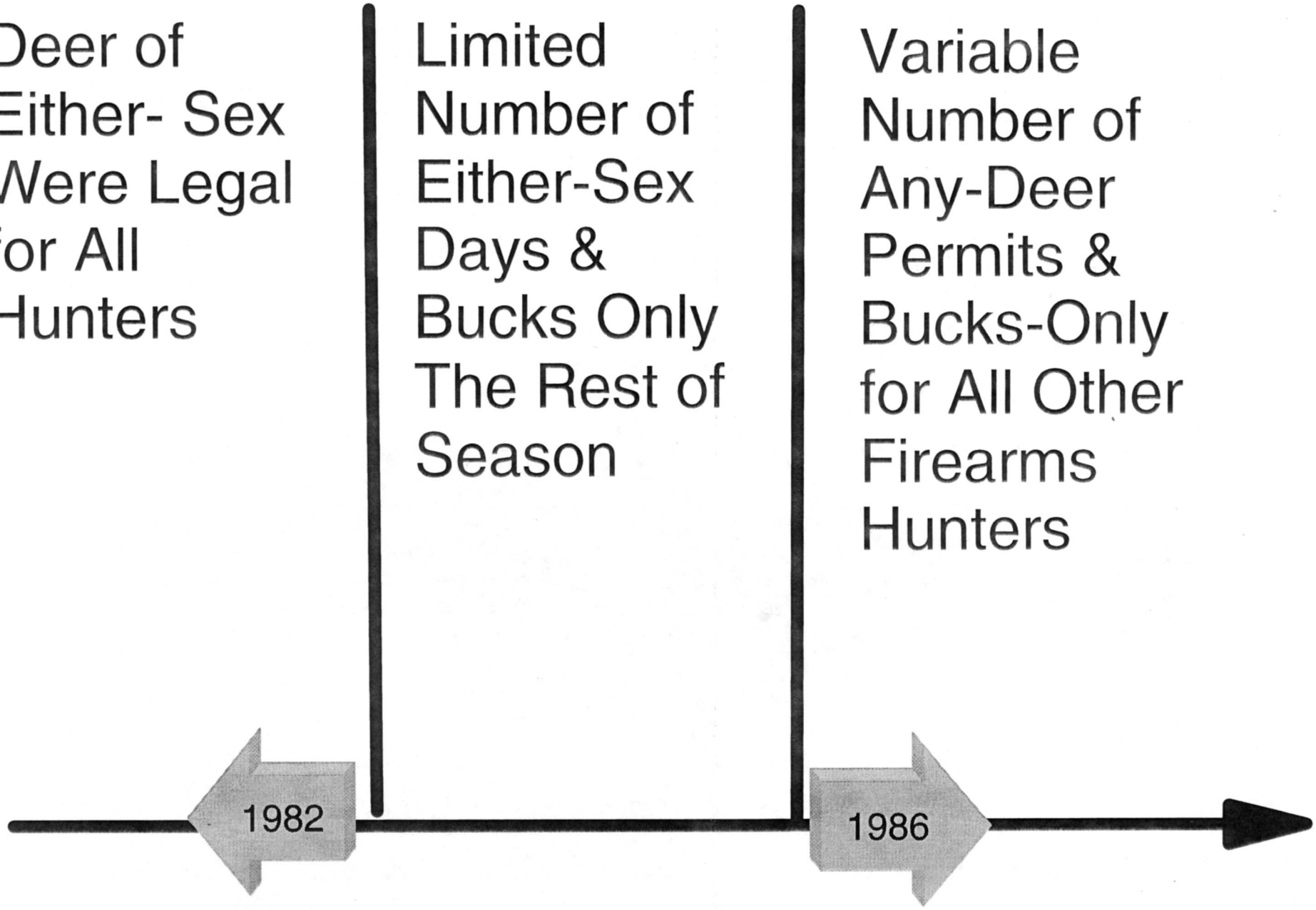
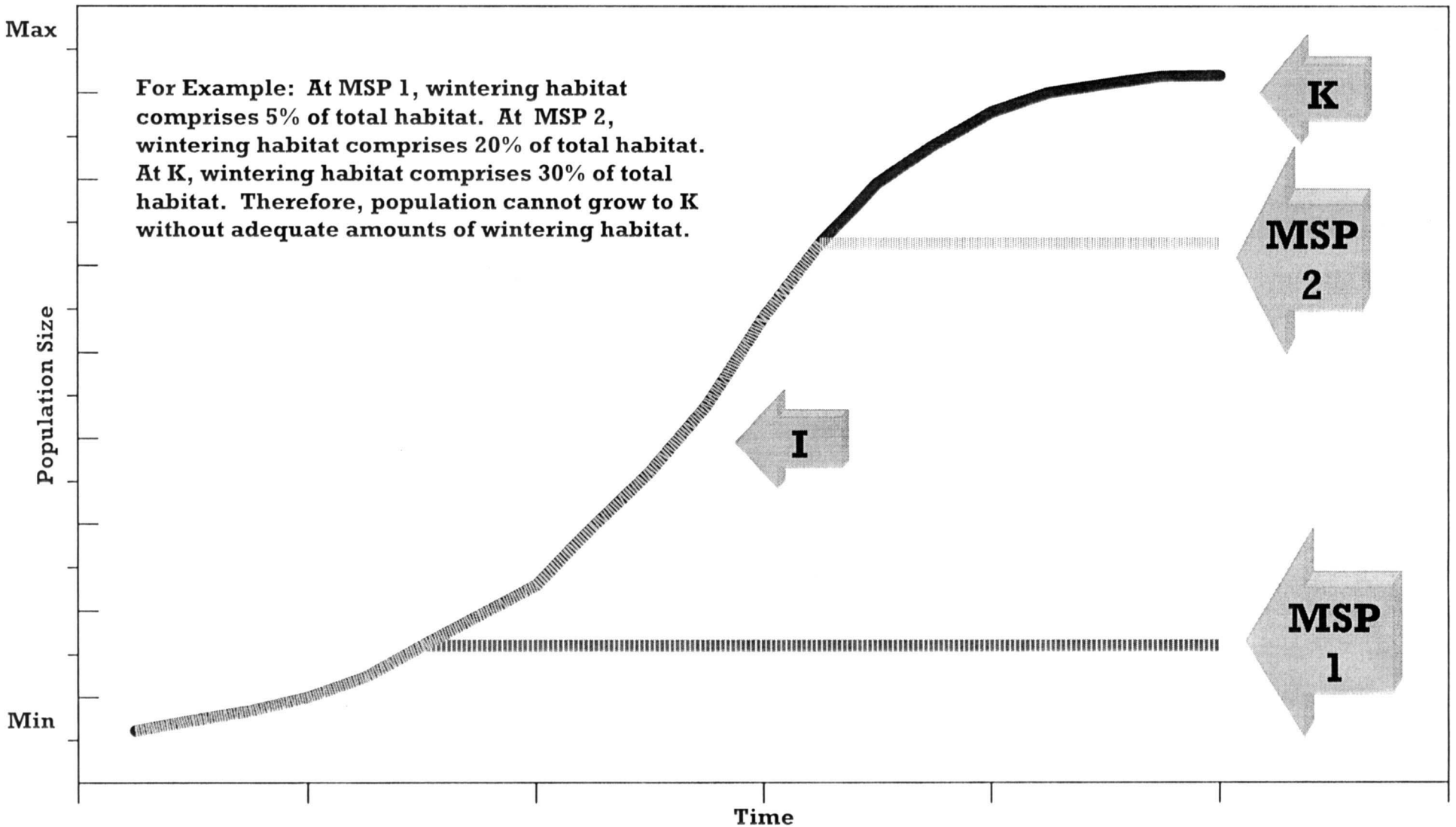


FIGURE 3. POPULATION GROWTH PATTERN OF DENSITY-DEPENDENT SPECIES LIKE DEER AND MOOSE



K denotes ecological carrying capacity when wintering habitat is not a limiting factor.
I is that point where maximum sustained yield (MSY) occurs.
MSP is the maximum supportable population given limited wintering habitat.

FIGURE 4. RELATIONSHIP BETWEEN ANTLER DEVELOPMENT OF YEARLING BUCKS AND ECOLOGICAL CARRYING CAPACITY (K)

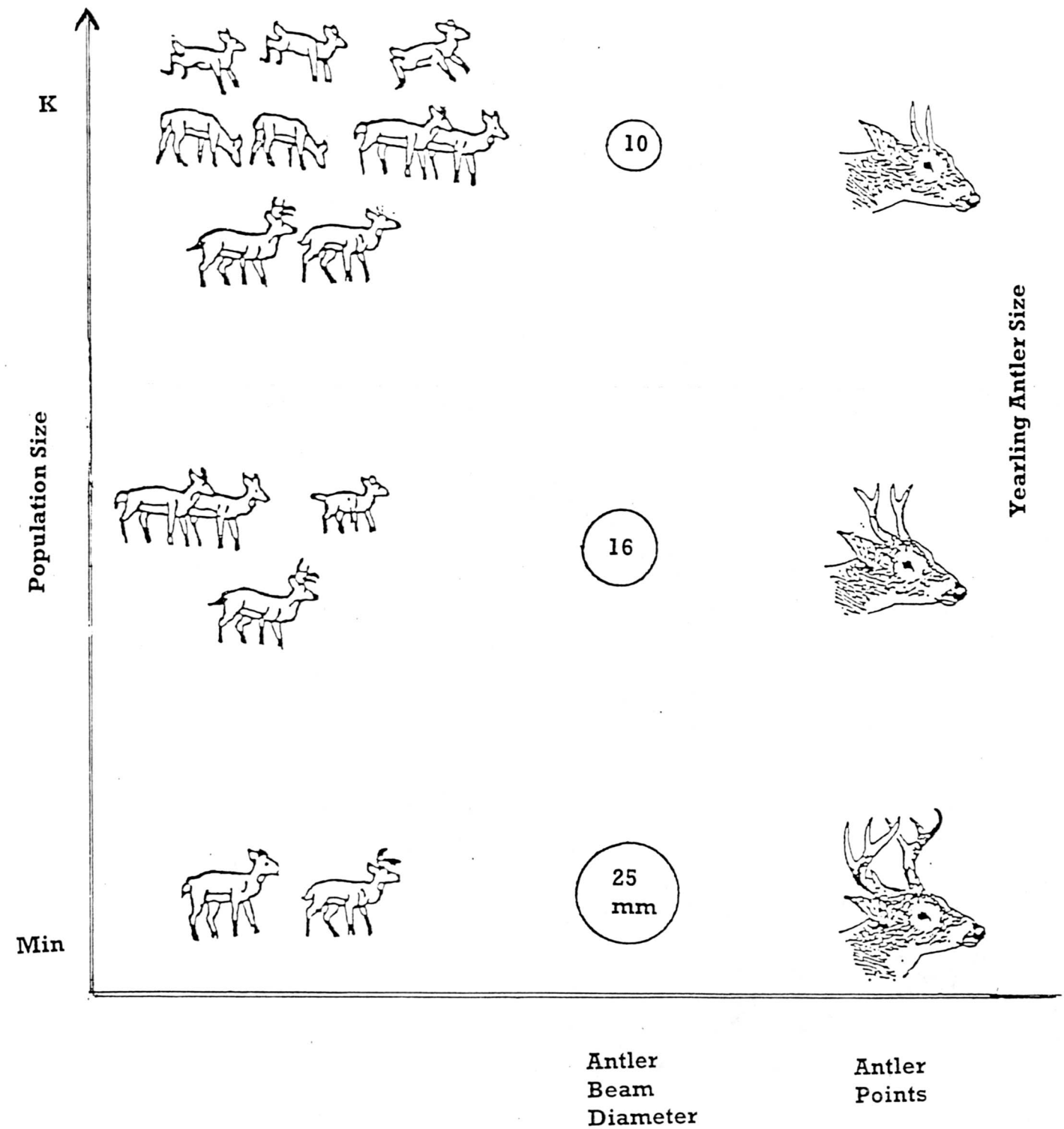


FIGURE 5. ADDITIVE VS. COMPENSATORY DEER MORTALITY FOR A POPULATION BEING HELD AT A GIVEN LEVEL IN RELATION TO CARRYING CAPACITY

