Snowshoe Hare (*Lepus americanus*) Assessment 2001

Final – July 19, 2002

Walter Jakubas and Randy Cross

Maine Department of Inland Fisheries and Wildlife

Wildlife Resource Assessment Section

Bangor, Maine 04401

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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 on 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 and its habitat. A Summary and Conclusions section summarizes the major points of the assessment.

NATURAL HISTORY

Description

The common names for *Lepus americanus* -- snowshoe and varying hare -- refer to the species' most noted characteristics: enlarged hind feet, that allow ease of travel in deep snow, and seasonal changes in coat color, from brown in the summer to white in the winter and *vice versa*. The large ears and hind feet are characteristic of the genus *Lepus*. Of the 26 species of hare in the world, the snowshoe hare is the smallest (Keith 1990). The large hind feet of the snowshoe hare effectively give it the lowest foot loading (mass/in^2) of any mammal, other than the wolverine (*Gulo gulo*) (Keith 1990).

As mentioned above, the snowshoe hare's appearance varies seasonally. In summer, their pelage is brown with lighter under parts. It gradually changes to white in winter taking 70-90 days from October to December (Brooks 1955). In spring, their pelage changes back to brown from March to May (70-90 days). The progression of color change varies with the season. In spring, the change from white to brown starts dorsally and progresses ventrally; in fall, the color change follows the reverse order (Severaid 1942). Although snowshoe hare appear white during the winter, their winter coat is actually made up of three layers of color. The outermost layer (made up of guard hairs) is white, the middle zone is tawny brown, and the innermost zone ranges from gray to black (Grange 1932). The winter coat of snowshoe hare not only offers them visual protection from predators but is 30% more insulative than their summer coat (Hart et al. 1965, Feist and Rosenmann 1975; as cited in Keith 1990).

Adult weights range from about 1.1 kg to 1.8 kg (2.5 lb to 4 lb) with females averaging slightly heavier than males (Severaid 1942). This is nearly twice the size of adult New England cottontails (*Sylvilagus transitionalis*), which also occur in Maine. Nevertheless, juvenile hare are sometimes mistaken for cottontails in summer.

The average weight of snowshoe hare varies sexually, annually, seasonally, and geographically. Studies in Alberta indicate that weights of hare may vary 17% year to year. Seasonally, their weights peak in November, after which they may lose 14% of their weight through March (Keith 1990). The largest snowshoe hare occur in the northwestern (Alaska, Yukon) and eastern parts of their range, while the smallest hare occur in the west (Washington and Oregon) (Keith 1990).

Snowshoe hare are primarily nocturnal. They spend most of the day resting in shallow depressions called forms. Forms are chosen at random but are typically located in dense cover. When approached, hare remain motionless in these forms before sprinting away.

Distribution

The snowshoe hare's geographic range largely coincides with the distribution of boreal forest in North America. This includes the spruce forests in Canada, Alaska, and Maine and the mountains of the eastern and western United States; aspen dominated forests and mixed wood forests of the prairie provinces; northern hardwood/coniferous forests in the lake states; and the coastal conifer forests of the Pacific Northwest (Keith 1990). In Maine, hare occur throughout the state, wherever adequate cover exists.

Population cycles and densities

In much of the boreal forest of North America, snowshoe hare appear to go through an 8 to 11 year population cycle (Keith 1963, 1990, Boonstra et al. 1998). Hare populations most commonly go through cycles in regions where optimal habitat is continuous and extensive (e.g., Alaska and Canada). Hare densities during cyclic highs often exceed 500 hare / km^2 (1295 hare / mi^2) and occasionally double that density (Keith 1990). Spring populations, during cyclic highs, may have densities 24 times that of spring populations during cyclic lows (Keith 1990). Many scientists have speculated on the cause of these cycles with explanations involving everything from sunspots to stress. Recently, two hypotheses have received considerable attention and have undergone rigorous testing. The "Keith hypothesis" (1974, 1990) proposes that cyclic declines in hare populations are caused by (1) a winter food shortage at the peak of the hare population (this results in poor nutrition and fewer hare being born) and (2) predation, where after the initial food shortage, predation maintains low hare numbers until predators themselves become rare. Alternatively, the "predation hypothesis" (Krebs et al. 1986) proposes that predation, by itself, is sufficient to account for the cyclic decline in the hare population. At this time, it appears that the predation hypothesis is the more credible of the two.

Predation may affect the behavior and physiology of hare in several ways, in addition to direct mortality. Hik (1995) proposed that hare are able to assess the risk of predation in different habitats and restrict their activity to areas with dense cover during times of high predation levels. Although areas with dense cover afford hare protection from predators, these areas usually contain food of poor nutritional quality. Poor quality

food can limit the reproductive fitness of hare. Frequent encounters with predators cause hare to undergo chronic (long term) stress. Chronic stress may decrease a hare's reproductive rate, overall physical condition, and cognition (the ability to think) Boonstra et al. 1998). High stress levels may account for the marked deterioration of reproduction during a cyclic decline of snowshoe hare and the lag in recovery of hare reproduction (the adverse effects of stress can be passed on to the next generation of hare; Boonstra et al. 1998).

Keith (1963) considered hare populations in the eastern United States to be noncyclic; and later noted that adequate indices were not available to verify this conclusion (Keith 1990). This does not mean that hare populations in the east stay at the same level year after year. Rather, there does not appear to be a broad-scale (e.g., throughout the NE states) synchronous fluctuation in hare populations. In the east, hare habitat tends to be more fragmented than in much of the boreal forest region of Canada. In fragmented habitat, hare populations are thought to be regulated by predation, as hare move between areas having secure cover (Keith 1990). Even in cyclic populations (e.g., Alberta) hare populations in woodlots (fragmented habitat) fluctuated to a lesser degree than populations in continuous habitat (Keith 1990).

Hodges (1999) raised the possibility that southern populations of hare might cycle at a low amplitude. However, the data used to analyze a possible hare cycle in Maine were weak (mail-in hunter surveys) and were not positively correlated with population fluctuations in other New England states (Murray 2000). Anecdotal reports of local changes in hare populations in Maine are common. However, these local

fluctuations may be more due to habitat changes rather than being part of a larger cyclic phenomenon.

Although high hare densities in some noncyclic populations may equal or exceed densities in some cyclic populations, the majority of noncyclic populations exist at densities 1/10 to 1/5 of those reached at cyclic peaks. In Maine, spring hare densities ranged from 10 to 170 per km^2 (26 to 440 per mi^2) (Litvaitis et al. 1985).

Home Range and Dispersal

Home range size is influenced by a number of factors including sex, age, density, and food supply. Keith (1990) reviewed six studies and reported that the average home range size of hare, throughout the year, ranged from 2.9 to 10.2 ha (7.2 to 25.2 acres). For females, home range size may decrease by 70% as they near the end of a pregnancy, while juveniles may double their home range size in early fall (Keith 1990). Snowshoe hare commonly disperse 1 to 10 km (0.62 to 6.2 mi) and may shift their home ranges 400-800 meters (0.25 mi to0.5 mi) (Keith 1990). Rates of dispersal tend to be highest during winters of food shortages, with most of the dispersing animals being made up of juveniles. Sudden mass movements of hare, over many miles, have been noted in Minnesota, Manitoba, and Alaska when hare populations are near the peak of their cycle (Keith 1990).

Food Habits

The summer diet of the snowshoe hare consists mainly of green succulent plants, such as, grasses, ferns, and forbs (Aldous 1936). Herbaceous plants are eaten

until fall frosts kill them, after which woody vegetation becomes the dominant food in the diet of snowshoe hare. Woody vegetation commonly eaten by hare in Maine include: aspen (*Populus* sp.), birch (*Betula* sp.), maple (*Acer* sp.), willow (*Salix* sp.), and cedar (*Thuja* sp.). Less preferred species, that are eaten only occasionally or when other foods are scarce, include fir (*Abies* sp.), spruce (*Picea* sp.), and pine (*Pinus* sp.).

In the winter, snowshoe hare consume about 300 g (11 ounces) of mixed browse per day with most browse having a diameter less than 4 mm (0.16 in) (Pease et al. 1979, Bryant 1981). As food becomes scarce (e.g., when hare densities are high), hare may resort to bark stripping, often girdling and killing small trees (Devos 1964). While they normally browse to a height of 45 cm (17.7 in), the deep snows of winter help hare to reach browse as high as 2 meters (6.6 ft.) above the ground (Bider 1961).

There is some dispute on whether food availability and quality occasionally limits the population growth of hare. In cyclic populations in Manitoba, Keith (1990) observed food shortages and concluded that food shortages increase the relative vulnerability of juvenile hare to predation. Boonstra et al (1998) concluded that food availability was not a limiting factor, at anytime, for hare populations on their Yukon study site, but noted that foraging behavior (i.e., predator avoidance) may have limited the hare' accessibility to food. Other authors, notably Bryant et al. (1991), proposed that changes in quality of browse, as dictated by plant chemicals repellent to hare, may limit food supply, and hence limit hare population growth.

Cover Requirements

The density of cover, or protection from predators, is thought to be the factor that most likely limits the number of hare a given habitat can support. Carreker (1985) predicted that cover becomes suitable for hare when stems up to 40 inches above the ground provide ≥ 40% visual obstruction and that optimal habitat suitability is attained at 90% visual obstruction. However, he noted the trade-off between optimal cover and food, in that food supply was optimal at only 50% visual obstruction.

