Forest Management Guidelines for the Provision of White-tailed Deer Habitat

VERSION 1.0

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Dennis R. Voigt
Jim D. Broadfoot
James A. Baker

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Ontario Ministry of Natural Resources
Forest Management Branch
Forest Program Development Section
Suite 400, 70 Foster Drive
Sault Ste. Marie, Ontario
P6A 6V5

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Summary of Forest Management Guidelines for the Provision of White-tailed Deer Habitat

This is a summary of the guidelines that have been prepared to help planning teams and managers address the needs of deer in the preparation and implementation of forest management plans.

The purpose of these guidelines is to assist resource managers to maintain or create through management a forest that has the structure and composition to provide a functional habitat for white-tailed deer (*Odocoileus virginianus*) and to assist in sustaining their populations. The implementation of these guidelines should not conflict with the maintenance of ecosystem structure, composition and function needed to ensure sustainability and ecological integrity of forest ecosystems for a variety of species.

The size, location and migration of deer populations need to be considered in conjunction with these guidelines to manage the supply of deer habitat. A single population of deer may encompass from a hundred to several thousand square kilometers. Thus, implementation of guideline prescriptions should consider a multi-scale perspective. Landscape considerations should guide decisions at the stand level. Adequate assessment data are essential to make accurate prescriptions and determine the impact of past and future timber management on the provision of deer habitat.

The attached background document consists of (1) an overview of the seasonal ecology and habitat needs of deer, (2) the implications of forest management activities, (3) additional detail about recommendations to manage habitat, (4) discussion about application now and in the future.

Recommended Guidelines

The Forest Management Guidelines for the Provision of White-tailed Deer Habitat include provisions for both summer and winter deer habitat. Since deer in forested areas of Ontario are migratory between summer and winter ranges, it is important to distinguish between habitat requirements on each type of range.

On winter range, the primary concern is habitat that provides adequate coniferous shelter interspersed with sufficient winter food in areas where winter concentration occurs. Forest management is beneficial when it maintains cover and provides winter browse. It can be detrimental when excessive amounts of conifer cover are removed or converted to mixedwoods or hardwoods.

On summer range, deer thrive in early successional forests. In almost all of the summer range, any forest cutting will be beneficial to deer as it will likely increase

forage production and thus reproduction of deer. In most of Ontario, forest management on deer summer range currently provides adequate summer habitat by using silvicultural systems best suited for forest management.

Landscape Level

Winter

The identification of winter concentration areas or yards is necessary before determining stand level prescriptions for winter habitat. Winter concentration areas (yards) vary considerably in cover species, browse species, winter severity and deer use patterns across the range of deer in Ontario. It is important that local managers be knowledgeable of this variation in the assessment of the carrying capacity of their yards. The three most important features of a successful yard are traditional use, cover and browse (see Stand Level for cover and browse needs).

Traditional Use: Deer show a strong traditional use of winter concentration areas and are reluctant to change their migration habits. Within the principal range of deer in Ontario, traditional yards represent 10-15% of the summer range area. A greater percentage may be required where many deer migrate from surrounding units, especially in areas with high population targets or severe winters. Winter range conditions are an important limiting factor to deer populations in Ontario and the further loss of suitable conditions within yards should be avoided.

Summer

Summer range prescriptions need to consider landscape level diversity of habitat types in the area used by the deer from each yard.

Summer range has a major influence on deer productivity and the ability of deer to survive winter effects. Harvest operations will be beneficial to deer regardless of the silvicultural methods used because forage is produced. Since deer thrive in early succession forests on summer range, silvicultural systems which produce more early succession forests or more open canopy will enhance summer range.

Summer range can be enhanced more by dispersed small but heavy cuts rather than large clearcuts and large areas of light selection cutting. Cuts of this former type produce the early successional types favoured by deer, greater edge effects and diverse habitat.

In most of Ontario, openings, clearings, fields and early succession forest stages make up at least 10-15% of the area. That percentage will provide adequate summer range if widely distributed. Creation of openings should be coordinated with forest management activities. The provision of permanent openings on only 5% of the area will be beneficial to deer and many other wildlife species.

Stand and Site Level

Winter

Cover: Hemlock and cedar are the best interceptors of snow and often grow in association with preferred browse species. In the absence of hemlock or cedar, a mixture of spruce, pine and/or balsam fir may be used by deer for yarding purposes.

Yards should have a mix of understocked conifers or mixed woods where browse is abundant, and an interspersion of heavily stocked and relatively pure conifer for movement to food areas, bedding, and refuge during winter storms. Known migration and travel routes and suitable bedding areas such as hemlock ridges and “knobs” should be avoided when deciding road locations.Tree removal should be limited to leave a residual stand that provides an 80% crown closure.