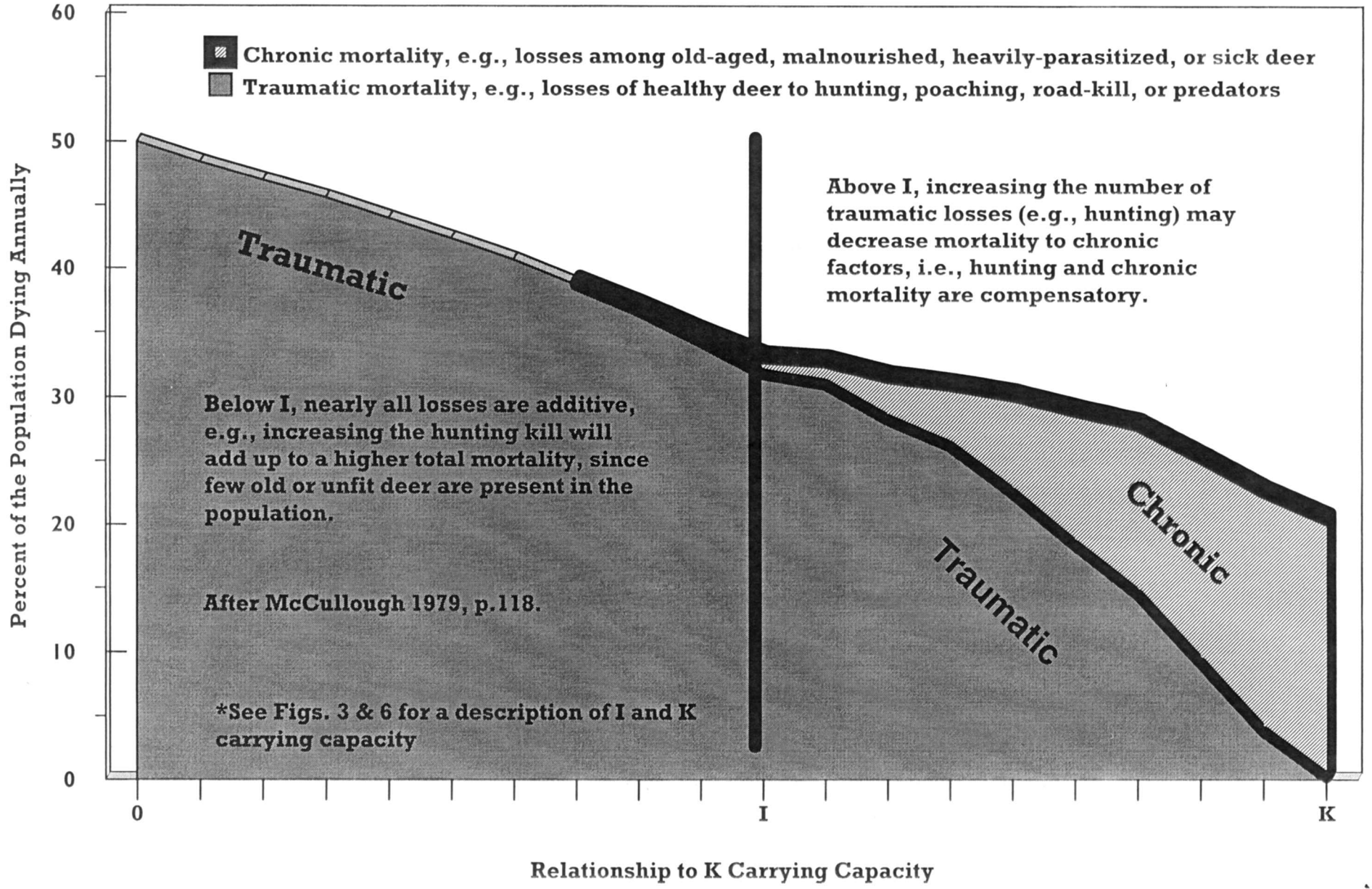
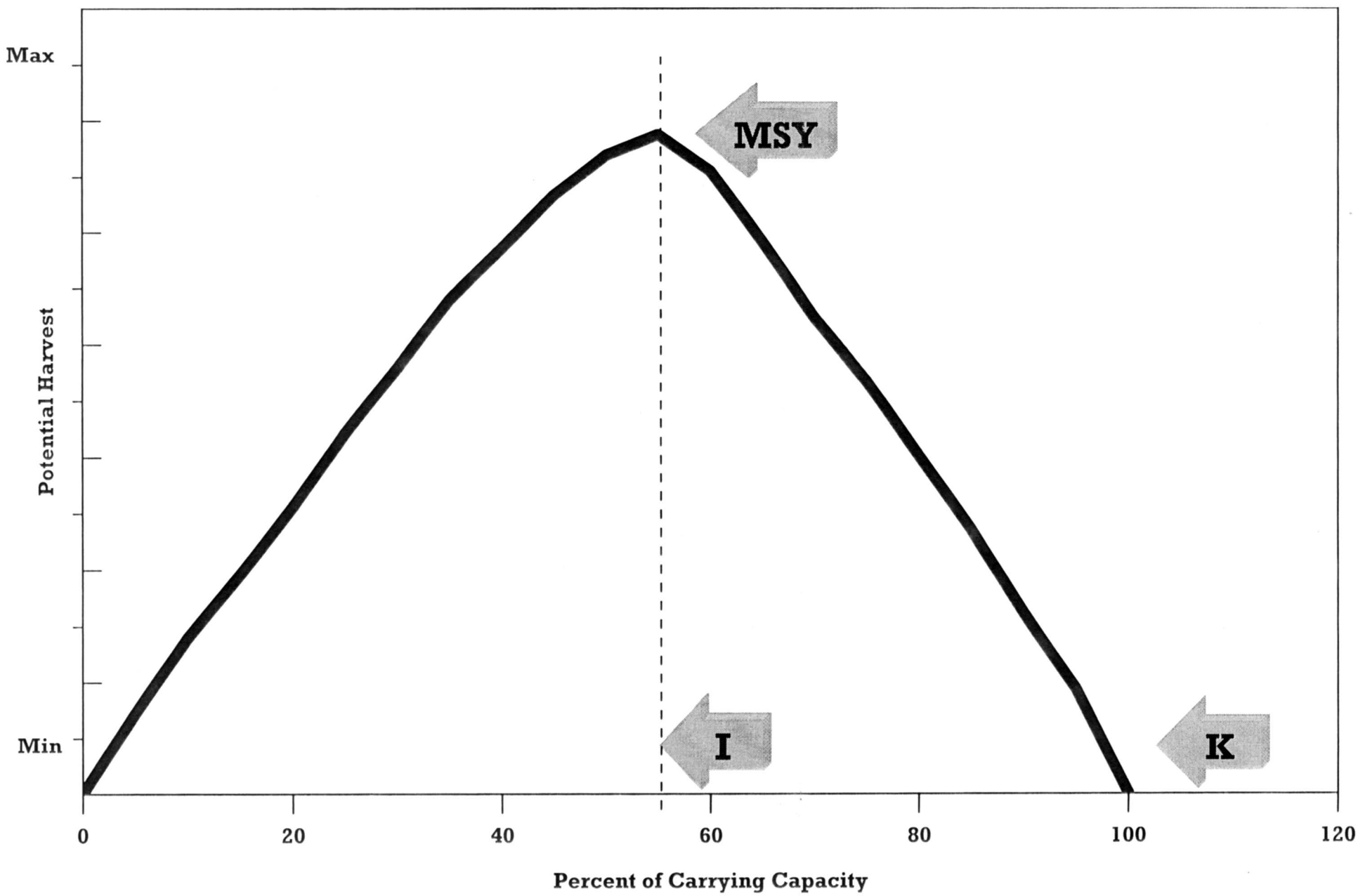


FIGURE 6. HARVEST POTENTIAL FOR DENSITY-DEPENDENT SPECIES LIKE DEER AND MOOSE



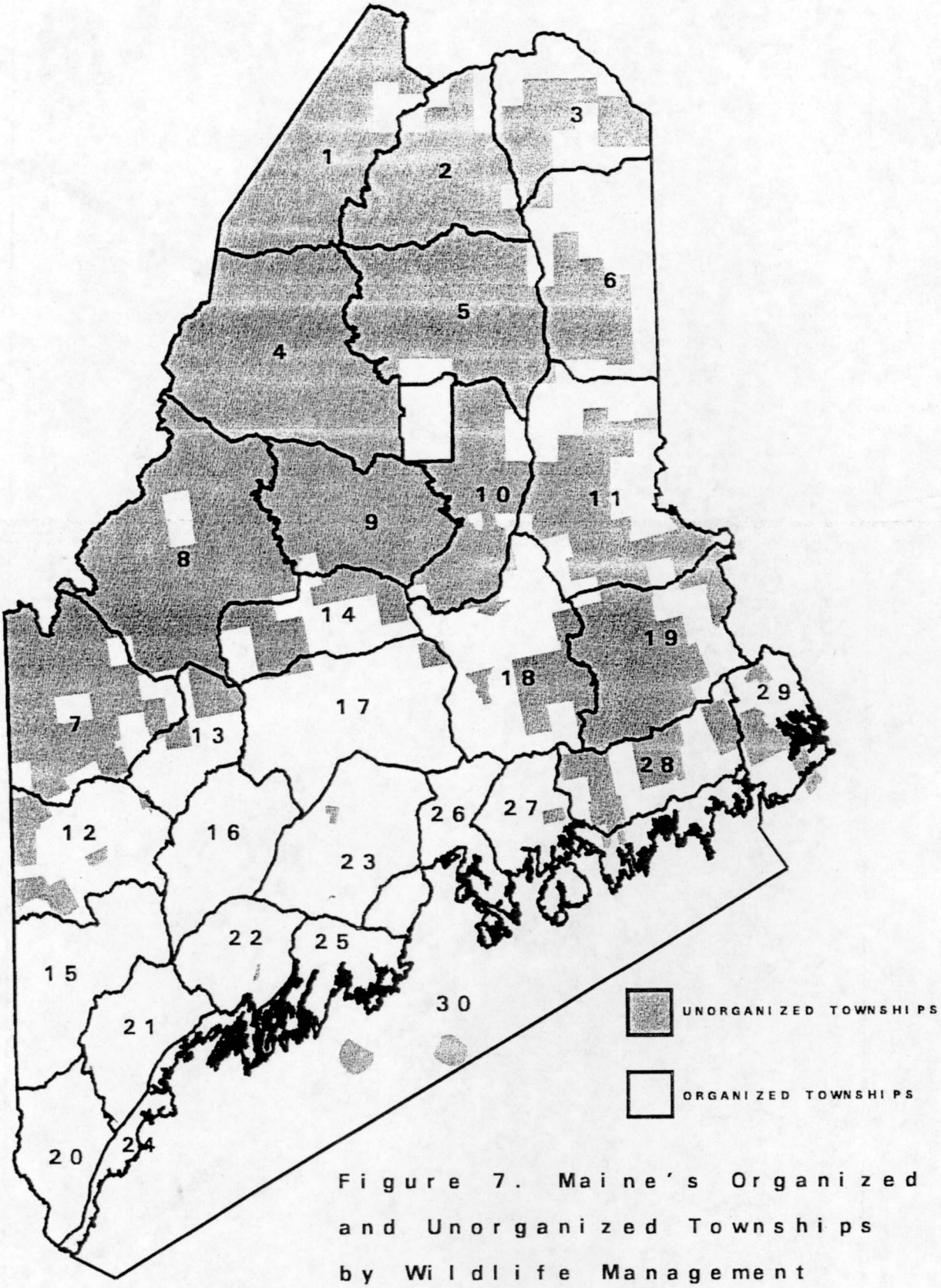


Figure 7. Maine's Organized and Unorganized Townships by Wildlife Management Districts, 1998