Throughout their range, snowshoe hare are highly associated with dense understories (Adams 1959, Brocke 1975, Wolff 1980, Wolfe et al. 1982). However, low-growing conifer cover appears to gain importance near the southern limit of the hare's geographic range (Buehler and Keith 1982; as cited in Keith 1990). Besides protection from predators, understory cover provides protection from precipitation and temperature extremes. Because winter is the period of greatest stress for hare, dense cover takes on a greater importance during this time of year (Whittaker and Thomas 1983).

Litvaitis et al. (1985) found densities of hare to be strongly correlated to understory density as measured by visual obstruction in two dissimilar areas in Maine. Evergreen saplings were especially important in the winter as they offer denser cover than their deciduous counterparts (Litvaitis et al. 1985). The importance of cover to hare has led to the development of models that predict the carrying capacity[1] of the habitat by the amount and quality of cover it provides.

[1] In this assessment carrying capacity refers to "ecological carrying capacity" as defined in Caughley and Sinclair (1994). These authors define carrying capacity as "... the natural limit of a population set by resources in a particular environment. It is one of the equilibrium points that a population tends towards through density-dependent effects from lack of food, space (e.g., territoriality), cover, or other resources." In essence, carrying capacity, or the number of animals the land can support, is determined by the resource that is in the most limited supply at a given time of year. These resources include food, water, cover, and space. In theory, an animal's population should increase until the most limited resource (e.g., food) is no longer available in sufficient quantities.

Reproduction

Breeding season for snowshoe hare in Maine begins in March (Severaid 1942, 1945). Females may produce 2 to 4 litters per season with 1-9 young per litter (Keith et al. 1966). The average number of young surviving the breeding season per female was highest in Alberta with 12.1 young / yr and lowest in Wisconsin (6.4 young / yr) (Keith 1990). Specific reproductive rates for wild Maine hare are not available. However, hare in the cyclic population of southern Quebec averaged 2.8 liters / yr, with 7.6 young / female surviving the breeding season (Alain 1967; as cited in Keith 1990), while hare in the Maritime provinces (noncyclic population) averaged 2.5 liters / yr with 7.2 young surviving (Wood and Munroe 1977; as cited in Keith 1990).

Severaid (1942) observed captive snowshoe hare in Maine and reported that characteristically newborn hare are fully furred, have open eyes, weigh about 70g (2.5 oz), and have a dense brown coat, with a small patch of white on the forehead. They are capable of moving around after one day and normally nurse for 25-28 days (except for the last litter of the season which may nurse much longer). They begin to feed on grass and other herbaceous plants after 10-12 days. Leverets (young hare) generally nurse just once each day for 5-10 minutes and spend the rest of the day separated from each other and their mother. Leverets attain their full adult mass by 12 weeks of age.

Snowshoe hare normally breed the spring following their year of birth (Vaughan and Keith 1980). Juvenile breeding (i.e., breeding the summer or fall following birth) occurs among first litter females, but it is uncommon and has little influence on hare numbers (Keith 1990).

Mortality

Predators of snowshoe hare come in about every shape and size. Mammalian predators range in size from the short-tailed weasel (*Mustela erminea*) to wolf (*Canis lupus*). Common mammalian predators in Maine include coyote *(Canis latrans*), red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), lynx (*Lynx canadensis*), mink (*Mustela vison*), fisher (*Martes pennanti*), and marten (*Martes americana*). Principal avian predators include great horned owl (*Bubo virginianus*), barred owl (*Strix varia*), goshawk (*Accipiter gentilis*), and red-tailed hawk (*Buteo jamaicensis*). Predators are the immediate cause of death for the vast majority of snowshoe hare. In cyclic and noncyclic populations, predators killed from 81% to 100% of raidocollared hare (Keith 1990).

Annual mortality rates for juveniles ranged from 75 to 95% (Meslow and Keith 1968, Dolbeer and Clark 1975, Keith and Windberg 1978), while adult mortality ranged from 66% to 81% depending on which phase of the population cycle hare were in (Keith 1990). Keith (1990) did not have specific information on mortality rates in noncyclic populations, but stated that mortality rates were similar during “decrease years” for both cyclic and noncyclic populations.

Diseases

Snowshoe hare serve as hosts to a variety of parasites. Ticks, fleas, and black flies are listed as the most common external parasites of hare but are not implicated as a significant source of direct mortality (Burgdorfer et al. 1961). Internal parasites include intestinal tapeworms and roundworms, lungworms, and filarial worms (which are

found around joints) (Bookhout 1971). Infection rates are generally high and may act in concert to lower an individual's resistance to disease, eventually causing the death of those most heavily infected (Erickson 1944).

Other diseases associated with hare include many viruses, salmonella, and tularemia (Hoff et al. 1970). Of these, tularemia is most notable due to its human health implications, but it occurs infrequently in hare. None of these diseases have been found to be a significant mortality factor.

Interactions with other species

Snowshoe hare have considerable influence on the ecological communities in which they live. As a prey species, it may be considered the universal entree. Consequently, as hare populations go through their normal fluctuations in size, the survival of predators and alternative prey are also affected. At high hare densities, predation on other prey species (e.g., red squirrel [*Tamiasciurus hudsonicus*]) may decrease, as predators focus on hare (O'Donoghue et al. 1998). High hare densities provide an abundant food source for predators which, in turn, may allow a predator's survival and reproductive rates to increase. Conversely, when hare populations decline, the resulting surplus of predators are forced to prey on other species, thereby increasing the mortality rates of alternative prey (e.g., ruffed grouse [*Bonasa umbellus*] and red squirrel), and predator survival rates may drop dramatically. The effects that snowshoe hare have on the population dynamics of its predators, has been well documented for lynx, great horned owl, and goshawk (Keith 1990). These effects are

so important that some jurisdictions (e.g., Quebec) base their management recommendations for predators, such as lynx, on the status of the hare population.

At high population densities of hare, the amount of food they consume influences the regeneration rate, survival, and nutritional value of many woody and herbaceous plants. Many of the plant species hare feed upon in their juvenile stage (maple, aspen, birch) are consumed by larger herbivores (e.g., moose and deer) as more mature plants. Therefore, heavy browsing by snowshoe hare can affect food suitability and availability for larger herbivores. In addition, when snow is deep, hare may reach as high as moose to obtain browse by standing on accumulated snow. Because snowshoe hare have such a broad influence on their ecological community, information on snowshoe hare population levels, habitat use, and distribution can give considerable insight into the status of other animal populations.

Snowshoe hare interact little with man despite their abundance. Unlike the eastern cottontail (*Sylvilagus floridanus*), snowshoe hare are reluctant to venture out into open areas to feed. Therefore, they are rarely implicated in crop or orchard damage. Similarly, hare damage to regenerating forests is usually minor. Bellefeuille et al. (2001), studied snowshoe hare use of 6 to 9 ha (15 to 22 acres) clearcuts, 4 to 8 yr after these sites were cut. On all sites, regardless of site treatment (scarification and pre-commercial thinning or natural regeneration) only 1% off all deciduous twigs were browsed and no coniferous twigs were browsed. Ground cover was less than 10% and lateral foliage density was less than 50% for all regeneration categories (hare prefer lateral foliage density to be in the range of 80% to 90%). Bellefeuille et al. (2001) concluded that it would take more than 10 yr for clearcuts to become suitable habitat for

hare, which is longer than the 3 to 5 yr predicted from earlier studies conducted in Maine. Thus, hare damage to seedlings in regeneration stands should be minimal, with the exception that edges near dense forest cover may receive heavier browsing pressure.

MANAGEMENT

Regulatory Authority

Regulatory authority to manage wildlife was granted to the Department in 1972. Prior to this, laws pertaining to snowshoe hare were set by the legislature.