Higher stocking levels are preferred where the cover species are other than hemlock or cedar, and in yards where good conifer is already scarce. Outside of bedding areas and travel corridors, conifer stands should be reduced in stocking, in order to encourage browse production. In hemlock or cedar stands, an average conifer crown closure of 60% is often adequate if the conifers are ideally arranged. A patchwork of small openings and clusters of conifers with branches touching is effective to achieve the proper conditions. A general guideline is that the average stocking should be approximately 60% based on trees 10 metres or higher.

In mixed wood stands where the conifer content is low, it is desirable to retain all of the conifers and to confine tree removal to the hardwood component. This is especially true where the silvicultural prescription is geared towards regenerating hardwoods rather than conifer.

Browse: The recommended amount of browse that is accessible to deer in winter yards should average 20 kg/ha of current annual growth (dry weight) of suitable species, between 0.5 and 2.0 metres in height. Diversity of browse is required and three or more suitable species should be available. Suitable species include cedar, hemlock, viburnums, red maple, striped maple, mountain maple, red oak, sugar maple, dogwood, beaked hazel, yellow and white birch, cherry, ground yew, white pine, and arboreal lichens.

To be accessible to deer, browse should be within 30 meters (m) of suitable cover in yards where snow depths exceed 50 centimeters (cm), or as far as 100 m or more in southern yards with less snow or on south-facing slopes. Arboreal lichens, where available, may provide a large portion of the required food supply.

Scheduling: Winter logging operations can be extremely beneficial to deer where edible treetops are felled by cutters and trails broken by skidding equipment are provided. For these reasons harvest operations may be scheduled during the yarding period, to the extent that it is possible and practical.

Regeneration: Many of the traditional yards have an abundance of older conifer but a scarcity of younger conifer stands and conifer regeneration. Provision of browse is often silviculturally easy but regeneration of conifers may be difficult in the presence of deer. Both hemlock and white cedar are preferred cover and preferred browse

species for deer but these species are difficult to regenerate to high stocking and they are slow to outgrow the reach of deer. In the interest of long-term conifer replacement, it may be necessary to accept temporary sub-optimum conditions for winter deer habitat in portions of the yard in order to provide the necessary conditions for conifer regeneration. Caution must be exercised that the tradition of use of that yard is not lost by negatively affecting large portions at the same time. The best solution may be to provide adequate stocking of other species such as red spruce, white pine, white spruce and balsam fir if hemlock cannot be regenerated. Hemlock and cedar may be regenerated in peripheral or adjacent areas and eventually provide cover.

Summer
Openings of 1 ha (ranging from 0.2-4 ha, maximum width 100 m) provide benefits when distributed throughout the area. The seeding of roads, landings, and site prepared areas with suitable grasses and forbs can enhance summer range by prolonging the longevity of openings and by providing early spring and late fall grazing for deer. Suitable species for seeding include the cool-season forages such as the clovers, red fescue and birdsfoot trefoil.

Besides the soft mast (e.g. raspberry) found in cutovers, hard mast (i.e. beech and acorn) can be valuable to deer during seed years. Selection and shelterwood cutting can enhance autumn food supply where suitable mast producers, including potential producers, are retained or released as in improvement cutting. The best seed producers are often large, full-crowned, and vigorous trees with a dominant position in the canopy. The best producers may be only 50-75 years old. Direct sunlight on the crown is an important factor in seed production, and suitable mast trees can be released by selection cutting in the same way as potential timber producers.

Application of the Guidelines

These guidelines **must** be considered in the preparation and implementation of forest management plans in the Great-Lakes-St.Lawrence Forest in areas where deer are designated as the primary cervid. In the transition areas to the Boreal forest either the deer or moose guidelines may be applied depending on which is the primary cervid. In many cases both can be applied without conflict or without significantly affecting wood supply.

To meet present and future habitat needs of deer throughout their range guidelines should be targeted specifically to either winter habitat or summer habitat.

The complexity of natural systems precludes a rigid set of rules. Rather, the guidelines identify key principles and recommendations that must be adapted to fit local situations based on the professional judgement of experienced practitioners. However, any deviations from the guidelines must be recorded and rationalized in the forest management plan on the basis of compelling biological or socio-economic concerns.

Forest Management Guidelines for the Provision of White-tailed Deer Habitat

Preface

These guidelines have been prepared to help planning teams develop and implement sound forest management practices that contribute to ensuring the long-term health of Ontario's forests. They comply with the Crown Forest Sustainability Act (CFSA) (RSO 1994) as well as the requirements of the April 1994 Decision of the Environmental Assessment Board.

Using the Guidelines

The *Forest Operations and Silviculture Manual* (CFSA, Section 68) lists these guidelines as ones which **must be** considered during the preparation and implementation of forest management plans.

The considerable ecological variation associated with natural systems precludes a rigid set of rules to cover all situations facing forest planners and managers. Rather, the guidelines identify key principles and recommendations that must be adapted to fit local situations based on the professional judgement of experienced practitioners. Any deviations from the guidelines must be recorded and rationalized in the forest management plans on the basis of compelling biological or socio-economic concerns.