FIGURE 8. DAYS OF DEER HUNTING OPPORTUNITY IN MAINE BY SEASON TYPE, 1933 TO 1998

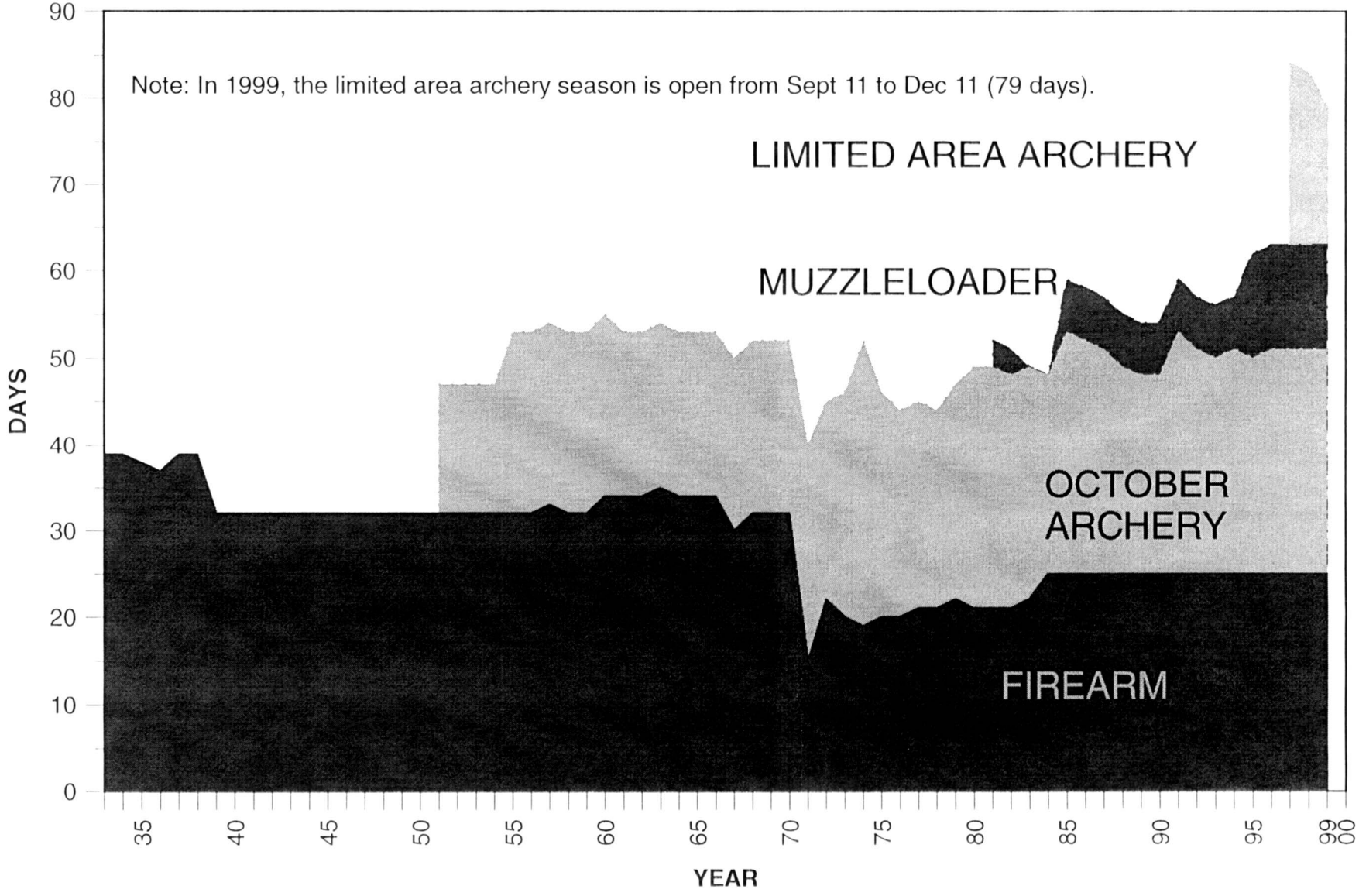


FIGURE 9. MAINE'S STATEWIDE WINTERING DEER POPULATION

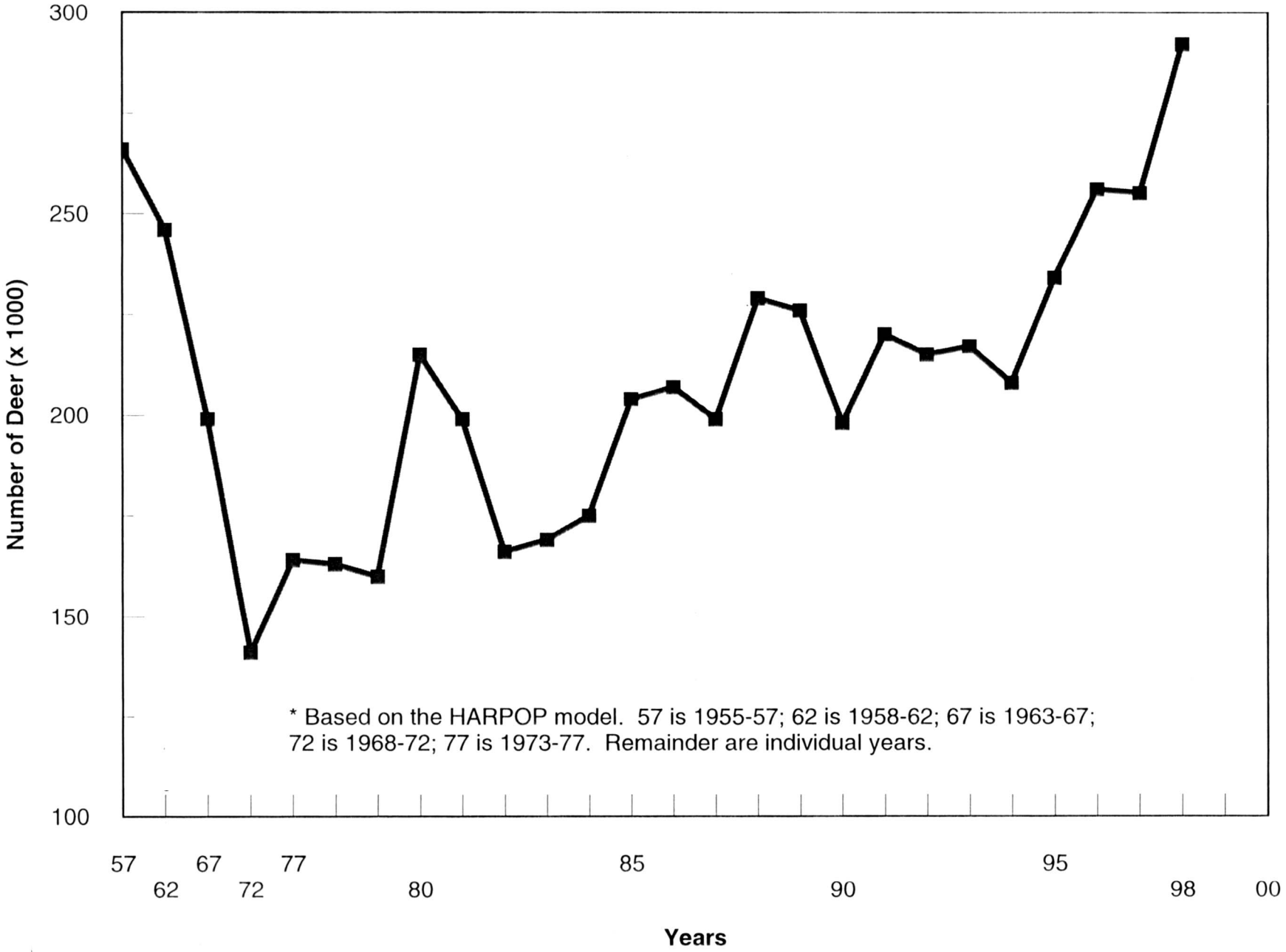


FIGURE 10. WINTERING DEER POPULATION DURING 1996-97 IN RELATION TO TARGET POPULATION BY WILDLIFE MANAGEMENT DISTRICTS IN MAINE