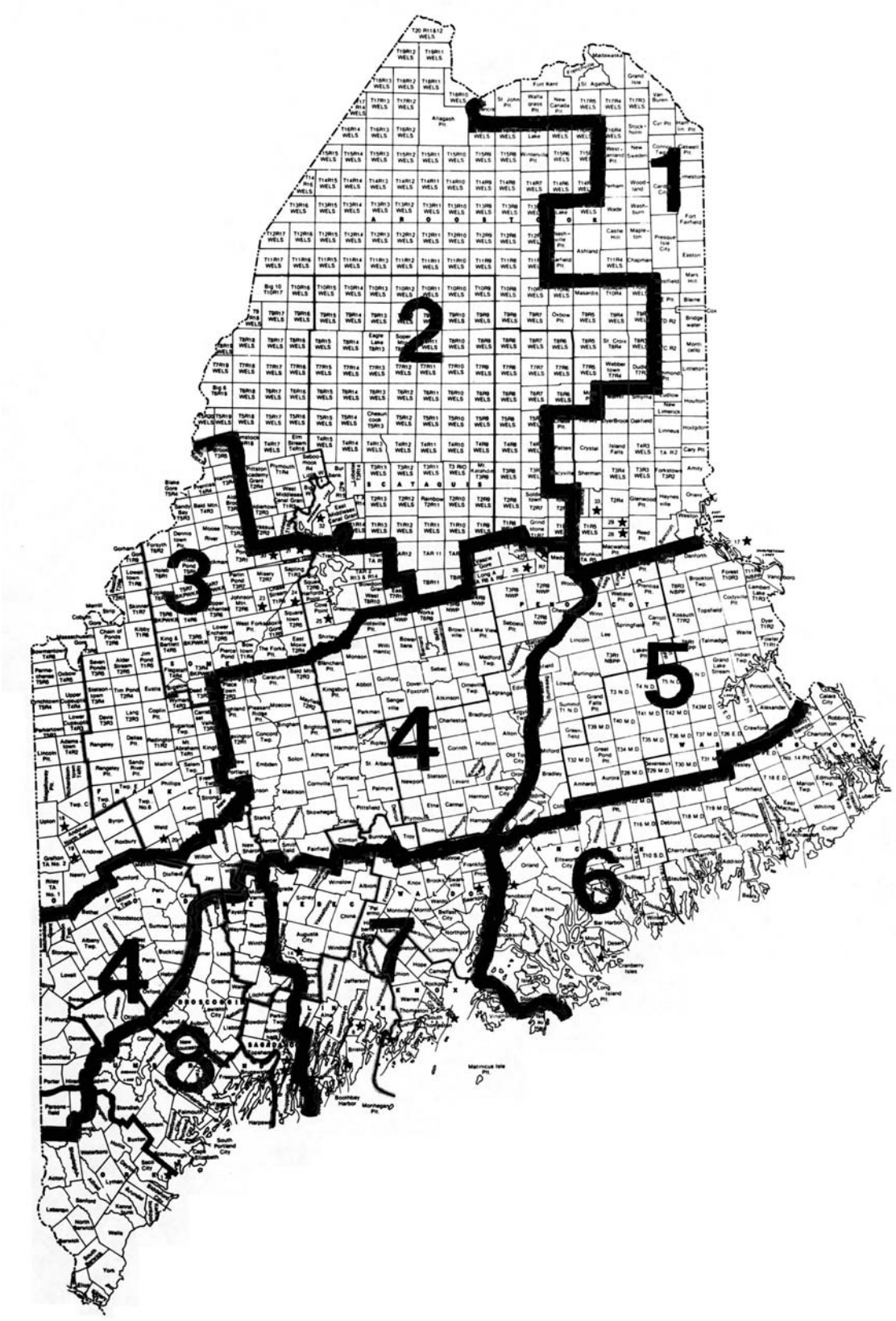
Past Goals and Objectives

The management goal derived from the first snowshoe hare assessment, in 1975, was to increase the annual harvest to 400,000 hare, while maintaining the hare population at 1975 levels. This harvest objective was never met. Consequently, the annual harvest goal was lowered in 1980 to 250,000 hare, which was still greater than the average annual harvest of the previous 5 yr (i.e., 230,000)[2]. From 1980 until 1983 the average harvest was estimated at 257,000 hare (Cross 1986).

The management goals of the 1985 species assessment were to (1) increase snowshoe hare numbers in Wildlife Management Units (WMU) 7, 8, and 4 (southern portion) by 1990, and (2) allow hare numbers and habitat quality to fluctuate naturally in the remainder of the state (Fig. 1). To achieve the first part of this goal, the working group proposed increasing habitat quality in WMUs 7, 8, and 4 by 10%. However, the feasibility of such extensive habitat management (approximately 400,000 acres) was questioned. Another objective of the 1985 assessment was to increase the harvest in WMUs 1, 2, 3, 5, and 6 by 10%. It was suggested that a harvest increase could be accomplished by a public information program that would call attention to areas with

[2] Harvest estimates were obtained from personal hunting reports filled out by hunting license holders.

Figure 1. Former Wildlife Management Units (WMUs) used by MDIFW in the 1985 assessment.



good hare densities that were being underutilized by hunters. These initial goals and objectives were kept in the 1991 and 1996 updates of the Department's strategic planning document.

Past Management

Prior to 1905, there were no laws restricting the harvest of snowshoe hare. The public laws of 1905 established the first closed season on hare in all but Hancock county. Open season dates were September 1 to March 31. The same law prohibited the use of snares and traps for the taking of hare, except it was lawful to catch hare in box traps in the counties of Oxford, Penobscot, and Piscataquis during the open season.

In 1917, hare season dates (September 1 to March 31) were established statewide and box trapping was allowed as well. The use of box traps was prohibited in 1929, and the opening date was changed to October 1, where it remains today (Table 1). The legislature changed season closing dates slightly (end of February to the end of March) mostly by county through 1972. The Department of Inland Fisheries and Wildlife was given regulatory authority in 1972. At that time, March 31 became the statewide closing date where it remains today (except for February 28 on Vinalhaven). The daily bag limit has remained at four with a possession limit of 8, from 1935 until present, with one exception—a limit of two in Somerset county during 1951. In 1969, the use of dogs to hunt hare during the deer firearms season was prohibited in six counties (Washington, Hancock, Waldo, Knox, Lincoln, and Sagadahoc). This law was

rescinded in 1997. In 1999, separate bag limits were instituted for snowshoe hare and New England cottontail.

Table 1. Snowshoe hare harvest regulations from 1935 to 2001 and estimates of hunter effort from 1955 to 1983. Harvest estimates and number of hunters were determined from mail-in hunting reports, hunter questionnaires, and Departmental Pittman Robertson reports. Counties in bold face type had their hunting regulations changed that year.

Year	Estimated Snowshoe hare Harvest	Total Number of Hunters	Hunting Season and Regulations
1935			Season Oct. 1 – March 31 Franklin and Somerset counties Season Oct. 1 – Feb. 28 all other counties Vinalhaven Nov. 2 to Jan. 31 Daily bag limit 4, Possession limit 8 Snares or traps not allowed, only shooting with guns Live trapping permitted with box traps in Washington and Hancock counties, $10 transportation fee for transporting live hare for sale within or beyond the borders of the state. No dead hares could be transported across state lines. (Legislature sets seasons by statute)
1937			Regulations the same as above except interstate transportation of hare was not permitted. Box traps could be used to live-trap hare and hare could be sold to the Department, if the Commissioner deemed it necessary for the distribution and conservation of hare or cottontail. No transportation fee.
1940			Same as above
1942			Same as above
1944			Season Oct. 1 – March 31 Franklin, **Oxford**, and Somerset counties Season Oct. 1 – March 15 **Waldo** county Season Oct. 1 – Feb. 28 all other counties Daily bag limit 4, Possession limit 8 Snares or traps not allowed, only shooting with guns Box traps could be used to live-trap hare and hare could be sold to the Department, if the Commissioner deemed it necessary for the distribution and conservation of hare or cottontail.
1953			Season Oct. 1 – March 1; Daily bag limit 4, possession limit 8 except in Somerset county where the daily bag and possession limit was 2. Sale of hare prohibited.
1955	193,500		Oct. 1 to March 31 in Franklin, Oxford, Knox, Somerset, Penobscot, Piscataquis, Aroostook, and York Counties Oct. 1 to February 28, all other counties Daily bag limit 4, Possession limit 8
1956	211,000		Same as above

Table. 1 cont'.

Year	Estimated Snowshoe hare Harvest	Total Number of Hunters	Hunting Season and Regulations
1957	304,600		Oct. 1 to March 31 in Franklin, Oxford, Knox, **Kennebec**, **Hancock**, **Washington**, Somerset, (***York –removed***) Penobscot, Piscataquis, and Aroostook, Counties Oct. 1 to February 28, all other counties. Daily bag limit 4, Possession limit 8. May use bow and arrow to take hare; Commissioner may purchase hare from trappers but general sale of hare or rabbits is prohibited
1958	292,400		Same as above
1959	230,700		Great Chebeague Is. closed to hare or cottontail hunting from April 1, 1959 to Sept. 30 1961 $50 fine for violation (all other laws as above)
1960	244,000		Same as above
1961	174,000		Oct. 1 to March 31 in Franklin, Oxford, Knox, Kennebec, Hancock, Washington, Somerset, **Lincoln**, Penobscot, Piscataquis, and Aroostook, Counties Oct. 1 to February 28, all other counties Daily bag limit 4, Possession limit 8. May use bow and arrow to take hare; Commissioner may purchase hare from trappers but general sale of hare or rabbits is prohibited
1962	159,700		Same as above
1963	138,000		Propagation of hare or cottontails on islands surrounded by salt water permitted
1964	141,900		Same as above
1965	136,400		Oct. 1 to March 31 in Franklin, Oxford, Knox, Kennebec, Hancock, Washington, Somerset, Lincoln, Penobscot, Piscataquis, **Waldo** and Aroostook, Counties Oct. 1 to February 28, all other counties. Daily bag limit 4, Possession limit 8. May use bow and arrow to take hare; Commissioner may purchase hare from trappers but general sale of hare or rabbits is prohibited. Propagation of hare or cottontails on islands surrounded by salt water permitted. Minimum $50 fine or 30 days in jail for violation of hare/rabbit laws.
1966	257,400		Same as above
1967	138,100		Oct. 1 to March 31 in Franklin, Oxford, Knox, Kennebec, Hancock, Washington, Somerset, Lincoln, Penobscot, Piscataquis, Waldo and Aroostook, Counties; Illegal to hunt hare in **Washington** county from Nov. 1 – Nov. 30 with hounds. Oct. 1 to March 20, **York** Oct. 1 to February 28 Cumberland, Androscoggin, and Sagadahoc (Other laws the same)

Table. 1 cont'.

Year	Estimated Snowshoe hare Harvest	Total Number of Hunters	Hunting Season and Regulations
1968	187,900		Same as above
1969	152,100		Illegal to hunt hare/rabbit with dogs during the open season on deer in Hancock, Knox, Lincoln, Sagadahoc, Washington, and Waldo counties. (other laws are the same as above)
1970	161,700		Same as above
1971	221,900		Oct. 1 to March 31 all other counties . Oct. 1 to March 20, **York** Oct. 1 to February 28 Cumberland, Androscoggin, and Sagadahoc (Other laws the same)
1972	291,600	46,597	IFW granted regulatory authority. Hunting season Oct-1 to March 31 for all counties
1973	352,900	58,234	Same as above
1974	247,900	51,715	Same as above
1975	239,600	53,706	Same as above
1976	212,400	49,830	Same as above
1977	217,500	51,414	Same as above
1978	201,100	47,351	Statewide hare/rabbit season Oct. 2 to March 31 Daily bag limit 4, Possession limit 8
1979	279,900	58,750	Statewide hare/rabbit season Oct. 1 to March 31 Daily bag limit 4, Possession limit 8
1980	227,000	55,105	Same as above
1981	300,400	69,466	Same as above
1982	288,000	65,542	Same as above
1983	217,500	53,264	Same as above
1984	No Survey Data		Same as above
1985	No Survey Data		Same as above
1986	No Survey Data		Same as above

Table. 1 cont'.