Development of the Guidelines

These guidelines have been developed by combining current scientific evidence from literature and results from field studies in Ontario by the Cooperative Deer Study as well as expert opinion. Various associated technical manuals are available and referenced as appropriate. A population model, the Ontario Deer Model is a valuable tool to use in conjunction with these guidelines to plan for sustainability of deer and their habitat. As further information and tools are developed they will be integrated into the guidelines. At a minimum Guidelines will be revisited every 5 years.

Consideration of Statement of Environmental Values

The Ministry of Natural Resources (MNR) is responsible for managing Ontario's natural resources in accordance with the statutes it administers. In 1991, the MNR released Direction '90s, which outlines the goal and objectives for the Ministry, based on the concept of sustainable development. Within MNR, policy and program development take their lead from Direction '90s.

In 1994, MNR finalized its Statement of Environmental Values (SEV) under the Environmental Bill of Rights (EBR). The SEV describes how the purposes of the EBR are to be considered whenever decisions that might significantly affect the environment are made in the Ministry. The SEV is based on Direction '90s, as the strategic directions outlined in Direction 90's reflect the purposes of the EBR.

During the development of these guidelines, the MNR has considered both Direction '90s and the SEV. These guidelines are intended to reflect the directions set out in those documents, and to further the objectives of managing our resources on a sustainable basis.

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1.0 Introduction

1.1 Evolving Management Philosophy

Historically, the Ministry of Natural Resources (MNR) attempted to manage habitat for some game species, and those species whose long-term survival was of concern (i.e. vulnerable, threatened and endangered species). In recent years, the appreciation of the connections among the components of natural systems, and the recognition of the intrinsic value of all species has grown. At the same time, it has become increasingly difficult to manage for the specific, often conflicting, habitat needs of an ever growing list of species. Thus, MNR's approach to resource management has been shifting to the maintenance of entire ecological systems and their associated biological diversity. This perspective does not preclude management for individual species (such as deer) as long as it does not threaten the long-term well-being of other species, or the functioning of the overall biological system.

This evolution in resource management has been reflected in, and encouraged by a number of government policy initiatives. For example, Ontario's Policy Framework for Sustainable Forests and the 1994 Crown Forest Sustainability Act promote the long-term health of forest ecosystems. At the National level, Ontario has indicated support for the provisions of the 1995 Canadian Biodiversity Strategy. These guidelines are expected to be applied in a way that contributes to the maintenance of ecological systems and biodiversity.

1.2 Evolving Management Methods and Technology

A key consideration in the maintenance of ecological systems is the need to manage at a number of spatial scales. Not only is it necessary to manage for particular habitat features at the forest stand level, but properties of landscapes (of which the forest stand is part) must also be managed.

Maintenance or creation of particular landscape characteristics (percent of forest types and age classes, forest patch size and distribution, etc) will increase the likelihood that all the biological diversity associated with the landscape will be perpetuated. This multi-scale perspective of habitat management requires that planning at the forest Management Unit (MU) level be closely linked to broader land use planning.

These guidelines deal with the desired properties of both landscapes and forest stands that together are considered necessary to ensure perpetuation of white-

tailed deer (*Odocoileus virginianus*) populations. These guidelines consist of 5 major parts: (1) the seasonal ecology and habitat needs of deer; (2) a description of implications of forest management activities; (3) recommendations for providing deer habitat during forest management planning at the landscape and stand level; (4) application of the guidelines; and (5) future directions.

1.3 Relationship between Deer and Other Resource Management

The purpose of these guidelines is to assist resource managers in their efforts to maintain or create through forest management a forest that has the structure and composition to provide a functional habitat for white-tailed deer. As such, these guidelines can be implemented as part of an ecosystem approach to forest management The implementation of these guidelines should not conflict with the maintenance of ecosystem structure, composition and function needed to ensure sustainability and ecological integrity of forest ecosystems for a variety of species.

This document elaborates on the habitat needs of deer and the concept of carrying capacity. The relationship between deer herd population dynamics and the quality and quantity of habitat is important to the sustainability of both deer and forest habitat. The document, **White-tailed Deer in Ontario: Background to a Policy** (Voigt *et al.* 1992), provides a biological and sociological rationale for management of deer in Ontario. It describes methods to calculate deer targets based on Habitat Supply Analysis and Hunter Demand Analysis. More sophisticated methods using a Habitat Supply Model are available for traditional deer range in central Ontario (*Broadfoot et al.* 1994, 1996a). The Controlled Deer Hunt and the Selective Harvest allow regulation of deer herds in relation to habitat supply and hunter demand. Analyses integrated with biological, sociological, cultural and political factors will assist in implementing these forest management guidelines.