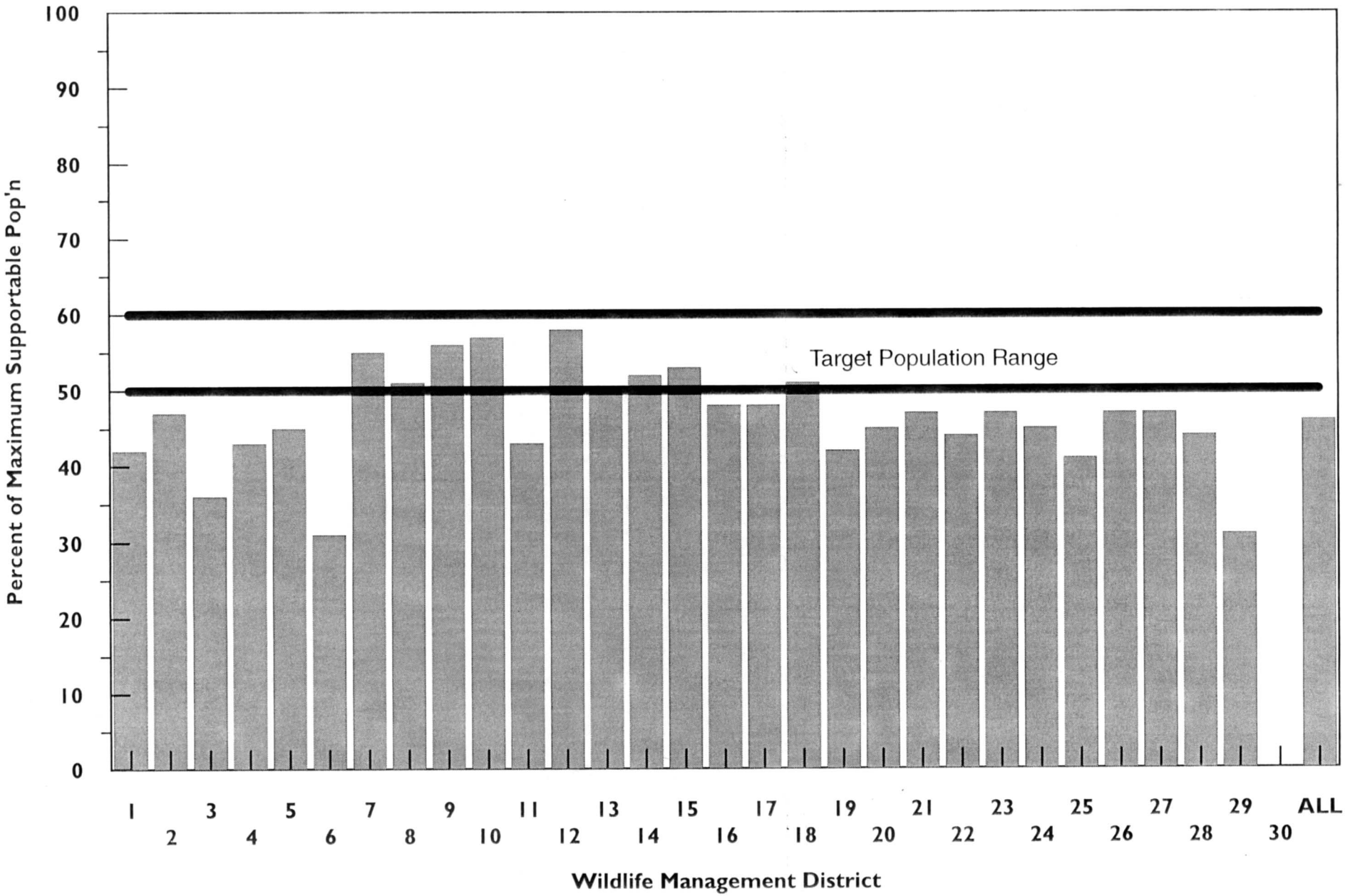
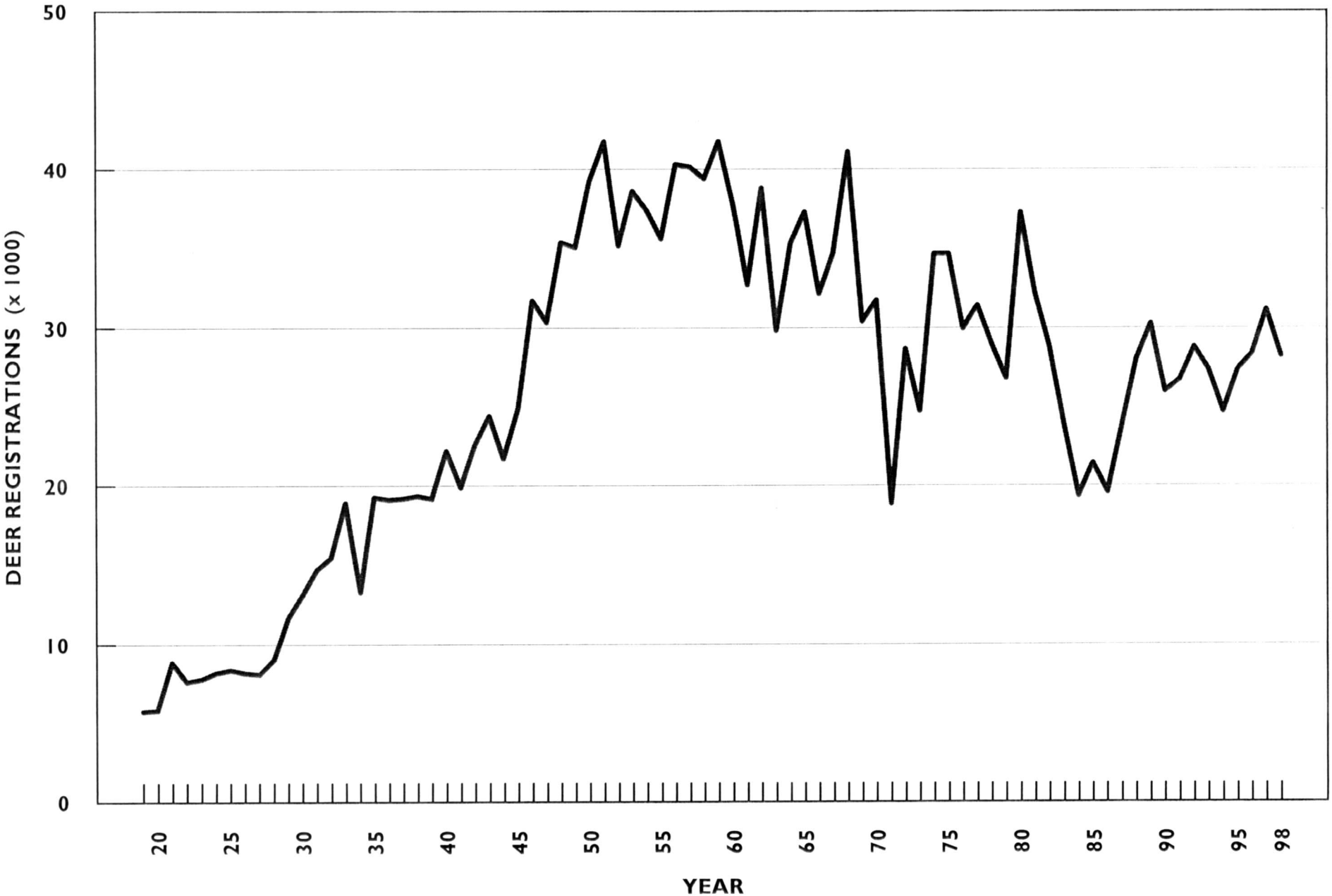


FIGURE 11. REGISTERED HARVEST OF DEER IN MAINE, 1919 TO 1998



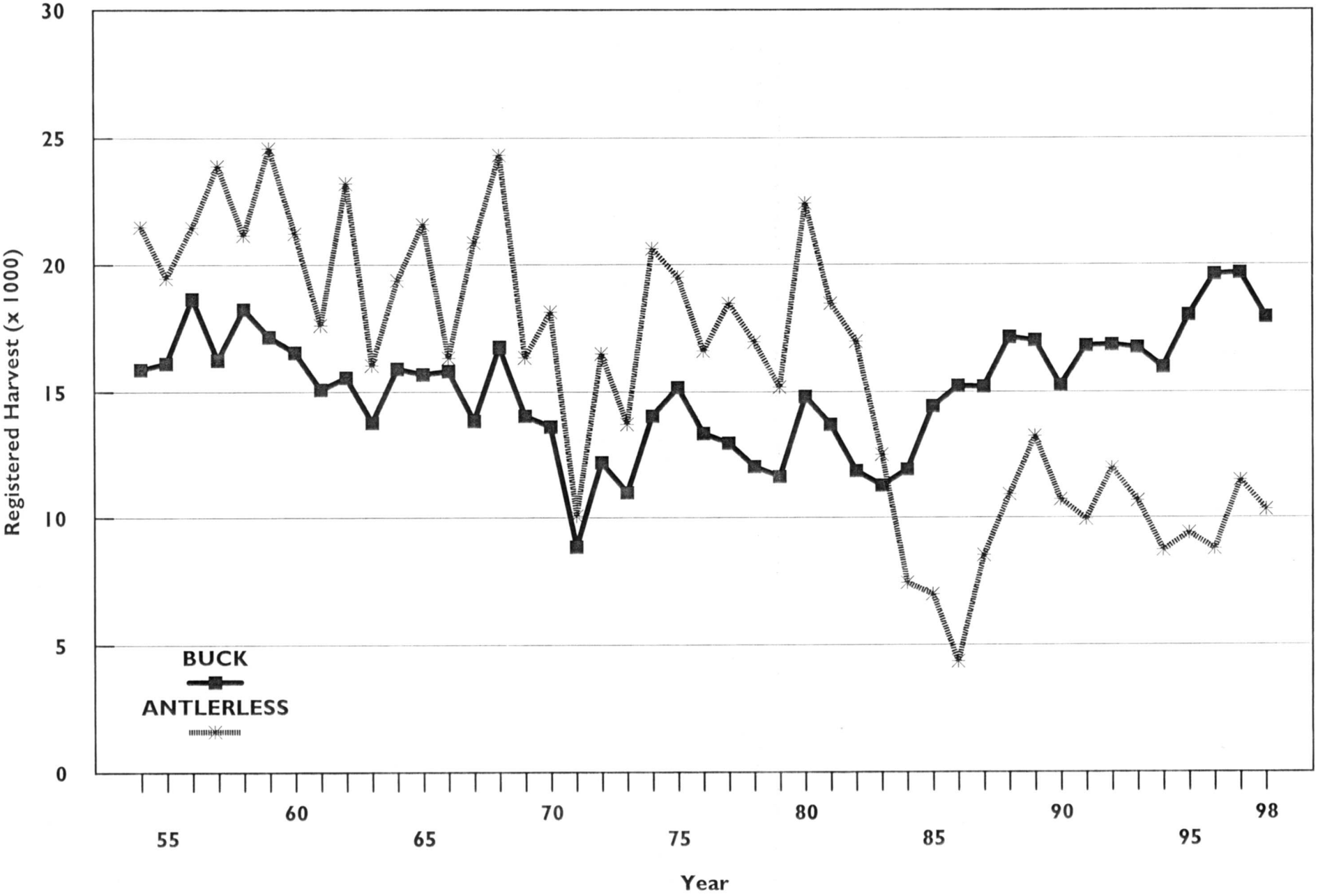
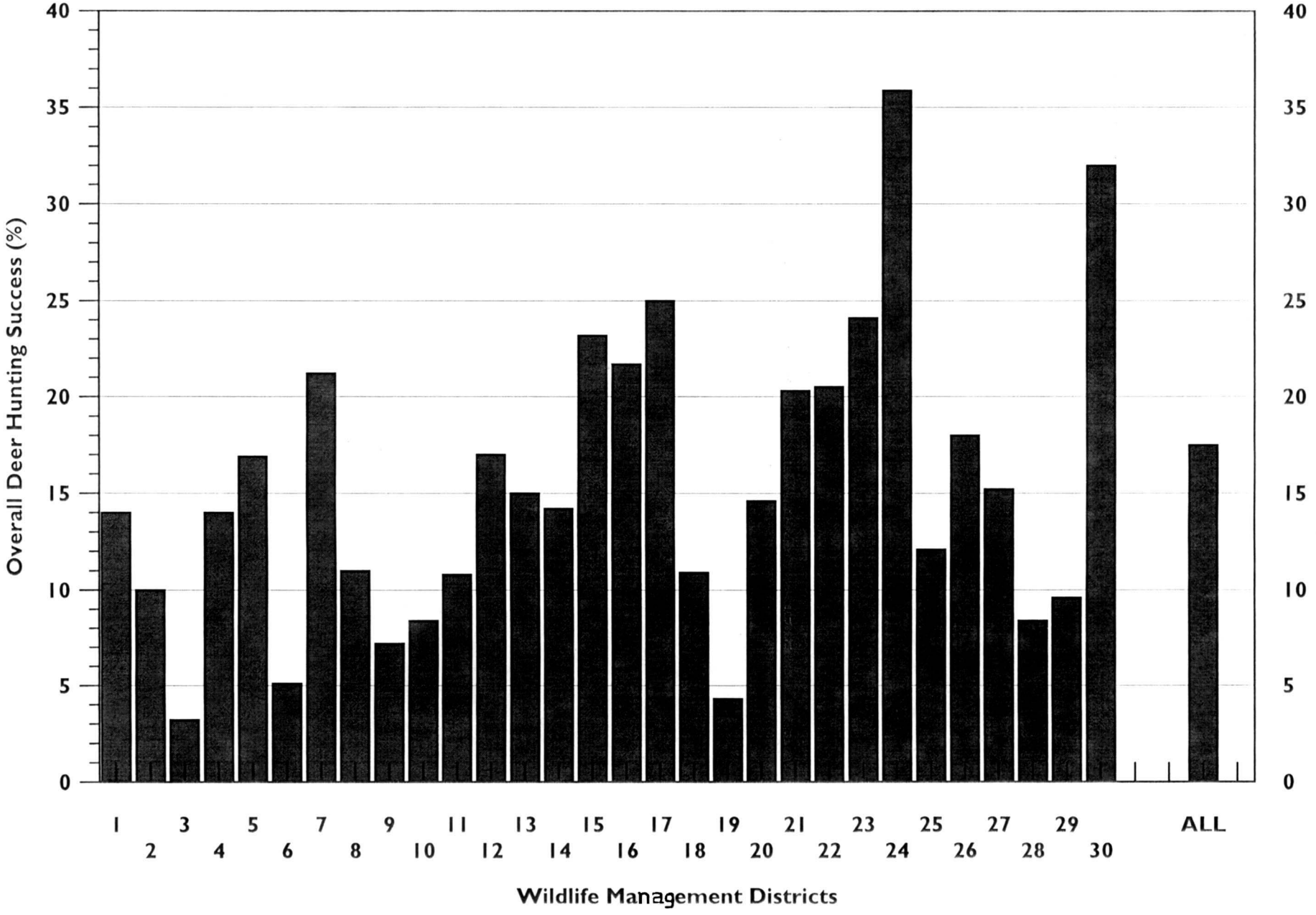