Year	Estimated Snowshoe hare Harvest	Total Number of Hunters	Hunting Season and Regulations
1988	No Survey Data		Same as above
1989	No Survey Data		Same as above
1990	No Survey Data		Statewide hare/rabbit season Oct. 1 to March 31 except **Vinalhaven** which was Oct. 1 to Feb. 28. Daily bag limit 4, Possession limit 8
1991	No Survey Data		Statewide hare/rabbit season Oct. 1 to March 31 except **Vinalhaven** which was Oct. 1 to Feb. 29. Daily bag limit 4, Possession limit 8
1992	No Survey Data		Same as above except Vinalhaven seasons dates changed back to Oct. 1 to Feb. 28
1993	No Survey Data		Same as above
1994	No Survey Data		Same as above
1995	No Survey Data		Same as above
1996	No Survey Data		Same as above
1997	No Survey Data		Prohibition of hunting rabbits with dogs during deer season dropped from summary
1998	No Survey Data		Same as above, except season on Vinalhaven adjusted for leap year.
1999	No Survey Data		Prohibition on use of dogs repealed; Daily bag limit on snowshoe hare stayed the same but the daily bag limit on cottontail rabbits was reduced to 1 and the possession limit was reduced to 2. (protecting the New England cottontail)
2000	No Survey Data		Same as above
2001	No Survey Data		Same as above

Current Management

No management activities are currently directed towards snowshoe hare other than (1) setting the length of the hunting season and (2) annually recording the abundance of hare tracks in conjunction with the Department's furbearer snow track survey. Hare populations are largely limited by habitat conditions, specifically, understory density. Since most forest land management is in the hands of private landowners, the Department has little influence on hare abundance. Hunter harvests have little to no effect on regulating local populations.

A recent management concern is the hunting of New England cottontail in southern Maine. Although hare and cottontail are fairly easy to distinguish, when the animal is in-hand, they may be difficult to tell apart under hunting conditions. In-hand, they can be told apart by foot size—adult cottontail have hind feet under 4 inches in length. Regulations designed to offer protection to cottontails were implemented for the 1999 hunting season. The daily bag limit of 4 “rabbits” can only include one cottontail and the possession limit of 8 may contain up to two cottontails.

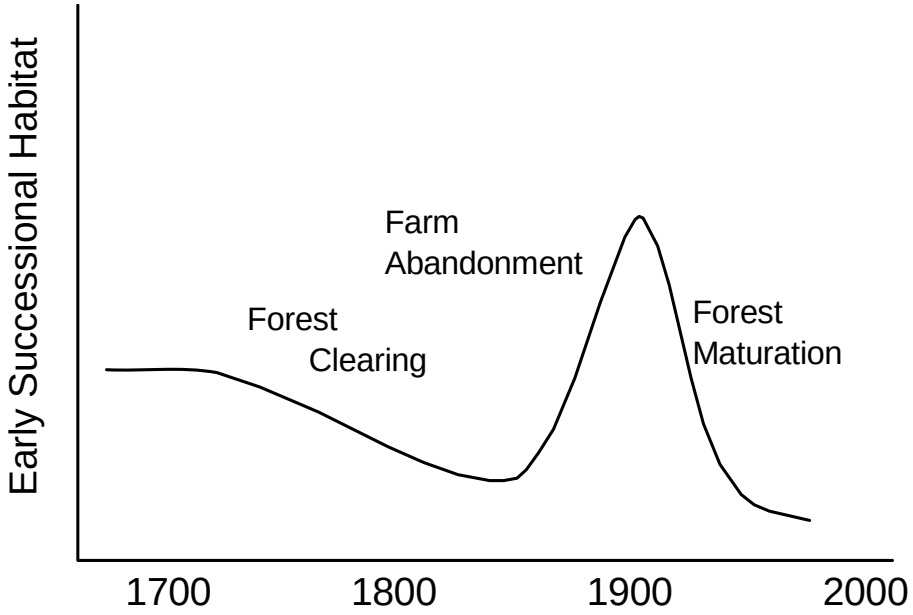
HABITAT ASSESSMENT

Past Habitat

Historically, the amount of regenerating forest available for snowshoe hare in Maine has varied with climate change, natural disturbance, and habitat manipulation by humans. At the time of colonization, Maine and other New England states were believed to be about 95% forested. Subsequently, forest clearing for agriculture, particularly in the southern part of the state, reduced the amount of forested land to its lowest level (approximately 75% forested) around 1875 (Litvaitis 1993). This was followed by farm abandonment, which dramatically increased the amount of early successional habitat, and later by forest maturation, which reduced the amount of early successional habitat (Fig. 2).

The snowshoe hare populations most affected by the above land-use changes were those in the southern half of Maine. Although the state, as a whole, was 75% forested around 1875, local land clearing was intensive in certain counties (e.g., Waldo county was importing firewood from Penobscot county; G. R. Lavigne, MDIFW, personal communication). In northern Maine, selective cutting, rather than clearcutting, was the most common timber management practice. This type of cutting produced a minimal amount of regenerating forest for snowshoe hare. However, forest fires, some which exceeded 800,000 acres, were more common during the early logging days. By the early 1900's, logging to support the fledgling pulp and paper industry resulted in more intensive cutting practices, but it wasn't until the 1960's that extensive clearcutting was

Figure 2. Suggested pattern of events that influenced the abundance of early successional habitat in New England from 1650 until present (adapted from Litvaitis 1993).



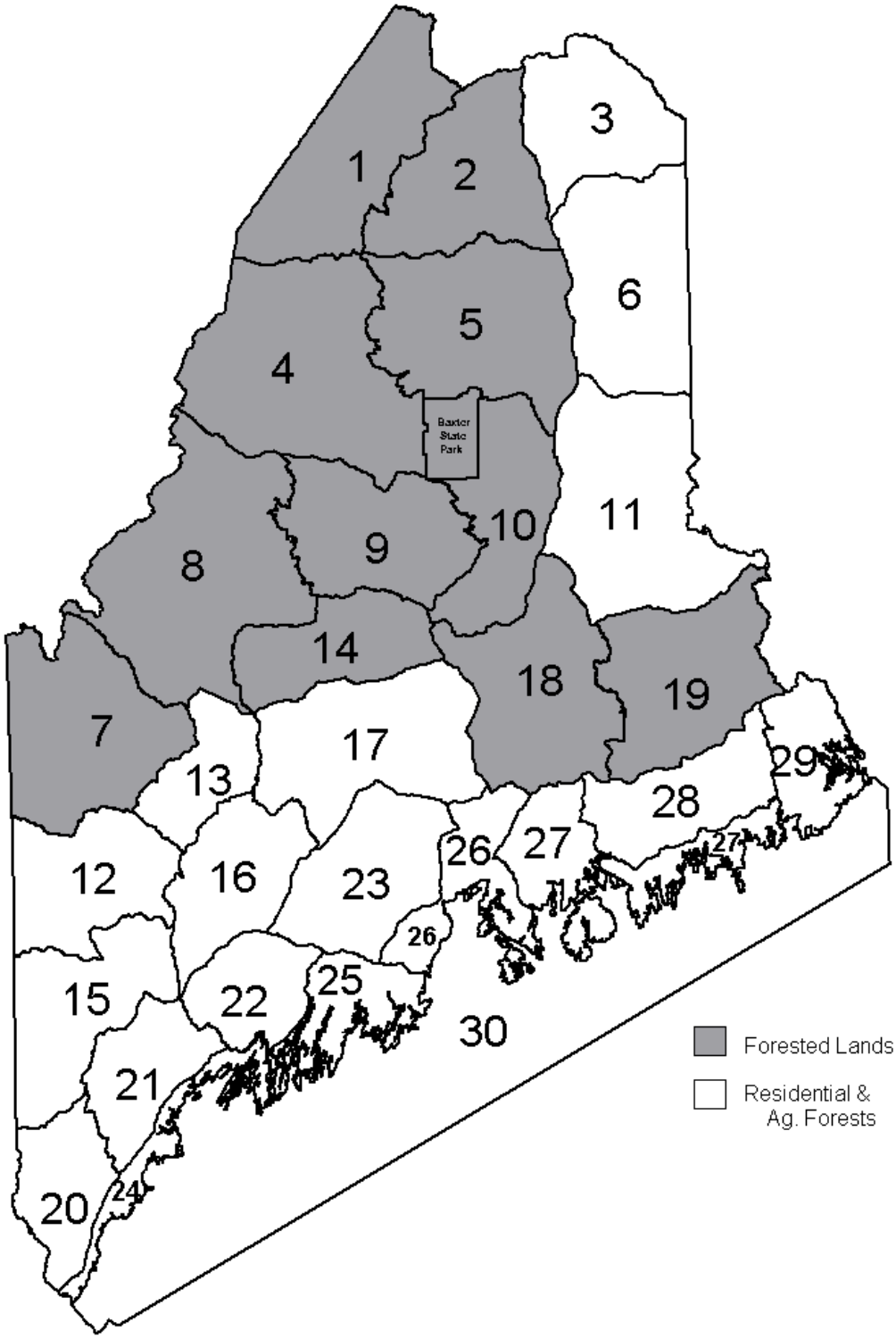
practiced in the northern forests (Lavigne 1999). In addition to fire and logging, cyclic outbreaks of spruce budworm have affected millions of acres of forest and killed large number of mature trees. These periodic die-offs (e.g., early 1900's, 1975; Lavigne 1999) allow forest regeneration to occur and provided excellent cover for hare 5 to 15 yr after the initial tree die-off.