The size, location and migration of deer populations should be considered in order to manage effectively the supply of deer habitat. A single population of deer may occupy an area of a hundred to several thousand square kilometres. Thus, when implementing guideline requirements managers should adopt a multi-scale perspective. Landscape considerations should guide decisions at the stand level. Adequate assessment data are essential to make accurate prescriptions and determine the impact of past and future forest management on the provision of deer habitat. A report entitled, **Field Inventory Techniques for Measuring Winter Deer Browse Supply and Consumption** (Broadfoot and Voigt 1996a), provides details for assessing carrying capacity and herd levels in relation to food supply. The information on carrying capacity is critical input for the **Ontario Deer Model** (Broadfoot and Voigt 1992) which is an important tool in making management decisions for the sustainability of deer and their habitat.

Since deer in forested areas of Ontario are migratory between summer and winter ranges, it is important to distinguish between requirements of deer on each type of range. Basically, throughout the range of deer in Ontario, all forested areas

are used by deer as summer range but only a small percentage (10-15%) of forested areas is winter range (Broadfoot *et al.* 1996b). The guidelines are designed to provide food and cover in both summer and winter ranges. Winter range can be delineated using Ranta (1997) (see chapter on Identification and Delineation of White-Tailed Deer Winter Habitat) (Ranta 1994) and a report on deer migration entitled **White-tailed Deer Migration Behaviour: A Resource Management Perspective** (Broadfoot and Voigt 1996b).

Deer use edges where cover and food are close together.

2.0 Seasonal Ecology Of Deer

2.1 Deer Habitat Needs

Although the habitat needs of deer can be listed simply as food, cover and water, interactions with habitat are very complex. In brief, energy is supplied from plant food. That energy is required for movement, survival, growth and reproduction. Cover also plays a key role in determining energy costs, and provides access to food resources and protection/escape from predators.

During the summer months deer use energy for antler development, lactation and body growth. Deer will eat up to 4 kg (dry weight) of green plant material each day (Holter *et al.* 1977). Although there is an abundance of green food, deer become extremely selective, choosing high protein, high energy, highly digestible food types (Nudds 1980). Deer have physiological constraints for food digestion and thus only a small percentage of the total quantity of plant biomass is consumed (Hanley *et al.* 1989). Consequently, their diet is restricted to growing tips and succulent shoots of herbaceous plants and forbs (Swift 1948). Deer switch their diet continually from one species to another as different plants grow, develop and flower. Flowers are eagerly sought along with other low fibre food, such as new herbaceous growth, for efficient digestion. Grasses grow from their base and are usually not well digested by deer, but in the spring and fall, when new tips appear, grasses are quite palatable and are heavily consumed (McCaffery and Creed 1969, Rogers *et al.* 1981).

In the fall, as day lengths shorten and temperatures drop, deer begin to accumulate fat reserves to help supply energy during the winter months (Verme and Ozoga 1980, Serveringhaus 1981, Hobbs 1989). High energy, high carbohydrate food sources are sought. Green plants, such as clovers, that grow during the cool-seasons of spring and fall, even after the first heavy frosts, are important as are high carbohydrate items including mast crops of acorns and beech nuts. Accumulations of fat on deer reflect the length of the fall season and the quality and quantity of fall food (Mautz 1978). Adult does require good fall range to recover from the stresses of nursing fawns

and to develop fat reserves for the winter. Fawns and yearlings are still growing and have relatively large energy demands as well as a need to accumulate fat in the fall. Adult bucks expend a great deal of energy during the pre-rut period from late September through October. During the rut from November into December, bucks may eat little but use much energy pursuing does. It is not uncommon for prime bucks to deplete their fall accumulation of fat at this time (Sauer 1984, Broadfoot and Lintack 1991).

During the winter months, deer in most of Ontario must subsist on a diet of low quality food. The major food at this time of year is browse which is comprised of the woody twigs and buds of deciduous trees and shrubs, and conifer leaves, such as cedar and hemlock. Browse is low in protein and energy and high in fibre (Ullrey *et al.* 1964, Ullrey *et al.* 1967, Mautz *et al.* 1976). Even with an unlimited food supply, deer on this winter diet will lose weight because the digestion of high fibre food requires a great deal of energy (Verme and Ullrey 1984, Gray and Servello 1995). In some areas such as northwestern Ontario arboreal lichens (*Usnea spp.*) are an important food supply.

Deer have developed special adaptations to deal with difficult conditions during winter. These include reduced activity, food intake and the ability to lower temperatures in their extremities (Verme and Ullrey 1984). Reduced activity and food intake results in a lowering of metabolism (Silver *et al.* 1969, Mautz *et al.* 1992, Worden and Pekins 1995). Reduced metabolism acts similar to lowering a thermostat on a furnace in that less fuel (in this case fat) is burned. This suite of natural adaptations enables deer to survive when temperatures are coldest and most severe in mid-January and February.