30
25
20
15
10
5
0
Registered Harvest (x 1000)
BUCK
ANTLERLESS
55
60
65
70
75
80
85
90
95
98
Year

FIGURE 13. DEER HUNTING SUCCESS BY WILDLIFE MANAGEMENT DISTRICTS IN MAINE, 1997



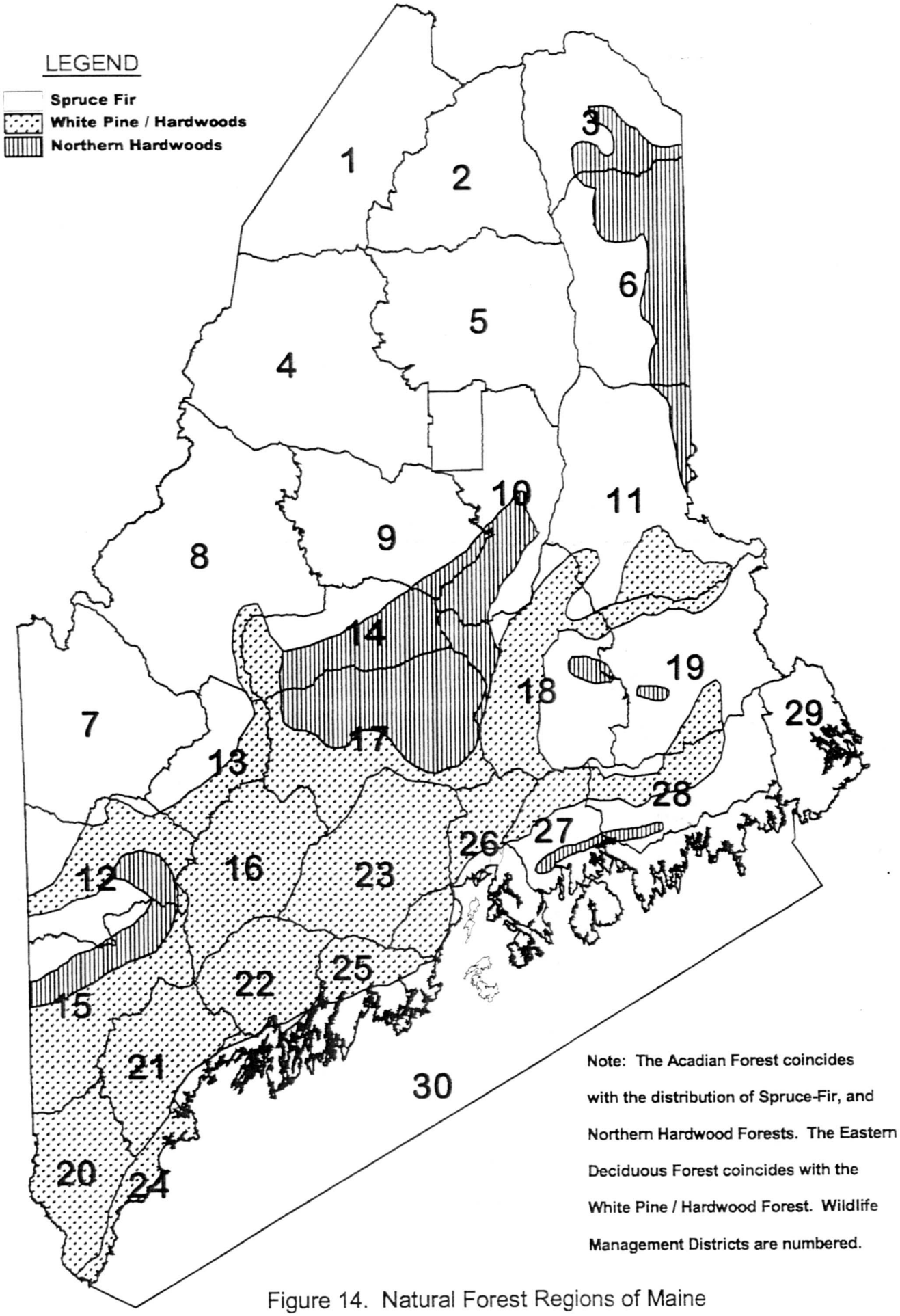
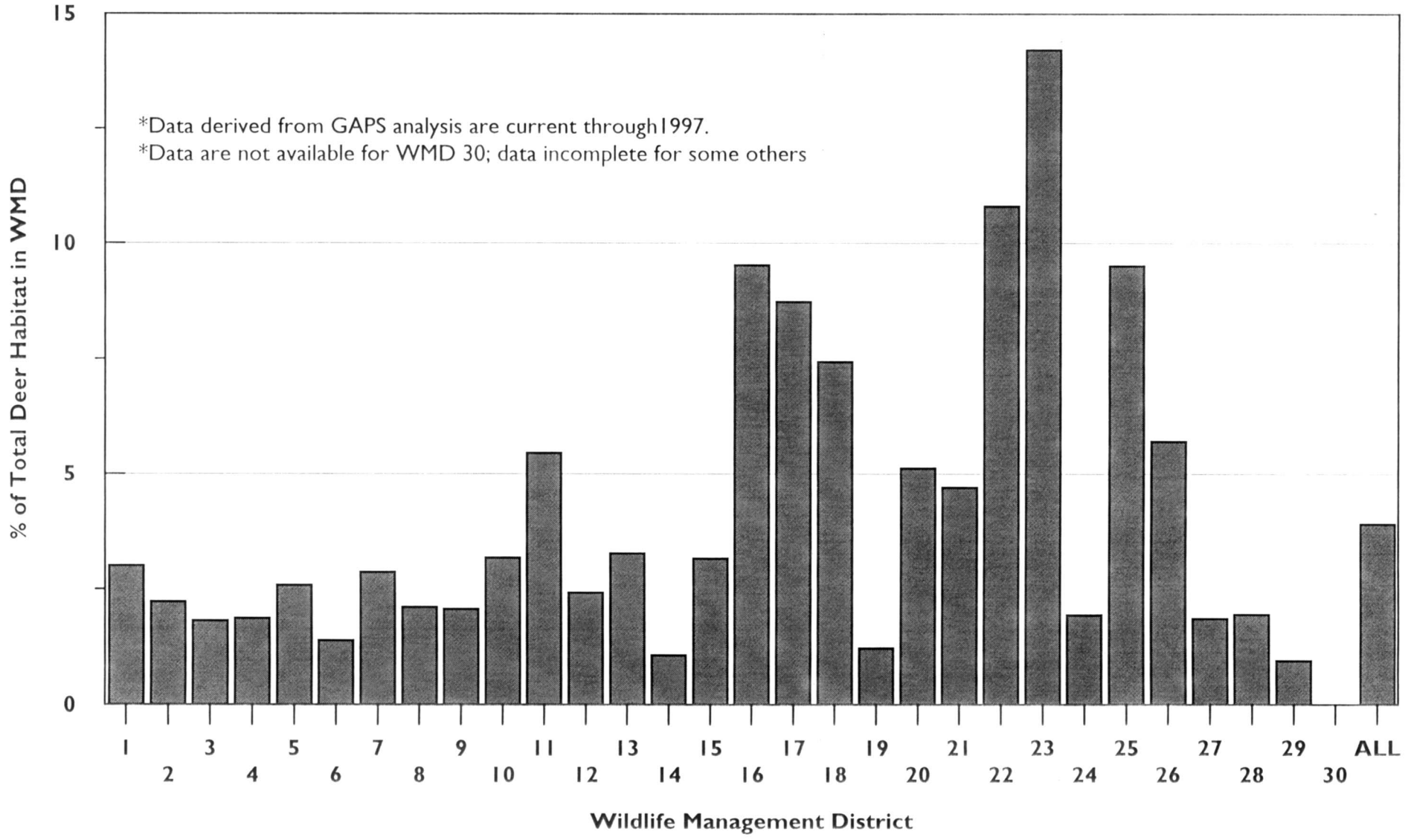


Figure 14. Natural Forest Regions of Maine

FIGURE 15. AREA OF KNOWN DEER WINTERING AREAS IN RELATION TO AREA OF TOTAL DEER HABITAT BY WILDLIFE MANAGEMENT DISTRICTS IN MAINE, 1997