Most of the snowshoe hare habitat in Maine would be classified as forest land. During the last decade, there has been very little change in the amount of forest land in the state. Statewide, there is about 1% less forest land now than in the early 1980's (Griffith and Alerich 1996). The greatest change occurred in Washington county, which lost about 7% of its forested land to development, from 1982 to 1995. Over this same period, early successional forests increased in the state by 39%, while the acreage of pole and saw timber (hemlock-pine and spruce-fir) declined by 42% (Griffith and Alerich 1996).

Current Habitat

The quality of forest cover for snowshoe hare, and subsequently carrying capacity, were evaluated by grouping habitat types into Forested Lands (i.e., those areas dominated by forests primarily in the northern and downeast portions of the state (WMDs 1, 2, 4, 5, 7 -10, 14, 18, 19 and Baxter State Park) and Agricultural and Residential Forests (forested areas occurring in WMDs 3, 6, 11, 12, 13, 15, 16, 17, 20 – 30) (Fig 3). It was impossible to evaluate cover in areas considered not forested (see definitions [USFS 1997]) because stem count data does not exist for these areas. Nonforested areas include woody areas, such as bogs and swamps, which may well

Figure 3. Snowshoe hare habitat types in Maine in relation to Wildlife Management Districts (WMDs).



contain snowshoe hare habitat. These areas made up only 2% of potential snowshoe hare habitat (i.e., potential habitat = forested areas + swamps + bogs + idle farmland); and hence have little impact on the total carrying capacity of the state for snowshoe hare.

Forested lands were further subdivided according to harvest history, forest type, and stand size. These categories were (1) clearcut; (2) partial and strip cut; (3) not cut[3], coniferous pole and saw timber; (4) not cut, deciduous pole and saw timber; and (5) not cut, seeding sapling and nonstocked. Forested lands were grouped by these different forest practices to account for major differences in habitat suitability, which may occur among these different forest types (see, Fuller 1999, Hoving 2001) and to take into account shifts in cutting practices that have occurred recently in Maine (Maine Forest Service 1998). Fuller (1999) noted that hare densities were substantially higher (1.61 hare / ha vs. 0.01 hare / ha, respectively) in regenerating clearcuts (approximately 16 yr old) as compared to 3-4 yr old partial harvest sites (residual basal area >6.9 m^2 / ha). The current and future carrying capacity of Maine's forests for snowshoe hare may depend on the ratio of clearcut to partially harvested areas on the landscape. The acreage clearcut in Maine decreased by more than 50% from 1991 to 1997 on commercial forest, while partial harvested areas composed 94% of the total acreage harvested in Maine in 1997 (Maine Forest Service 1998).

Unfortunately, data in this assessment cannot be directly compared to previous assessments to determine changes in carrying capacity (Appendix 1 and 2). Total carrying capacity for snowshoe hare in the state in 1995 was estimated to be 7,526,000

[3] "Not cut" refers to no evidence of harvesting at the time the survey was made.

hare, of which 4,852,000 hare could be supported in the area represented by Forested Lands, and 2,674,000 hare could be supported in the Agricultural and Residential Forests (Table 2). Carrying capacity estimates did not vary among forest categories in Forested Lands except for "not cut, deciduous pole/sawtimber", which had a lower carrying capacity than the other categories (Table 2). This lack of difference in carrying capacity among the forest categories was due to the limits of Litvaitis et al.'s (1985) regression equation[4] and the coarseness of Forest Resurvey categories. For example, partial cut is a broad term used to describe any technique that results in an incomplete removal of overstory during a single harvesting operation. Consequently, the areas classified as partial cuts may vary widely in their suitability for snowshoe hare. Likewise, the clearcut classification may include clearcuts that vary in regeneration time. Thus, these stands will also vary in their suitability for snowshoe hare. At this time, Forest Resurvey data is not detailed enough to distinguish the differences in hare carrying capacity among harvest regimes noted by Fuller (1999). Models based on remote sensing data and track counts (e.g., Hoving 2001) may provide more accurate ways for assessing hare habitat conditions in the future.

Areas classified as Agricultural and Residential Forests varied more in habitat suitability than areas under the Forested Lands classification (Table 2). This variance, and the lower suitability of these areas for hare, is likely due to the greater deciduous component in these forests than in more northerly forests. Currently, the amount of cover is excellent in the forests of northern Maine. All forests types except "not cut,

[4] Litvaitis et al.'s (1985) regression equation has an upper limit for predicting hare densities near 1.5 hare / ha. Therefore any habitat type which had a Stem Cover Unit value >55,652 was automatically assigned a hare density of 1.5 / ha (Appendix 1). All of the categories under Forested lands, except "not cut, deciduous pole/sawtimber" had SCUs > than 55,652.

Table 2. Area, stem cover units (SCU) per hectare, density of hare, and approximate number of hare in various forest types in (a.) Forested Lands[5] (i.e., those areas dominated by forests primarily in the northern and downeast portions of the state – WMDs 1, 2, 4, 5, 7 -10, 14, 18, 19and Baxter State Park) and (b) Agricultural and Residential Forests[5] (forested areas occurring in WMDs 3, 6, 11, 12, 13, 15, 16, 17, 20 –30).

A.

Parameter	Clearcut	Partial & Strip-Cut	Not cut Coniferous Pole/Sawtimber	Not cut Deciduous Pole/Sawtimber	Not cut Seedling/Sapling and Nonstocked
Area (mi^2)	1,956	4,258	3,079	3,715	1,489
SCU/ha	99,598	61,474	65,354	38,026	91,455
Hare/mi^2	389	389	389	177	389
Carrying capacity expressed as number of hare	760,884	1,656,362	1,197,731	657,555	579,221

B.

Parameter	Clearcut	Partial & Strip-Cut	Not cut Coniferous Pole/Sawtimber	Not cut Deciduous Pole/Sawtimber	Not cut Seedling/Sapling and Nonstocked
Area (mi^2)	866	4,751	2,829	3,643	1,418
SCU/ha	70,850	43,097	37,501	26,812	64,904
Hare/mi^2	389	239	172	45	389
Carrying capacity expressed as number of hare	336,874	1,135,489	486,588	163,935	551,602

[5] In 1995, the area making up the Forested Lands category covered 15,028 mi^2, while the Agriculture and Residential Forests category represented 16,009 mi^2. The area termed Forested Lands included 14,497 mi^2 of forested habitat, 205 mi^2 of non-forested snowshoe hare habitat, and 326 mi^2 of non-habitat for snowshoe hare. The area termed Agriculture and Residential Forests lands included 13,507 mi^2 of forested habitat, 344 mi^2 of non-forested snowshoe hare habitat, and 2,158 mi^2 of non-habitat for snowshoe hare. Carrying capacity estimates were only attempted on forested habitats.

deciduous pole/saw timber" provided optimal hare cover (i.e., Stem Cover Unit (SCU)> 55,652). Only the "clearcut" and "not cut, seedling/sapling" categories of the Agricultural and Residential Forests reached optimum values for snowshoe hare cover (Table 2).

Many of the small coastal islands (WMD 30) are uninhabited by hare, despite attempts to propagate hare on coastal islands in the early 1960's (Table 1). One exception is Great Duck Island, a 70 acre island which lies about 6 miles southeast of Mount Desert Island. Hare were apparently imported to the island around 1960 and persist at high numbers. Although local hunters enjoyed pursuing hare with hounds on the island, the hare over-browsed much of the island's vegetation (R.B. Allen, MDIFW, personal communication). In contrast to the small islands, many of the larger islands including Mount Desert, Vinalhaven, North Haven, Islesboro, Deer Isle/Stonington, and Isle au Haut support hare populations.

In order to determine whether carrying capacity for snowshoe hare changed between the 1985 and 2001 assessments, an attempt was made to replicate the methods used in the 1985 assessment and apply them to the 1997 Forest Resurvey data (Appendix 2). These results should only be viewed as an indicator of habitat trends and do not represent the true magnitude of these changes.

Statewide, carrying capacity for snowshoe hare appears to have increased from the 1982 to the 1995 forest inventory (USFS 1997; Table 3). Comparisons to the 1985 assessment were made using Wildlife Management Units (WMUs; Fig.1). Northern Maine (WMUs 1, 2, and 3; roughly Wildlife Management Districts [WMDs] 1-13; Fig. 3)

Table 3. Habitat Suitability Index values by Wildlife Management Unit (WMU) from the 1985 snowshoe hare assessment (Cross 1986), and as calculated in Appendix 2. These values should only be used as an indicator of direction of change in carrying capacity and do not represent the true magnitude of change.

WMU	Current	1985	% change
1	0.61	0.29	110%
2	0.89	0.35	154%
3	0.59	0.27	119%
4	0.33	0.25	32%
5	0.68	0.45	51%
6	0.50	0.40	25%
7	0.14	0.18	-22%
8	0.21	0.20	5%

had the greatest increase in carrying capacity (may have doubled), central and eastern Maine (WMUs 4, 5, and 6; WMDs 14-19 and 27-29) showed moderate increase in carrying capacity, and carrying capacity in southern and coastal Maine (WMUs 7 and 8; WMDs 20-26) stayed the same or decreased (Table 3).