White-tailed deer store large quantities of fat during the fall (McCullough and Ullrey 1983). On a winter diet of woody browse, fat reserves can be used to balance energy requirements for about 3 months (Worden and Pekins 1995). As a result, energy reserves are usually exhausted by the end of winter. The energy demands of pregnant does increase during the last 2-3 months of pregnancy (Verme and Ullrey 1984). The length of time that deer can survive on a restricted winter range can be critical. A winter extended by only a few weeks can significantly reduce the survival of deer (Verme 1968). In early spring, a supply of high quality food can be very important (DelGiudice *et al.* 1991). Deer eagerly seek the cool-season forages like grasses, legumes and new growing greenery at this time (Rogers *et al.* 1981).

In summary, the seasonal biology and habitat needs of deer dictate a diversity of habitat types. Seasonal needs can only be met on a single parcel of land by provision of a variety of habitat types, interspersed with early and late successional stages. Deer migrate and shift home ranges seasonally in an attempt to meet their habitat needs.

2.2 Seasonal Migration

A major adaptation of deer to winter conditions in Ontario is seasonal migration. At the onset of winter, deer in most areas of Ontario migrate to winter concentration areas, called yards. These areas are characterized by the presence of conifer trees which intercept snowfall (Hanley and Rose 1987). Conifers also provide shelter from wind and help conserve energy loss through radiation. Thus, the presence of conifer allows deer to move freely in accessing winter food. Irregular terrain and other physiographic features, fallen trees and dense forest also help to conserve energy by providing shelter from wind chill. In some areas of North America, where winter weather is cold and windy, deer survive well without conifers. However, those areas have relatively little snowfall and abundant, high energy food (Moen 1968). Concentrations of deer result in the establishment of a network of trails and runways that further help reduce energy costs. Yarding behaviour further reduces the risks of predation by providing escape routes along trails. The alertness of groups of deer also helps to detect predators. Some studies have suggested that deer migration to winter concentration areas has evolved to reduce the chance of predation (Nelson and Mech 1981, Messier and Barrette 1985).

Winter concentrations of deer are established in traditional locations in Ontario. Many areas exist that have suitable habitat but are not used. Since does return each year to the same winter area, accompanied by their fawns, the establishment of new areas is difficult. During mild winters deer concentrate less and appear reluctant to enter the core areas of yards. Thus, winter concentration areas are used differently each year depending on winter conditions. After a series of mild winters, the establishment of new yarding areas can be expected if food and cover is suitable and predation is not limiting (Broadfoot and Voigt 1996b).

Most deer delay moving into yards until after the snow cover builds to about 20 cm. Thus, in much of Ontario deer do not enter the yards until about the 3rd or 4th week in December. In early winters entry to yards may occur before December or in late winters it may not occur until mid-January. The exodus of deer from the yards is delayed until there is only a few centimetres of snow left on the ground. Thus, the dates vary from late March until mid-April (Broadfoot and Voigt 1996b) in central Ontario to late April in northwestern Ontario.

Summer dispersion areas can be 7-10 times larger than the winter concentration area, i.e. winter yards comprise only 10-15% of the summer dispersion area (Broadfoot *et al.* 1996b). Habitat management for summer ranges requires different guidelines than for winter ranges.

2.3 The Concept Of Habitat Carrying Capacity

Carrying capacity is a concept basic to wildlife management. Carrying capacity (K) is defined as the maximum number of deer an area can support on a sustained basis, i.e. without detrimental effects on the habitat (Voigt *et al.* 1992). The carrying capacity on any given area is dynamic because it varies as the requirements of deer and resource supplies change (Moen

1973, McCullough 1979, McCullough 1984). Deer herds above carrying capacity will consume more food than grows each year which eventually results in a decline in food and therefore carrying capacity. A decline in deer numbers then occurs.

Many factors affect carrying capacity but the key measure of K is the amount (kg) of deer food per hectare that is available or accessible to deer. Thus, browse that is located too far from conifer cover because of deep snow or slash, etc., is not accessible to deer and therefore does not contribute to carrying capacity. An accurate measure of K would take into account constraints on processing slow-to-digest woody browse, reduced energy requirements of deer, the supply of fat reserves and the use of thermal cover to conserve energy. These adaptations determine the amount of browse that deer can consume, and the amount of fat and protein that must be mobilized to make up energy deficits, and consequently the number of deer an area can support.

Since forage is the support base for herbivore populations, the relationship between deer and their environment can be examined on the basis of seasonal changes in availability and quality of food (Short *et al.* 1974) in relation to seasonally varying deer physiological requirements (Moen 1973, Verme and Ullrey 1984). If the energy needs of deer and the energy supplied by available food can be estimated, carrying capacity can be calculated from the amount of usable forage available divided by individual deer intake (Broadfoot and Voigt 1996a). Since the amount of forage varies from place to place, local inventories of availability should be made to ensure accuracy. If done carefully, carrying capacity estimates based on available forage and nutritional requirements permit realistic habitat evaluations (Wallmo *et al.* 1977) and provide a basis for management decisions, especially the control of deer numbers (Moen *et al.* 1986, McCullough 1987).