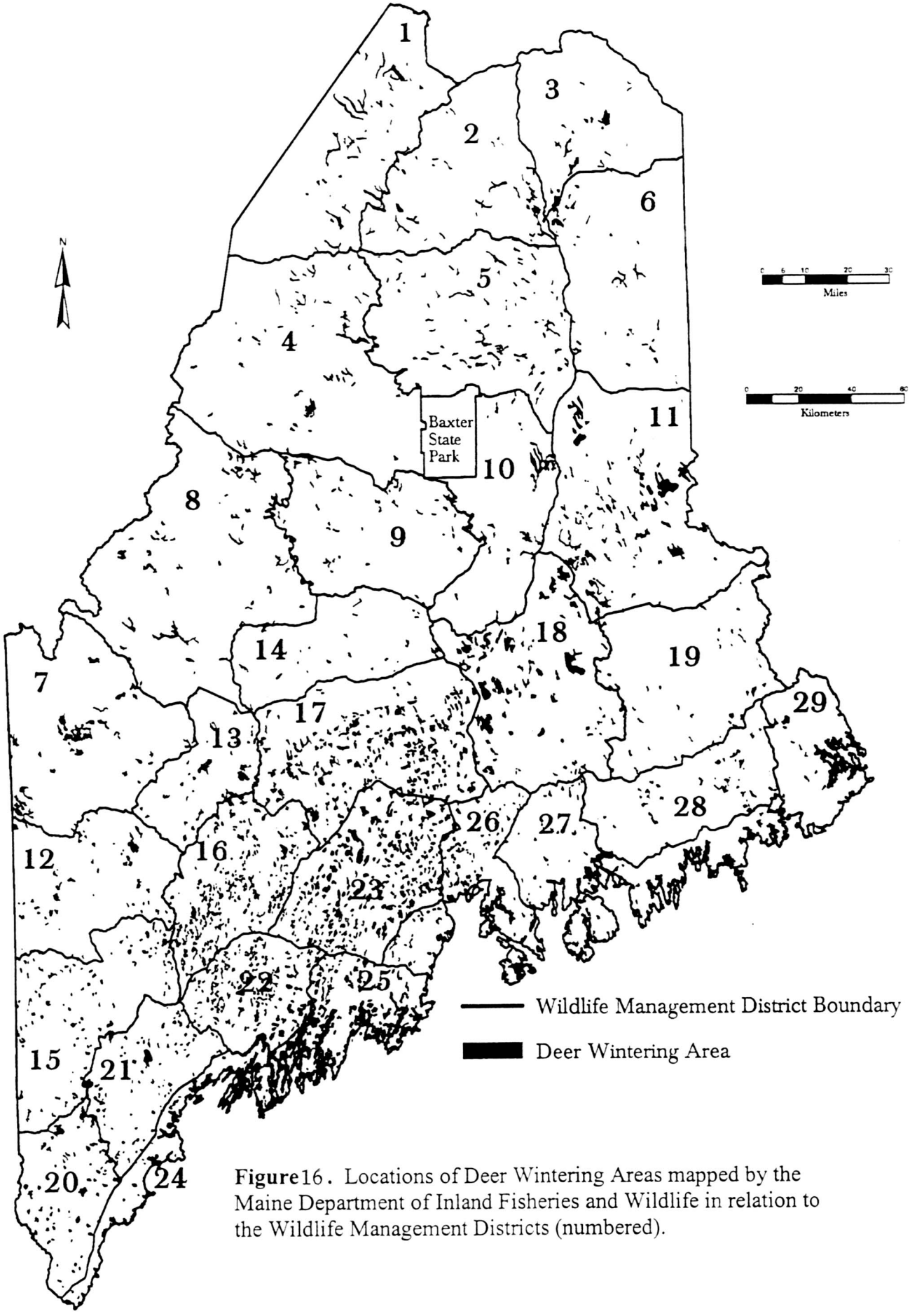


Figure 16. Locations of Deer Wintering Areas mapped by the Maine Department of Inland Fisheries and Wildlife in relation to the Wildlife Management Districts (numbered).

FIGURE 17. DENSITY OF RURAL ROADS (PAVED AND GRAVEL COMBINED), BY WILDLIFE MANAGEMENT DISTRICTS IN MAINE, 1997

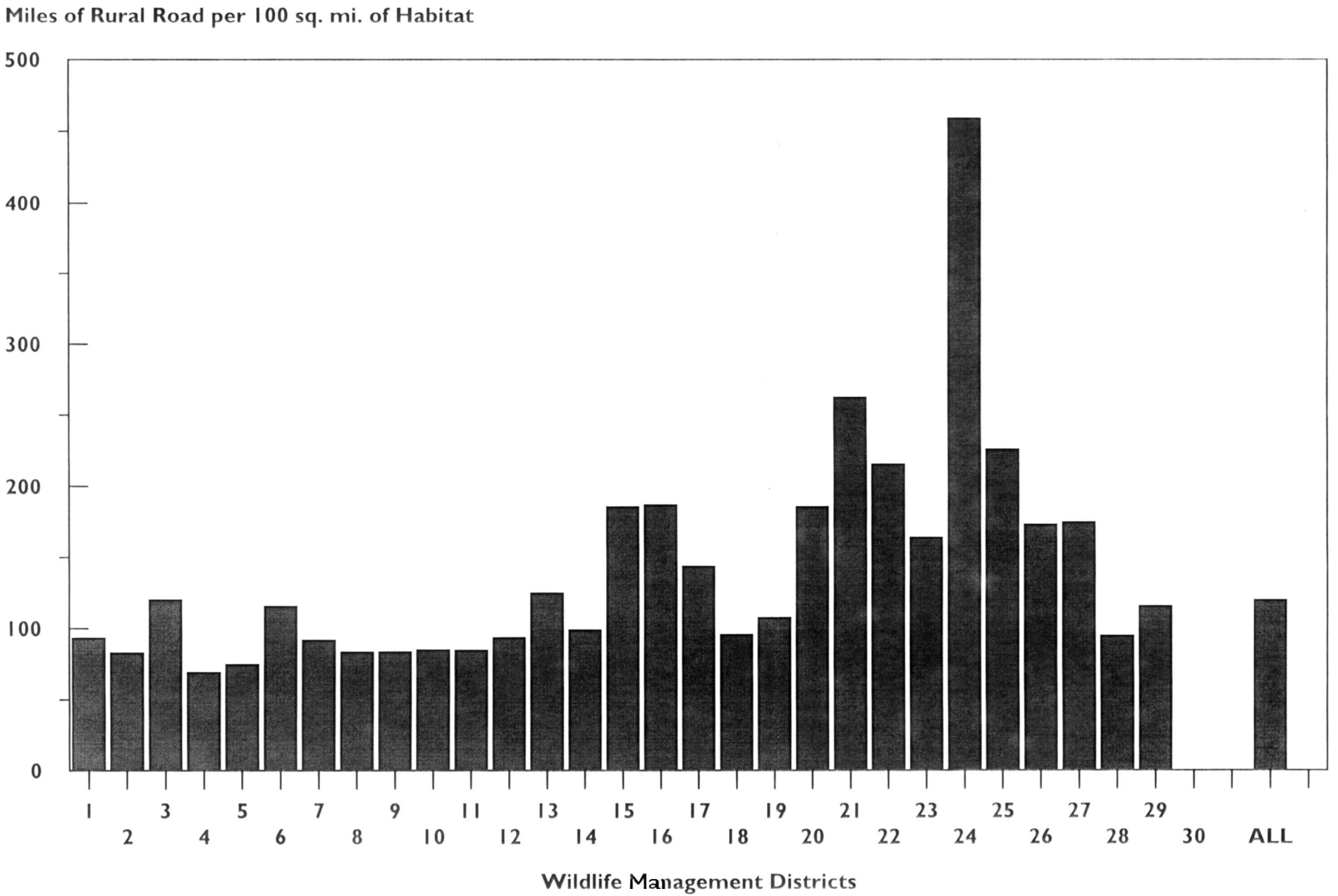


FIGURE 19. PERCENT VS. ACTUAL NUMBER OF MATURE BUCKS IN THE STATEWIDE BUCK HARVEST IN MAINE, 1976 TO 1998

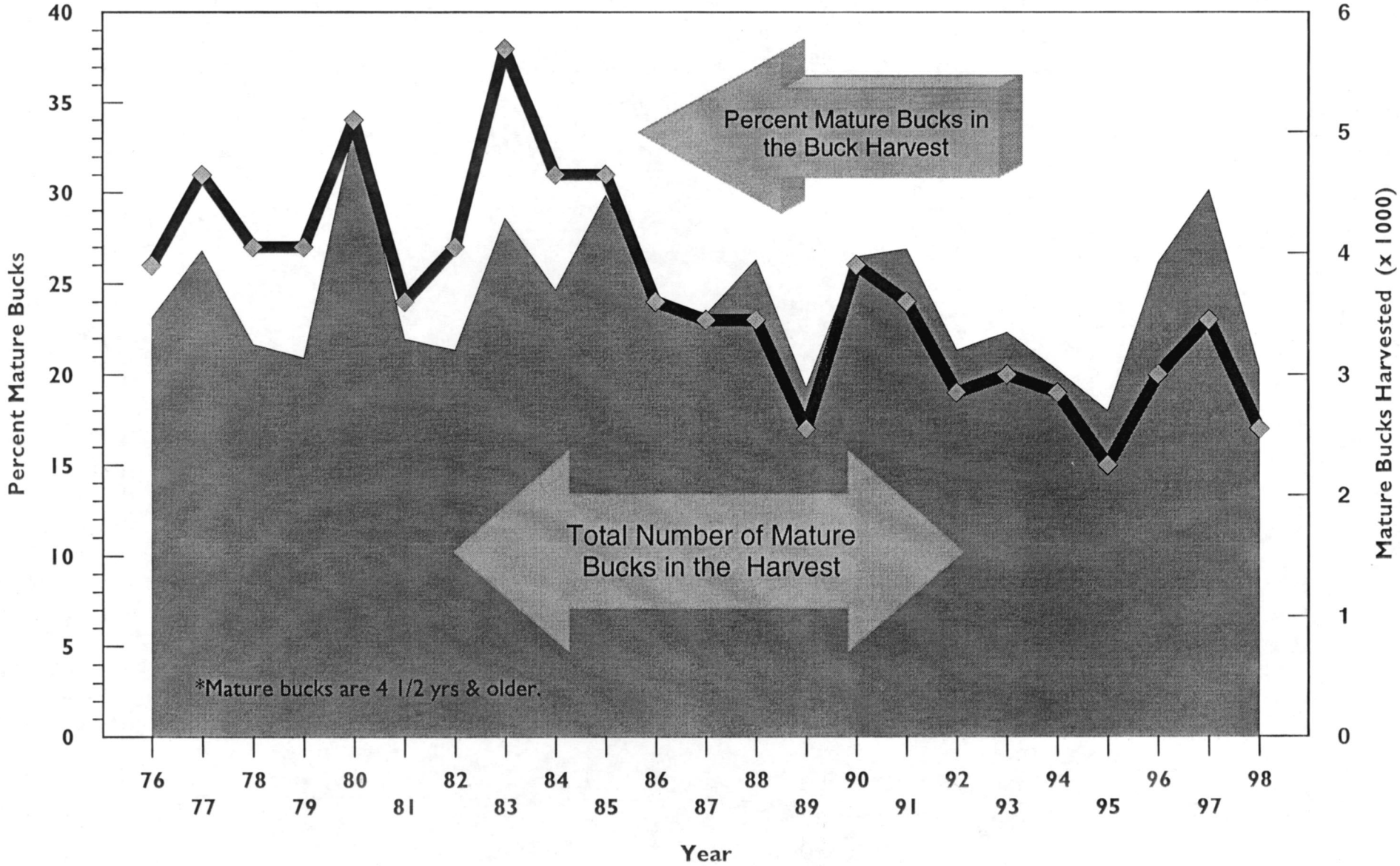


FIGURE 20. TRENDS IN THE PERCENT OF THE STATEWIDE BUCK HARVEST COMPRISED OF MATURE BUCKS VS. OVERALL DEER HUNTING EFFORT IN MAINE, 1976 TO 1998