The timing of the 1982 and 1995 Forest Resurveys resulted in large differences in habitat quality being recorded for the two periods. Much of the data published in 1982 was collected prior to the spruce budworm outbreak and the ensuing salvage cuts. Both of these events created forest openings which were eventually favorable to snowshoe hare. Thus, habitat conditions reported in 1982 represent some of the poorest conditions in recent years, and the 1995 data reflect a period when the forest openings regenerated to near optimal conditions for snowshoe hare.

Habitat Projections

If current forest harvesting trends continue, less acreage will be clearcut in the future, a greater percentage of the forests will receive pre-commercial thinning treatments, and partial harvesting will be the dominant tree harvesting technique. In addition, many of the salvage cuts, from the last spruce budworm outbreak, will have reached a regeneration stage that is less favorable for hare. Currently, studies are underway at the University of Maine (D. Harrison and J. Homyack) to determine the effect of pre-commercial thinning on hare populations. Additional studies are needed on a range of partial harvest types to determine how these cutting practices are affecting hare and other species that depend on dense understories.

The future carrying capacity of Maine's forests for snowshoe hare will depend on the willingness of the forest industry to leaving adequate slash and saplings, for cover, following cutting operations. Given the high amount of cover currently available for hare, the carrying capacity of hare will likely decrease in the future, especially as regenerating clearcuts grow past the point where they are useful to hare. Although the age composition of stands is predicted to remain relatively stable in the future (Chilelli 1998), the harvest techniques used to maintain this composition may dictate the carrying capacity for hare 30 yr from now.

POPULATION ASSESSMENT

Past Populations

In the 1975 hare assessment, the statewide fall estimate of the population was 4,796,000. This estimate was produced by applying different hare densities to areas of different forest types across the state. In 1985, the fall population of hare in Maine was estimated to be 8,522,000. This estimate was calculated by combining the results from a Habitat Suitability Index (HSI) model (Cross 1985) with impressions from regional biologists regarding the relationship of the population to the carrying capacity of the habitat. At the time, there was general agreement that the use of "general impressions" to estimate population size led to large errors, and should not be attempted in the future[6].

Current Populations

The size of Maine's snowshoe hare population was not estimated for this assessment. Rather the carrying capacities of the forested areas in Maine were estimated using linear regression (Litvaitis et al.1985; see Current Habitat). A population estimate was not attempted for the following reasons:

[6] Casual observations tend to highlight areas with very high or very low densities and are complicated by changes in habitat quality (carrying capacity). In addition, regional biologist must have long-term (in excess of 10 years) familiarity with hare densities, within their region, (not to mention a great memory) in order to conclude that hare densities have changed from one assessment period to the next.

- Hare populations go through natural fluctuations, which would be impractical to control or manage on a large scale. Therefore, the most critical aspect of hare management is insuring that the carrying capacity of the habitat remains adequate to support the desired maximum number of hare. Consequently, we should be more concerned about tracking changes in carrying capacity than natural fluctuations in hare populations.

- Currently the Department does not have a hare population index that is tied to the size of any hare population. Therefore, we do not have the information necessary to make an estimate on the number of hare we have in any part of the state.

Hoving (2001), working with MDIFW snow track data collected during the winters from 1994-95 to 1998-99, noted that the number of transects having abundant hare tracks quadrupled over this time period. High numbers of hare have also been noted by Department personnel working on the lynx research project near Clayton Lake, in northwestern Maine, from 1999 to 2001. These observations and studies suggest that current hare populations are high in northern Maine. This contrasts with downeast and southern Maine, where hare numbers do not appear to be markedly higher (T. L. Schaeffer and P. A. Bozenhard, MDIFW, personal communication).

Population Projection

The population of snowshoe hare will likely decrease in the near future. During the next 3 to 5 years we are likely to see a reduction in hare populations in northern and north-central Maine. Snow track counts and observations by the public and staff uniformly agree that hare populations in these areas have increased during the last 3 to 5 yr. Given the fluctuating nature of snowshoe hare populations, it is probably safe to assume that populations which are currently high will decrease in the next 5 yr.

Of greater concern is maintaining the carrying capacity of the habitat for hare. Future forest cutting practices will have a large influence on hare numbers. Although the effect of partial cutting on hare numbers is still an open question, current timber management is moving away from clearcuts, which, in the past, have produced excellent hare habitat. Many areas that currently provide good hare habitat (spruce budworm killed forests and clearcuts) will mature past the point they are useful to hare in the next 15 yr. Given the optimal habitat conditions that exist now, and the uncertainty about the effects that partial cutting and pre-commercial thinning will have on hare numbers, it seems reasonable to expect, at least, a slight decrease in carrying capacity. A decrease in carrying capacity for hare may be most noticeable the next time hare populations rebound to high densities. If the carrying capacity for hares is reduced substantially, hare may not reach current population levels, and/or the habitat may not be able to support high hare densities for the same duration, as compared to present.

USE AND DEMAND ASSESSMENT

Past Use and Demand

Two of the earliest methods for capturing hare in Maine were snares and box traps. Native Americans typically captured hare using rawhide snares set in runways and used hare as a source of meat and fur (Speck 1940). Box traps were used into the early 20th century until they were banned in 1929. Other methods of hunting hare include using dogs to flush or chase hare (e.g., hunting hare with beagles), stalking, and incidentally shooting hare while hunting other game.

Most hare hunting occurs in southern Maine; therefore, harvest estimates are heavily influenced by southern hare populations and hunting conditions. In 1971, 85% of the hare hunting effort was in four WMUs (1, 4, 7, and 8 [roughly WMDs 3, 6, 11-18, 20-26]), with 57% of the hare coming from the southern most WMUs (i.e., 7 and 8 [roughly, WMDs 16, 20-26]). Less than 1% of the statewide hunting effort on hare occurred in northern Maine (WMU 2). Harvest estimates derived from hunter questionnaires from 1951 to 1983 range from 99,000 (1951) to 353,000 (1973); however the reliability of these estimates is questionable (Table 1). Approximately, 45,000 to 70,000 hunters annually pursued hare from 1972-1983, 1987, and 1988.

Current Use and Demand

Nonconsumptive Use

In 1993, 73% of Maine residents 16 yr or older participated in primary nonconsumptive wildlife activities (i.e., nonconsumptive activities not incidental to other

activities), while 16% of the residents hunted, and less than 1% trapped (U.S. Dept. of Interior et al. 1993). Nonconsumptive use of hare is likely limited to occasional "backyard" viewing or glimpses of hare while hiking or hunting. Nevertheless, these occasional glimpses provide enjoyment for many people. In addition to actual sightings, the abundance of snowshoe hare tracks following a fresh snowfall is fascinating to some wildlife enthusiasts (especially younger ones). At this time there are no specific surveys of Maine residents indicating the percentage of people who enjoy watching small mammals, such as snowshoe hare.

Perhaps of greater significance than direct nonconsumptive use of hare, are the number of animals that depend on snowshoe hare as a major food source. These would include lynx, bobcat, great horned owl, fox, fisher, marten, and coyote. If hare populations were reduced, the populations of these animals would also be affected. A reduction in these animal populations, of course, would have implications for both nonconsumptive and consumptive use of Maine's wildlife.

Consumptive Use

A total of 76,000 residents and nonresidents hunted small game in Maine in 1996 (U.S. Dept of Interior et al. 1996). Small game hunters made up 36% of all the resident and nonresident hunters in Maine that year. The majority (87%) of small game hunters were Maine residents, while only 13% of small game hunters were nonresidents. The total number of hunting trips made by small game hunters was 1,026,000 with the vast majority of those trips being day-trips. Hare and rabbits were the second most popular animals pursued by small game hunters, with ruffed grouse being the most popular

(U.S. Dept of Interior et al. 1996). Approximately 20,000 hunters pursued hare or rabbit in Maine (10% of all hunters).

The number of snowshoe hare hunters are not expected to change markedly in the near future. Commercial interest in snowshoe hare hunting seems to be increasing. Guided hare hunts are now advertised by many outfitters during the slower winter season. This trend may continue into the near future while hare populations remain high.

Use and Demand Projections

Unless, timber management practices have a major impact on the carrying capacity for hare, it is not expected that long term use or demand for hare will be affected. Minor long term changes in the hare population likely will not limit human use of this species, since current consumptive use could be increased and still be sustainable. Short term use and demand will be affected by normal fluctuations of local hare numbers.

Any decrease in the hare population will have the greatest impact on species that are highly depended on hare as a food source. Hence, nonconsumptive and consumptive use of these species by humans may be affected. Lynx prey almost exclusively on snowshoe hare and are currently considered a Federal Threatened species. Short or long term changes in hare numbers likely would affect the distribution and number of lynx in Maine. Other species that are the highly vulnerable to a decrease in the snowshoe hare population are fisher (currently high in northern Maine) and bobcat (fall of 1999 the statewide population was considered high).

SUMMARY AND CONCLUSIONS

The common names for *Lepus americanus* -- snowshoe and varying hare -- refer to the species' most noted characteristics: enlarged hind feet and seasonal changes in coat color. The snowshoe hare's geographic range largely coincides with the distribution of boreal forest in North America. In Maine, hare occur throughout the state, wherever adequate cover exists.

In much of the boreal forest of North America, snowshoe hare appear to go through an 8 to 11 year population cycle. Hare populations commonly go through population cycles in regions where optimal habitat is continuous and extensive (e.g., Alaska and Canada). Hare densities during cyclic highs in these regions often exceed 500/km^2 (1295/mi^2) and may reach 1000/km^2 (2590/mi^2) (Keith 1990).