Since Ontario deer migrate between winter and summer range, they respond to a winter carrying capacity (Kw) and a summer carrying capacity (Ks). Summer and winter carrying capacities are very different because of food quality, quantity, and accessibility, as well as seasonal energetic costs.

The rate at which deer populations grow (from a very few individuals to high numbers at carrying capacity) is density dependent (McCullough 1990). As the density of deer increases, there is less food and cover available for each deer. Many physical characteristics of deer decrease as herds grow towards carrying capacity, including reproductive rate (Gross 1969, McCullough 1979, Verme 1987, Porter 1991), survival (Fowler 1981, Caughley 1977), weight of individuals (Leberg and Smith 1993) and size of antlers (Severinghaus and Moen 1983). Hunter success and harvest size are also density dependent. Some population characteristics are more influenced by winter range carrying capacity and others by summer range K. These concepts are important to understand when evaluating the significance of habitat and in making critical management decisions (Broadfoot and Voigt 1992).

Because of the high reproductive capability and time-lags in responses of deer and vegetation, it is common for deer numbers

or populations to irrupt and overshoot carrying capacity (McCullough 1987). In a stable environment, deer numbers would oscillate around year-round carrying capacity, but, very few environments remain stable for long.

2.4 Reproduction In Deer

Habitat has a major influence on deer reproduction. Adult does breed first around mid-November followed by yearling does in late-November and fawn does in early December. At high densities, deer may not be bred until the 2nd or 3rd estrous and that results in late born fawns with a reduced chance of survival (Ozoga and Verme 1982). The percentage of fawn and yearling does that breed depends on their physical development, which is primarily determined by food supply during the growing season, but is also influenced by length of growing season and conditions during growing season (Verme 1967). Day length may also have an influence on when, or which, does might ovulate (Verme and Ozoga 1987).

The reproductive performance of does is primarily determined by the nutritional value of summer range.

Although some residual effects on doe nutritional status occur after long, severe winters (Mech *et al.* 1987), the reproductive performance of does is primarily determined by the nutritional value of food obtained on summer range (Verme 1967) as well as age. The population level of the herd in relation to the carrying capacity of the summer range is a major determinant of reproductive rate or gross productivity. The conception rate of does in the fall is a function of their condition or fitness. As density of does increases the reproductive rate declines since there is relatively less food available per deer (Fig. 1). Theoretically, the reproductive rate of deer would drop to zero if deer ever reached 100% summer carrying capacity.

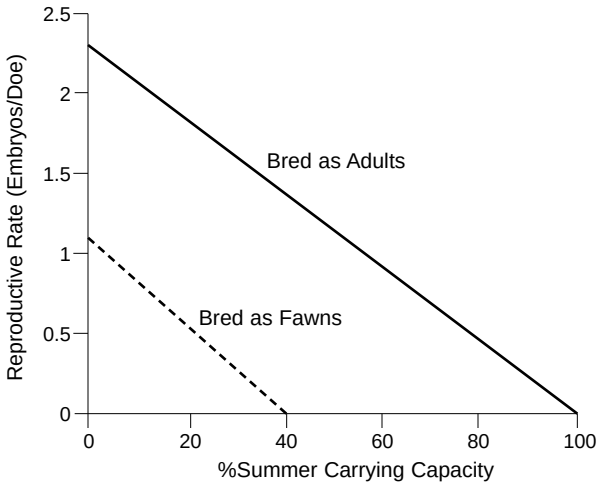

Fig. 1 Changes in embryos per doe in relation to % summer carrying capacity.

Although there is much variation in the quality and quantity of summer range in different areas of Ontario, deer herds are at a relatively low-percentage of summer range carrying capacity compared to winter K. Reproductive rates for Ontario deer suggest that during the summer, densities of deer vary from less than 10 to 50% of summer range carrying capacity since embryos per adult doe vary from about 1.0

to near 2.0. The percentage of fawns that breed varies from 0 to 60%; this is a further measure of summer range and growing conditions. Breeding of fawns often ceases when herds are at 40% of summer K (Broadfoot and Voigt 1992). Fawn breeding may be related to the weight of fawns at the breeding season. If fawns fail to reach 36 kg, they seldom breed (Moen 1973). Other factors such as day length also affect fawn breeding and may override good summer conditions at northern latitudes (Budde 1983). Doe reproductivity during the mid-1980's for the Algonquin Region (Strickland pers. comm.) suggests that those herds were at about 30% of summer K.