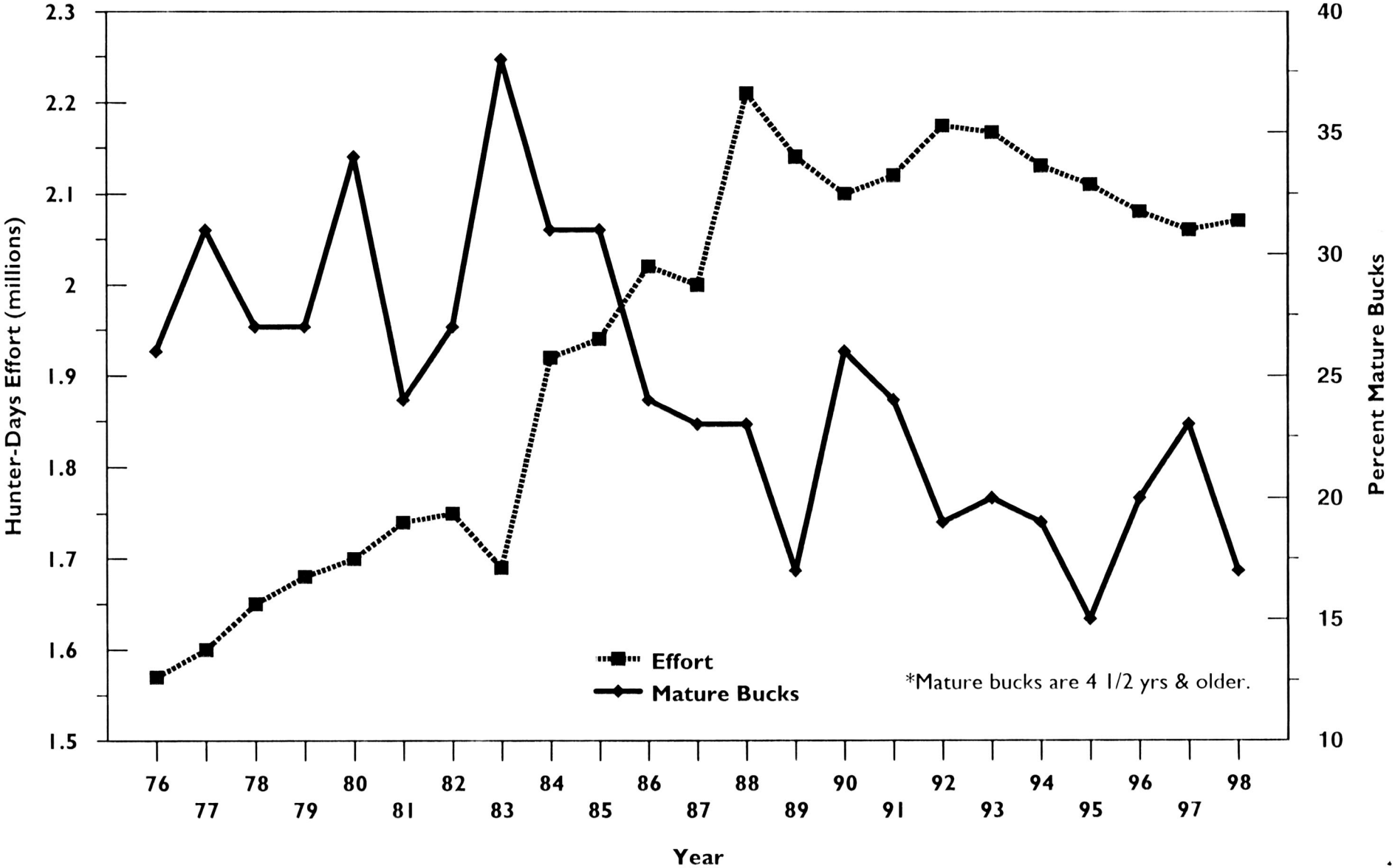


FIGURE 21. EFFECT OF OVERALL DEER HUNTING EFFORT ON THE PERCENT MATURE BUCKS IN THE STATEWIDE HARVEST OF BUCKS IN MAINE, 1976-98

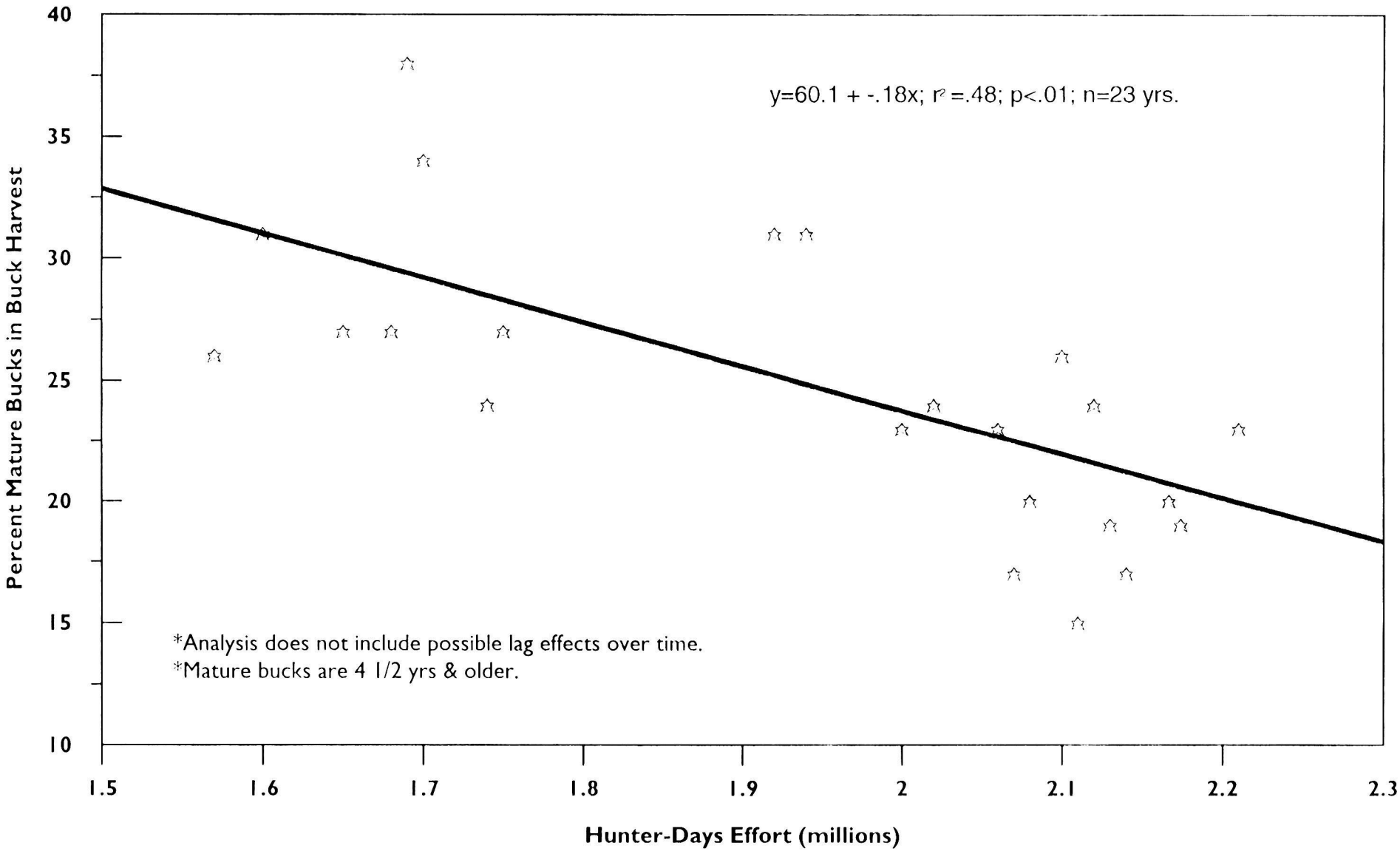


FIGURE 22. EFFECT OF HUNTING EFFORT ON THE RELATIVE ABUNDANCE OF MATURE BUCKS IN THE HARVEST AMONG MAINE'S WILDLIFE MANAGEMENT DISTRICTS, 1990-96

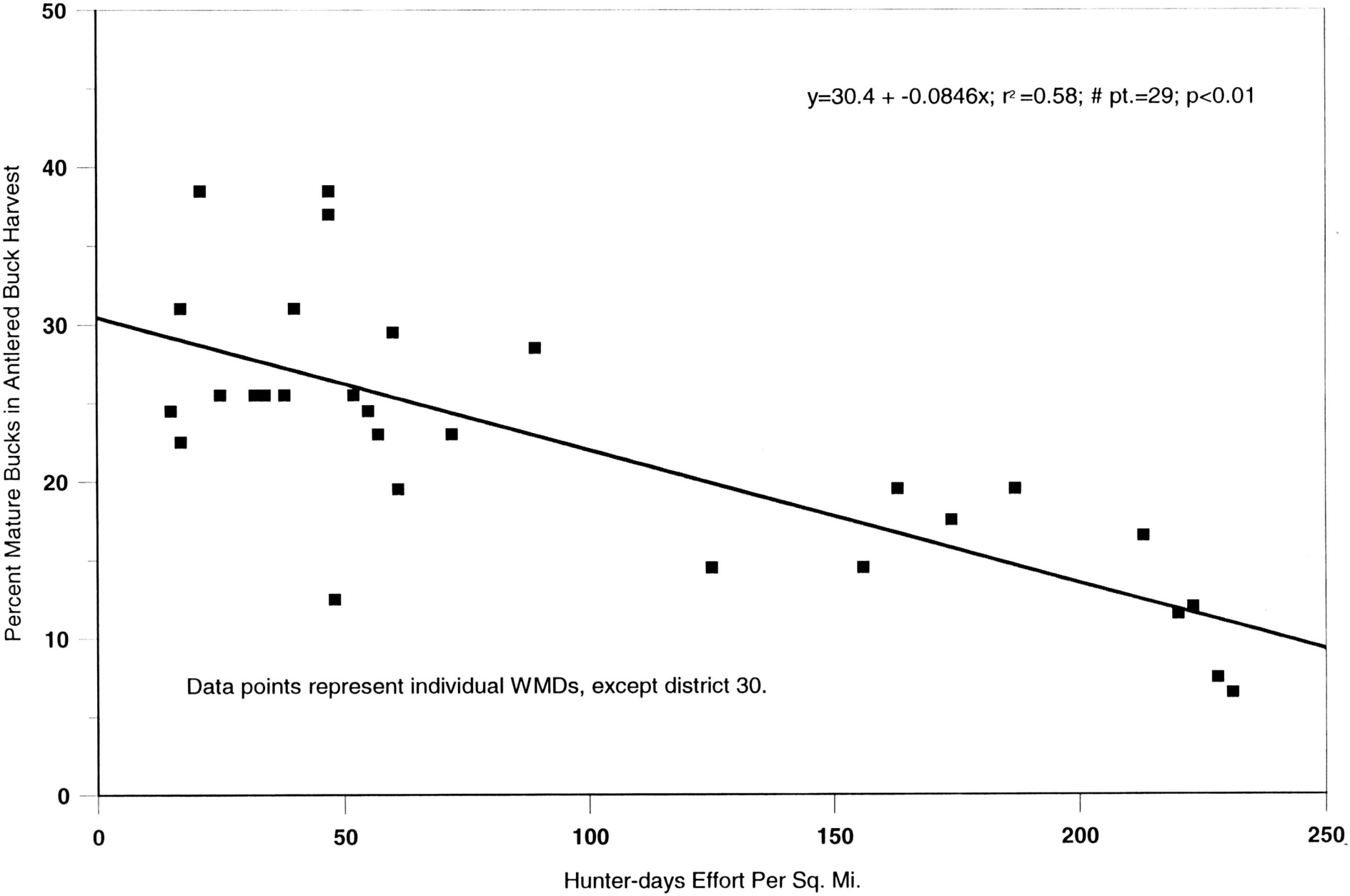


FIGURE 23. PERCENT OF THE ANTLERED BUCK HARVEST COMPRISED OF MATURE BUCKS DURING 1990-97, BY WILDLIFE MANAGEMENT DISTRICT IN MAINE