Hare populations in the eastern United States are considered noncyclic. In the east, hare habitat tends to be more fragmented than in the boreal forest region of Canada. In fragmented habitat, hare populations are thought to be regulated by predation, as hare move between areas having secure cover. Although high hare densities in some noncyclic populations may equal or exceed densities in some cyclic populations, the majority of noncyclic populations exist at densities 1/10 to 1/5 of those reached at cyclic peaks. In Maine, spring hare densities ranged from 10 to 170 per km^2 (26 to 440 per mi^2).

The density of cover, or protection from predators, is thought to be the factor that most likely limits the number of hare a given habitat can support. Throughout their range, snowshoe hare are highly associated with dense understories. However, low-

growing conifer cover appears to gain importance near the southern limit of the hare's geographic range.

The quality of forest cover for snowshoe hare, and subsequently carrying capacity, were evaluated by grouping habitat types into Forested Lands (i.e., those areas dominated by forests primarily in the northern and downeast portions of the state (WMDs 1, 2, 4, 5, 7 -10, 14, 18, 19 and Baxter State Park) and Agricultural and Residential Forests (forested areas occurring in WMDs 3, 6, 11, 12, 13, 15, 16, 17, 20 – 30). Forested lands were further subdivided according to harvest history, forest type, and stand size. These categories were (1) clearcut; (2) partial and strip cut; (3) not cut, coniferous pole and saw timber; (4) not cut, deciduous pole and saw timber; and (5) not cut, seeding sapling and nonstocked. Forested lands were grouped by these different forest practices to account for major differences in habitat suitability, and to take into account shifts in cutting practices that have recently occurred in Maine.

During the last decade there has been very little change in the amount of forest land in the state. Statewide, there is about 1% less forest land now than in the early 1980's. However, early successional forests, a forest type favorable to hare, increased in the state by 39%,while the acreage of pole and saw timber (hemlock-pine and spruce-fir) declined by 42%. From 1991 to 1997, the amount of acreage clearcut in Maine decreased by more than 50% on commercial forests. In 1997, partial harvested areas composed 94% of the total acreage harvested in Maine.

Total carrying capacity for snowshoe hare in the state in 1995 was estimated to be 7,526,000 hare, of which 4,852,000 hare could be supported in the area represented by Forested Lands, and 2,674,000 hare could be supported in the Agricultural and

Residential Forests. Carrying capacity estimates did not vary among forest categories in Forested Lands except for "not cut, deciduous pole/sawtimber", which had a lower carrying capacity than the other categories. The lack of difference in carrying capacity among the forest categories can be explained by: (1) the broad time frame (15 yr), during which forest inventory data was collected, and our need for specific information on the characteristics of early successional habitats (or forest regeneration); and (2) a definition of partial cuts that encompassed many types of cutting practices; hence, a broad spectrum of cover densities for hare were included in this habitat type.

In order to determine whether carrying capacity for snowshoe hare changed between the 1985 and 2001 assessments, an attempt was made to replicate the methods used in the 1985 assessment and apply them to the 1997 Forest Resurvey data (Appendix 2). Statewide, carrying capacity for snowshoe hare appears to have increased from the 1982 to the 1995 forest inventory. The timing of the 1982 and 1995 Forest Resurveys resulted in large differences in habitat quality being recorded for the two periods. Much of the data published in 1982 was collected prior to the spruce budworm outbreak and the ensuing salvage cuts. Both of these events created forest openings which were eventually favorable to snowshoe hare.

If current forest harvesting trends continue, less acreage will be clearcut in the future, a greater percentage of the forests will receive pre-commercial thinning treatments, and partial harvesting will be the dominant tree harvesting technique. In addition, many of the salvage cuts, from the last spruce budworm outbreak will have reached a regeneration stage that is less favorable for hare. Given the high amount of cover currently available for hare, the carrying capacity of hare will likely decrease in the

future. Although the age composition of stands is predicted to remain relatively stable in the future, the harvest techniques used to maintain this composition may dictate the carrying capacity for hare 30 yr from now.

Carrying capacity, rather than population size, was estimated for snowshoe hare. A population estimate was not attempted because (1) Hare populations go through natural fluctuations, which would be impractical to control or manage on a large scale, (2) the most critical aspect of hare management is insuring that the carrying capacity of the habitat remains adequate, and (3) the Department does not have the information necessary to make an estimate on the number of hare we have in any part of the state.

Given the fluctuating nature of snowshoe hare populations, it is probably safe to assume that populations which are currently high will decrease in the next 5 yr. In 10 to 15 yr, the optimal habitat conditions that currently exist will likely decline. Added to this, is the uncertainty of the effects of partial cutting and pre-commercial thinning on hare numbers. Given these factors, it seems reasonable to expect a slight decrease in carrying capacity for snowshoe hare.

Prior to 1905, there were no laws restricting the harvest of snowshoe hare. The public laws of 1905 established the first closed season on hare in all but Hancock county. The same law prohibited the use of snares and traps for the taking of hare. The use of box traps was prohibited in 1929, and the opening date was changed to October 1, where it remains today. The Department of Inland Fisheries and Wildlife was given authority in 1972 regulate the management of wildlife. At that time, March 31 became the statewide closing date (except for February 28 on Vinalhaven) for snowshoe hare.

No management activities are currently directed towards snowshoe hare other than (1) setting the length of the hunting season and (2) annually recording the abundance of hare tracks in conjunction with the Department's furbearer snow track survey. Since most forest land management is in the hands of private landowners, the Department has little influence on hare abundance. Hunter harvests have little to no effect on regulating local populations.

In 1993, 73% of Maine residents 16 yr or older participated in primary nonconsumptive wildlife activities (i.e., nonconsumptive activities not incidental to other activities), while 16% of the residents hunted, and less than 1% trapped (U.S. Dept. of Interior et al. 1993). Nonconsumptive use of hare is likely limited to occasional "backyard" viewing or glimpses of hare while hiking or hunting. A total of 76,000 residents and nonresidents hunted small game in Maine in 1996. Small game hunters made up 36% of all the resident and nonresident hunters in Maine that year. The majority (87%) of small game hunters were Maine residents, while only 13% of small game hunters were nonresidents. The total number of hunting trips made by small game hunters was 1,026,000 with the vast majority of those trips being day-trips. Hare and rabbits were the second most popular animals pursued by small game hunters, with ruffed grouse being the most popular. Approximately 20,000 hunters pursued hare or rabbit in Maine (10% of all hunters).

Snowshoe hare have considerable influence on the ecological communities they live in. As a prey species, it may be considered the universal entree. Consequently, snowshoe hare numbers affect both predators and the survival of alternative prey species. These would include lynx, bobcat, great horned owl, fox, fisher, marten, and

coyote. If hare populations were reduced, the populations of these animals would also be affected. A reduction in these animal populations, of course, would have implications for both nonconsumptive and consumptive use of Maine's wildlife.

Unless timber management practices have a major impact on hare carrying capacity, long term use or demand for hare will not likely be affected. Minor long term changes in the hare population will not limit human use of this species, since current consumptive use could be increased and still be sustainable. Short term use and demand will be affected by normal fluctuations of local hare numbers.

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Appendix 1. Habitat Calculations for Snowshoe Hare

Snowshoe hare habitat quality was measured, by M.E.R. Wickett, MDIFW, using a model developed from data collected in Pierce Pond and Cherryfield, ME (Litvaitis et al. 1985). In this model, Litvaitis et al. (1985) demonstrated a strong linear relationship between hare density and understory density expressed as stem cover units (SCU) per hectare. SCUs were calculated[7] using densities of coniferous and deciduous stems (stems / ha) $\geq$ 30.5 cm (1 ft) in height and $\leq$ 7.5 cm (3 in) diameter breast height (DBH). Coniferous stems provide greater visual cover in winter than deciduous stems; hence, they are given more importance in the model by weighting them by a factor of 3 (i.e., 1 coniferous stem = 3 deciduous stems). Litvaitis (1985) calculated SCU as the number of coniferous stems (Sc) / ha multiplied by 3, plus the number of deciduous stems (Sd) / ha (Eq. 1).

$$\text{Eq. 1} \qquad SCU = 3Sc + Sd$$

Cross (1985) developed a Habitat Suitability Index (HSI) for predicting the density of hare (hare / acre) that could be supported in Maine. The formula used by Cross (1985) (eq. 2) was similar to the regression equation used by Litvaitis (1985) (i.e., $y = 0.000046x - 1.06$, where SCU = x, and y = hare / ha) for predicting hare densities.

[7] Litvaitis (1985) set a minimum height of 0.5 m for stems to be included in SCU calculations. However, the only height measurement available in the 1995 forest inventory was the minimum height requirement for woody plants (i.e., 12 in [30.5 cm]). Therefore, all stems > 12 in were included when calculating SCU values.

However, in the 1985 HSI model, SCUs should not have been converted from stems / ha to stems / acre prior to dividing by 2.47[8].

Eq. 2 $$HSI = \frac{0.000046x - 1.06}{2.47}$$

Standard HSI models often use a number of habitat parameters to predict habitat suitability, and have values ranging from 0 to 1 (index values without units). Because equation 2 is essentially equivalent to Litvaitis et al.'s (1985) regression equation, it predicts hare / unit area, and not a unit-less index value. Use of 1 as an upper limit of the HSI model (eq. 2; Cross 1985), inadvertently set the maximum hare density at 2.47 hare / ha (1 hare / acre) which is 31% higher than the highest hare density reported by Litvaitis et al. (1985). This value also falls outside of the range of hare densities that is predictable using Litvaitis et al.'s (1985) regression equation.

The current assessment made the following corrections or adjustments to the procedure used by Cross (1985).

(1) Maximum hare densities were set at 1.5 hare / ha (0.61 hare / acre)[9].