Summer range also has a major effect on antler development in bucks. Since antlers and number of embryos per doe are both affected by summer range, it is not surprising that they are correlated (Severignhaus and Moen 1983). Measurements of the beam diameter of yearling bucks can be used to predict the reproductive rate of does on the same summer range (Fig. 2). Yearling antler beam diameters can be used to estimate the percentage of summer carrying capacity that the herd is at (Fig. 3) using the relationships in Fig. 1 and Fig. 2 (Broadfoot and Voigt 1992).

Although summer range of deer affects gross reproductive rate, nutritional levels of does (determined by habitat and weather) during the winter can also affect productivity. A long severe winter may have its greatest effect on the survival of newborn fawns. Small, weak, under-nourished and underweight fawns die within a few days or weeks of birth (Verme 1977). Depending on winter severity, the percentage of the fawn crop lost to post-

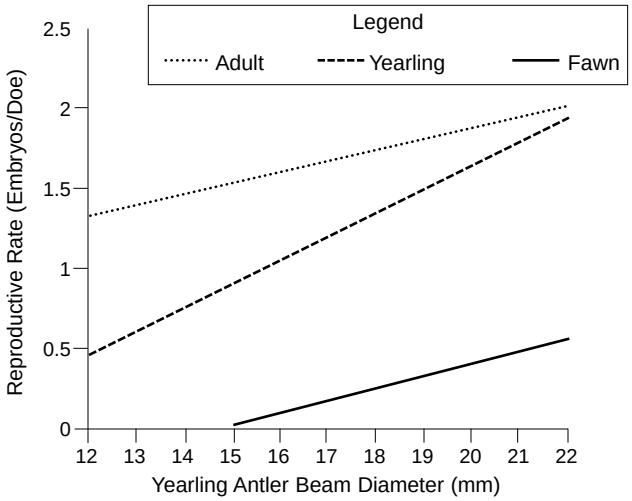

Fig. 2. Yearling antler beam diameter as a predictor of embryos per doe.

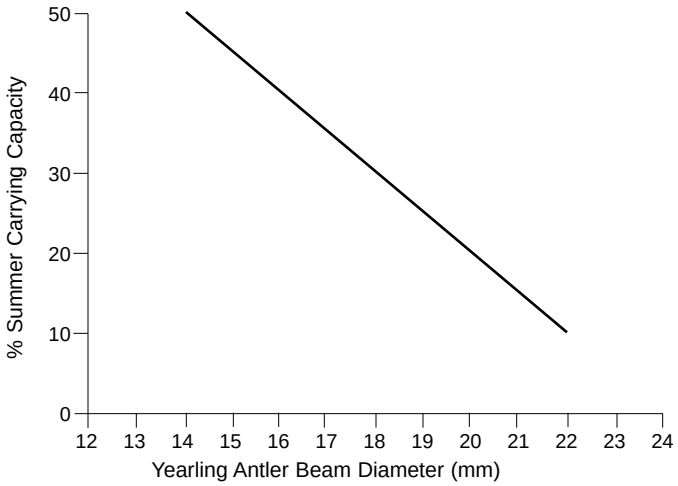

Fig. 3. Yearling antler beam diameter for estimating the % summer carrying capacity.

natal mortality may vary from as little as 10% to as much as 70% (Fig. 4). This post-natal mortality may be an even greater effect of severe winters than direct mortality due to malnutrition of wintering deer. However, does that lose their fawns at birth may be in much better condition for breeding in the fall of that year (Verme 1967).

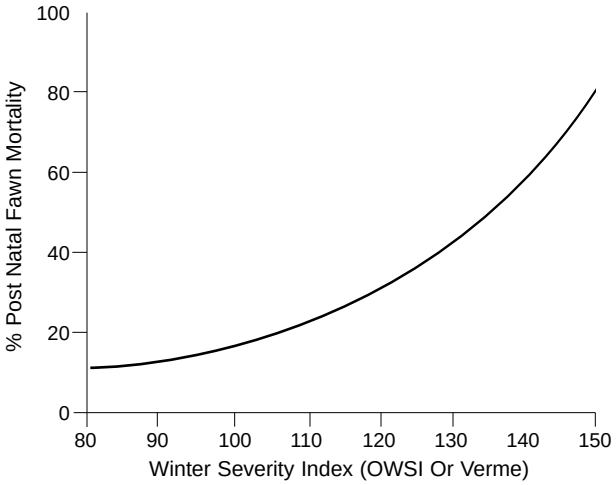

Fig. 4. Predicted post natal fawn mortality due to winter effects using the Ontario or Verme Winter Severity Index (OWSI).