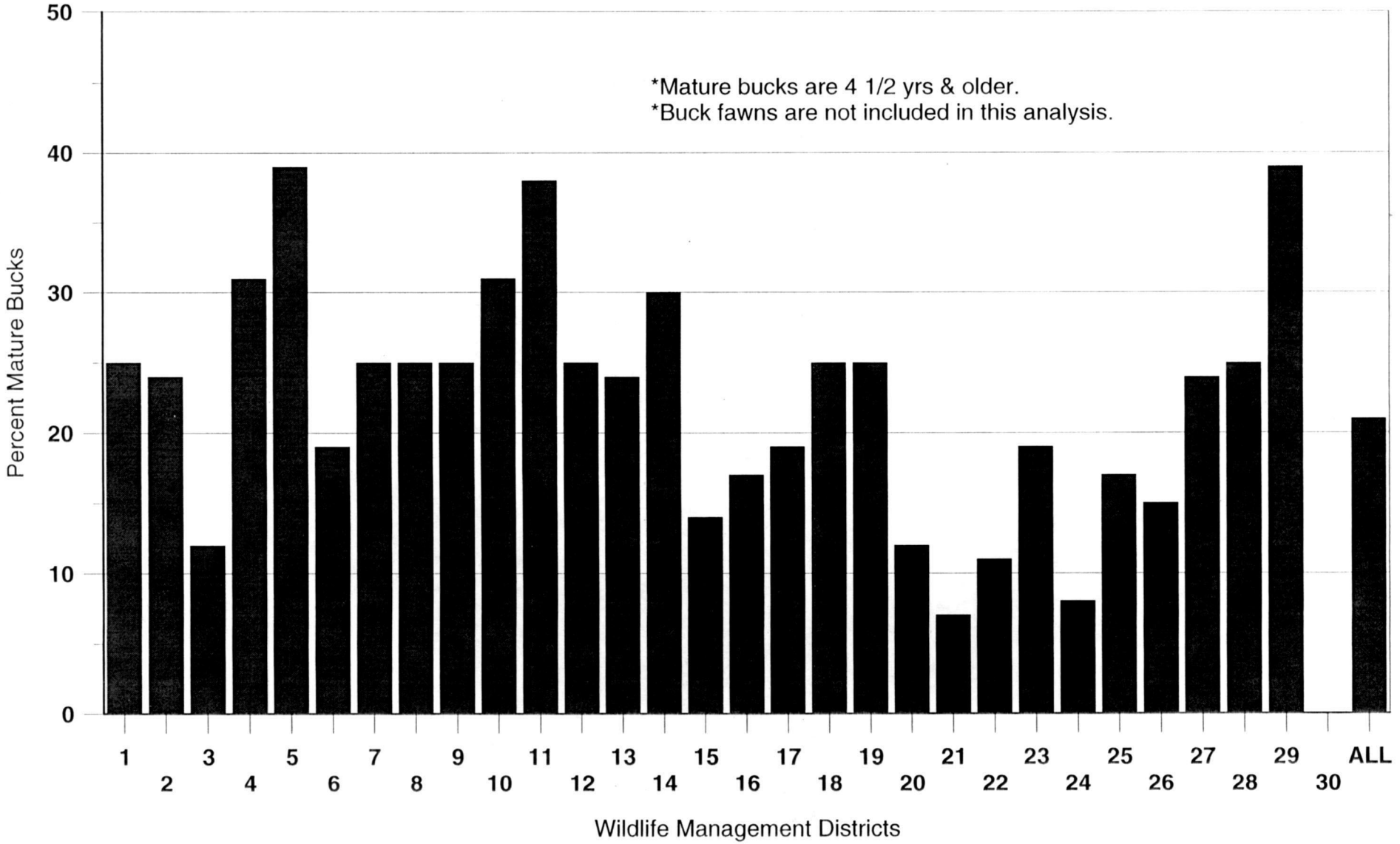


FIGURE 24. MEAN HARVEST OF YOUNGER VS. MATURE BUCKS DURING 1990-97 IN MAINE, BY WILDLIFE MANAGEMENT DISTRICT

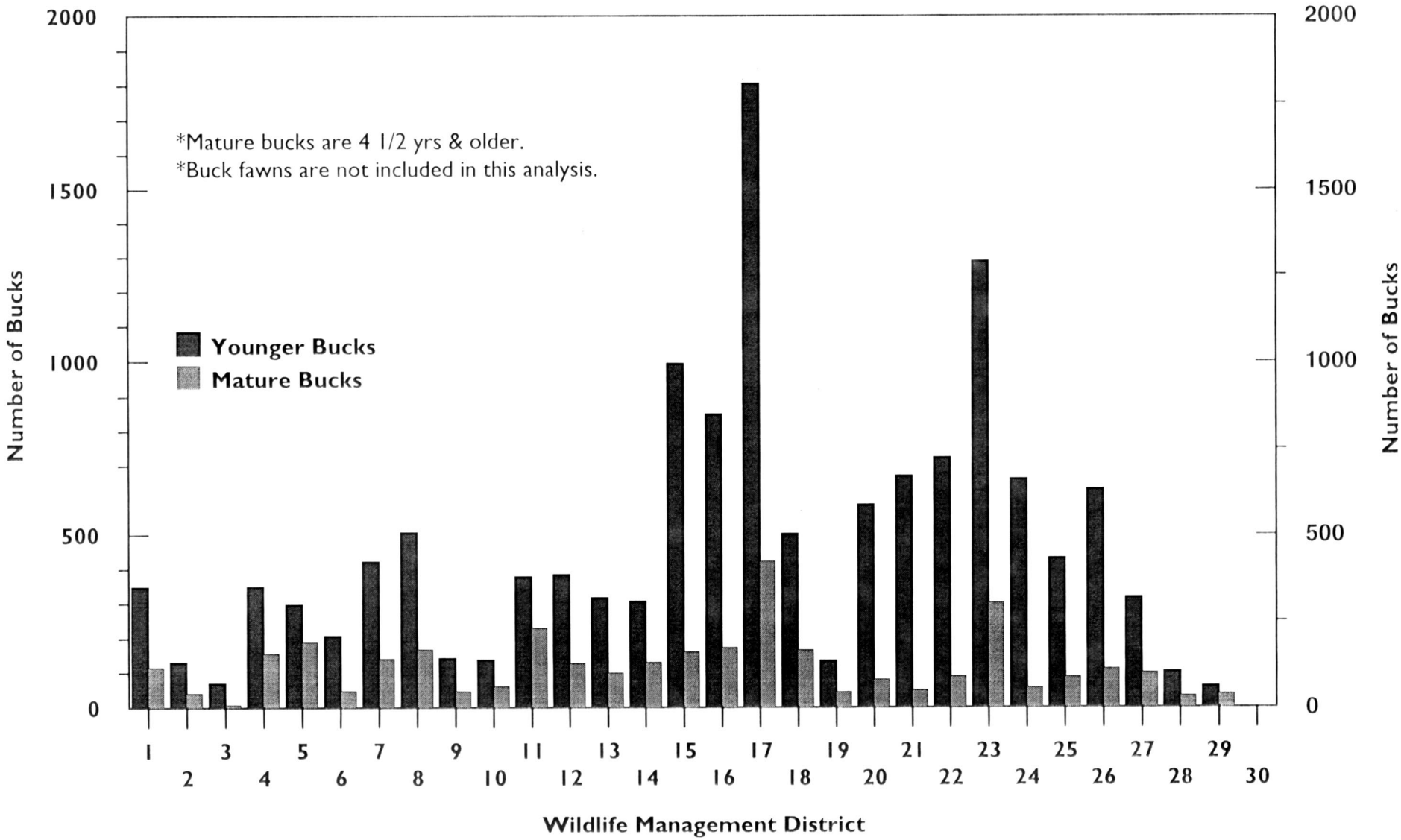


FIGURE 25. TRENDS IN THE NUMBER OF DEER HUNTERS VS. HUNTING EFFORT FROM 1976 TO 1998 STATEWIDE IN MAINE

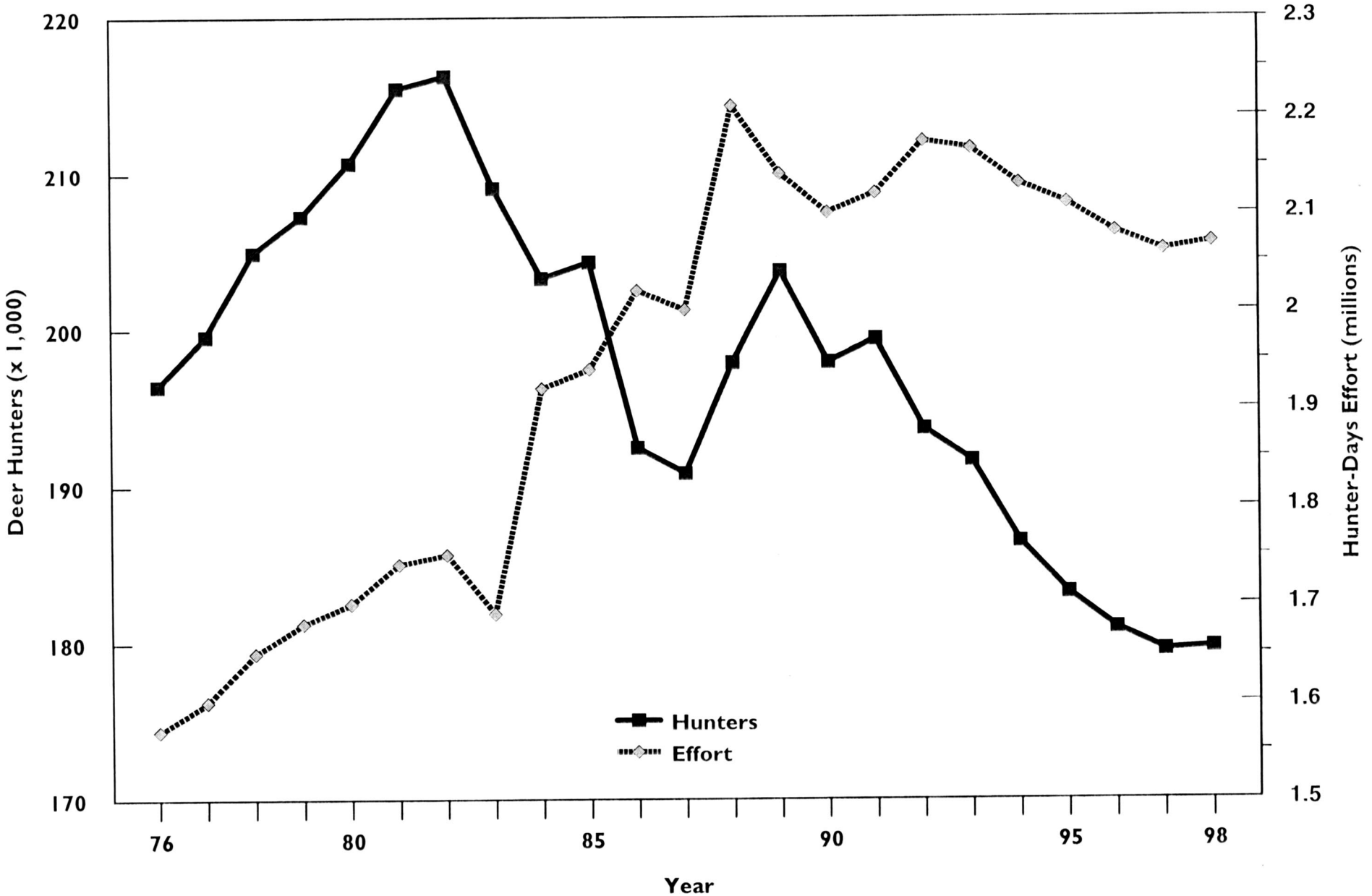


FIGURE 26. NUMBER OF PARTICIPANTS IN MAINE'S DEER HUNTING SEASONS, BY SEASON TYPE AND RESIDENCY, 1997