(2) The maximum DBH limit for stems was raised from 2.5 in to 3.0 in to better match Litvaitis et al.'s (1985) DBH limit of 7.5 cm.

[8] It appears that the 1985 calculations were made using the proper conversion factor for stems / ha. However, the formula in the HSI documentation was written incorrectly.

[9] This density was based on the endpoint of the regression line used in Litvaitis (1985); however, the highest density of hare recorded in Maine by Litvaitis (1985) was 1.7 hare / ha.

(3) The maximum SCU value was changed to 55,652 stems / ha (22,531 stems / acre) from 31,320 stems / acre. Therefore, any habitats having SCUs > 55,652 / ha were automatically assigned a hare density of 1.5 hare / ha.

(4) The minimum SCU (i.e., where $y = 0$) was changed to 23,043 stems / ha (9, 329 stems / acre). Therefore, any habitats having SCUs < 23,043 stems / ha will be automatically assigned a hare density of 0.

(5) The model used to assess the potential carrying capacity of habitat will no longer be referred to as the hare HSI model and HSI index values will not be calculated. Rather, hare densities will be calculated using the regression equation of Litvaitis (1985). Potential carrying capacity was calculated using density / habitat type and area of that habitat type.

(6) The land area assessed for its potential to support snowshoe hare included the following habitat types. Stem densities were calculated only on forested lands.

- Forest land (LU=20-52), included all stand sizes and stocking rates
- Nonforest land: idle farm land (LU=65,66); bog & swamp (LU=69,72)
- Cropland (LU=61,62) and improved pasture (LU=63,64) were not considered snowshoe hare habitat.
- The category Forested Lands included WMDs 1, 2, 4, 5, 7-10, 14, 18, 19 and Baxter State Park.
- The category Agriculture & Residential Forests included WMDs 3, 6, 11-13, 15-17, 20-30

(7) The following information was used to calculate stem density.

- Associated SAS program: stemcount_rev.SAS

- Number stems of hardwood and softwood (HWSW) shrubs, HWSW seedling-saplings(<=2.92"dbh) - stem counts: counted only on forest plots (LU=20-50, 52)
- Deciduous shrubs included alder (350)[10], chokeberry sp (365), azalea (366), barberry (368), NJ tea (458), sweet fern (485), alt-leafed dogwood (492), silky dogwood (493), round-leafed dogwood (494), gray-stem dogwood (496), red-osier dogwood (497), Am hazelnut (501), beaked hazelnut (502), leatherwood (525), autumn olive(535), huckleberry (549), witch-hazel (585), large-leaf holly (592), winterberry holly (593), bush honeysuckle (635), mountain-holly (685), buckthorn (845), smooth sumac (865), staghorn sumac (866), gooseberry (870), rose (905), briar(915), American elderberry (925), red-berried elderberry (926), spirea (937), Am bladdernut (982), viburnum (985), maple-leafed viburnum (986), hobblebush viburnum (987), wild raisin (988), arrowwood (989), nannyberry (990), blackhaw (991), highbush cranberry (992), common prickly ash (994), unknown (997)
- Evergreen shrubs included common juniper (61), Canada yew (232), bog rosemary (357), sheep laurel (605), mountain laurel (606), Labrador tea (608), rhododendron (855), sweetleaf (945), unknown (998). Common juniper and Canada yew stem counts were multiplied by 3.
- Hardwood seedlings/saplings included maple sp (310), boxelder (313), striped maple (315), red maple (316), silver maple (317), sugar maple (318), mountain maple (319), ailanthus (341), serviceberry (355), birch sp (370), yellow birch (371), sweet birch (372), river birch (373), paper birch (375), gray birch (379), American hornbeam (391), shellbark hickory (405), shagbark hickory (407),

flowering dogwood (491), hawthorn (500), American Beech (531), ash sp (540), white ash (541), black ash (543), green ash (544), apple sp (660), mulberry (680), eastern hophornbeam (701), sourwood (711), balsam poplar (741), eastern cottonwood (742), bigtooth aspen (743), quaking aspen (746), cherry-plum sp (760), pin cherry (761), black cherry (762), chokecherry (763), oak sp (800), white oak (802), northern pin oak (809), scrub oak (816), shingle oak (817), pin oak (830), willow oak (831), chestnut oak (832), n red oak (833), black oak (837), black locust (901), willow sp. (920), black willow (922), American mountain-ash (935), European Ash-ash (936), basswood (950), American basswood (951), elm sp. (970), American elm (972), slippery elm (975), rock elm (977), unknown (999)

- Softwood seedlings/saplings included balsam fir (12), larch-introduced (70), tamarack (71), Norway spruce (91), white spruce (94), black spruce (95), red spruce (97), jack pine (105), red pine (125), pitch pine (126), eastern white pine (129), northern white-cedar (241), eastern hemlock (261). These stem counts were multiplied by 3.

[10] Numbers correspond to USFS 1997 species codes.

Appendix 2. Habitat data used to compare changes in carrying capacity from 1982 to 1995

The following information was used to calculate stem densities and carrying capacity based on the methods used in the 1985 snowshoe hare assessment. The HSI formula developed by Cross (1985) was used as given, except SCU's were calculated as SCU / ha.

Acreages were determined from the 1995 U.S. Forest Service Forest Resurvey of Maine

- Snowshoe hare habitat included:
- Forest land (LU=20-52), included all stand sizes and stocking
- Nonforest land included idle farm land (LU=65,66); maintained r-o-w (LU=73,74) and did not include bog/swamp (LU=69,72)-if dry enough to support shrub/tree, likely categorized as forest.
- Cropland (LU=61,62) and improved pasture (LU=63,64) were not considered Snowshoe hare habitat.
- WMUs groupings - Commercial Forest: WMUs 2,3,5; Agricultural & Residential: WMUs 1,4,6,7,8
- Associated SAS program: stemcount.SAS
- Number stems of HWSW shrubs, HWSW seedling-saplings(<=2.5"dbh) - stem counts: counted only on forest plots (LU=20-50,52).
- Deciduous shrubs included alder (350), chokeberry sp (365), azalea (366), barberry (368), NJ tea (458), sweet fern (485), alt-leafed dogwood (492), silky

dogwood (493), round-leafed dogwood (494), gray-stem dogwood (496), red-osier dogwood (497), Am hazelnut (501), blueberry (983), beaked hazelnut (502), leatherwood (525), autumn olive(535), huckleberry (549), witch-hazel (585), large-leaf holly (592), winterberry holly (593), bush honeysuckle (635), mountain-holly (685), buckthorn (845), smooth sumac (865), staghorn sumac (866), gooseberry (870), rose (905), briar(915), American elderberry (925), red-berried elderberry (926), spirea (937), Am bladdernut (982), viburnum (985), maple-leafed viburnum (986), hobblebush viburnum (987), wild raisin (988), arrowwood (989), nannyberry (990), blackhaw (991), highbush cranberry (992), common prickly ash (994), unknown (997)

- Evergreen shrubs included common juniper (61), Canada yew (232), bog rosemary (357), sheep laurel (605), mountain laurel (606), Labrador tea (608), rhododendron (855), sweetleaf (945), unknown (998)
- Hardwood seedlings/saplings included maple sp (310), boxelder (313), striped maple (315), red maple (316), silver maple (317), sugar maple (318), mountain maple (319), ailanthus (341), serviceberry (355), birch sp (370), yellow birch (371), sweet birch (372), river birch (373), paper birch (375), gray birch (379), American hornbeam (391), shellbark hickory (405), shagbark hickory (407), flowering dogwood (491), hawthorn (500), American Beech (531), ash sp (540), white ash (541), black ash (543), green ash (544), apple sp (660), mulberry (680), eastern hophornbeam (701), sourwood (711), balsam poplar (741), eastern cottonwood (742), bigtooth aspen (743), quaking aspen (746), cherry-plum sp (760), pin cherry (761), black cherry (762), chokecherry (763), oak sp

(800), white oak (802), northern pin oak (809), scrub oak (816), shingle oak (817), pin oak (830), willow oak (831), chestnut oak (832), n red oak (833), black oak (837), black locust (901), willow sp. (920), black willow (922), American mountain-ash (935), European Ash-ash (936), basswood (950), American basswood (951), elm sp. (970), American elm (972), slippery elm (975), rock elm (977), unknown (999)

- Softwood seedlings/saplings included balsam fir (12), larch-introduced (70), tamarack (71), Norway spruce (91), white spruce (94), black spruce (95), red spruce (97), jack pine (105), red pine (125), pitch pine (126), eastern white pine (129), northern white-cedar (241), eastern hemlock (261).

Suitability Index: Based on 1985 Snowshoe hare HSI

x=total stem cover unit/ha

if x/ac <9325.6, HSI=0; if x/ac>31319.8, HSI=1.0 else HSI = ((0.000046*X)-1.06)/2.5

WMU analysis (to use as comparison with 1985 analysis): evergreen shrubs - weight all *3 only in WMUs 4,7,8; softwood seedling/sapling - weight all counts * 3

WMU Zone	Snowshoe hare Forested Habitat-#stem cover units/acre				TOTAL Stem Cover Units/acre
	deciduous shrubs	evergreen shrubs(wt. WMU:4,7,8 *3)	hardwood seedling & sapling (<=2.5")	softwood seedling & sapling (<=2.5")(wt all *3)	
Commercial Forest	6,392.17	1,110.15	5,321.04	13,441.07	26,264.42
Agriculture & Residential	5,384.69	1,508.83	3,487.78	7,293.59	17,674.90

WMU Zone	HSI SS Hare
Commercial Forest	0.77
Agriculture & Residential	0.38