2.5 Natural Mortality Of Deer

Natural mortality of deer is also affected by deer density in relation to habitat carrying capacity. Since adult deer density during the summer months is low in relation to Ks, adult mortality is also quite low. However, fawn mortality during the summer may be high. It is well documented that predation on fawns by coyotes, wolves and bears occurs (Mech 1984). Studies indicate that the magnitude of fawn predation is highly variable ranging between 0 % and 80 % of total summer fawn mortality. It is quite likely that some of the fawns consumed by wolves and bears are those that died shortly after birth, or fawns that would not have survived. This complicates the assessment of the effects of fawn predation on deer population dynamics. Major causes of summer mortality are road-kills, other accidents, predation and illegal kills (poaching). These mortality factors usually amount to only 3-7% of the annual mortality of adults. The Cooperative Deer Study has measured natural mortality of deer in Ontario during the summer for adults only (Voigt *et al.* 1992). Direct measures for fawns are not available. Figure 5 shows the best current estimates for density dependent mortality for all ages for summer and winter months during normal or mild winters. This relationship has been developed from computer simulation modelling and studies of radio-collared does and bucks. The summer rates do not include the early post-natal fawn losses due to “Verme” effects (section 2.4) . Figure 5 shows that a herd at 30% Ks would have a summer loss of 4%.

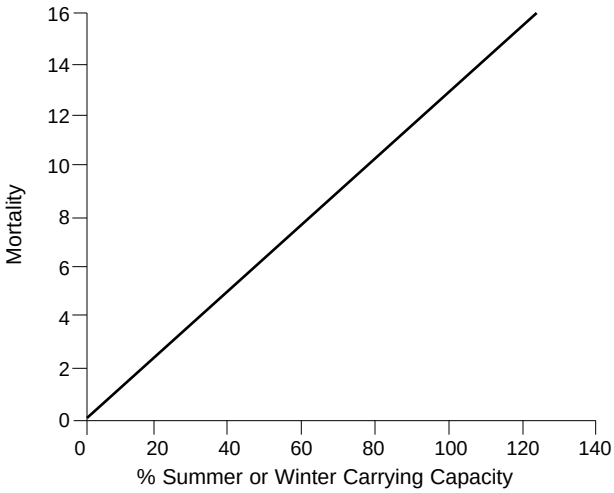

Fig. 5. Relationship between % summer mortality and summer carrying capacity and relationship betwen % winter mortality and winter carrying capacity.

Winter densities are very high since deer concentrate on areas about 10-15% as large as summer dispersion areas (Broadfoot and Voigt 1996b). During winter, the food supply is also much reduced. The consequence of these two factors is that winter carrying capacity is lower and the deer herd is much closer to winter K. In many parts of Ontario deer are at 80 to 120% of the carrying capacity of yards during normal winters. From Fig. 5 it is evident that deer populations living at 120% Kw will incur a winter mortality rate of about 16%. Winter mortality rates have very important effects since they may be

additive to hunting rates. Major causes of mortality are starvation and predation (Voigt *et al.* 1992). Fawns from the previous summer are most affected by winter conditions and adult does are least affected.

Winter food supply has a major effect on winter survival. The amount of available browse (kg/ha) is steadily depleted as winter progresses. Body weight also declines steadily as fat and muscle tissue are used. Because of variance in the weight of deer, some deer exceed the critical percentage of body weight loss within a few weeks of the onset of winter. Other deer gradually succumb as body weights decline over the winter. Based on these body weight losses, there is a rapid increase in the mortality rate at 10-12 weeks after winter starts in yards with relatively low food supplies (Hobbs 1989).

3.0 Implications of Forest Management Activities

The three basic silvicultural systems (clearcut, shelterwood and selection) are modified according to the silvics of the species involved, soil and site conditions, and market considerations. The effect of a silvicultural system on deer food is not consistent across all sites. On good sites, herbaceous growth can initially compete better than woody vegetation but on such fast growing sites rapid growth of the woody understory will form a complete canopy faster than on poor sites.

Silvicultural systems can be utilized to create diversity within a forest stand. Deer require habitat diversity to meet their annual needs. Deer activity during spring and autumn is high in permanent openings but during winter, coniferous forest cover is essential when snow depths exceed 50 cm. At first glance, a silvicultural system that produces an all-aged forest would appear to have higher diversity than an even-aged forest stand but long-term benefits are not so simply determined. In the selection system, the cutting of individual or groups of mature trees may be poor for improving deer habitat. Openings in the forest canopy may be too small to have a significant impact on forage regeneration although it may release commercial forest species. In contrast, a clear cut which regenerates to an even-aged forest may produce abundant deer food followed by a decline in food supply when the forest canopy becomes closed or food grows out of reach of deer. Large clearcuts on a unit of land may produce a boom, and then bust phenomenon in forage supplies. On summer ranges, if clearcuts are very large, entire deer home ranges may experience wide fluctuations in forage supply over time. Smaller clear cuts scattered over the same unit of land will show a similar forage response but individual deer home ranges will be less dramatically impacted. Portions of large clearcuts in or adjacent to yards may become inaccessible to deer when snow is deep.

3.1 Clearcut System

The clearcut system is an even-aged silvicultural system where the entire growth is harvested over a considerable area in one operation, with or without leaving seed-trees. The system is designed to provide the conditions necessary for the establishment and survival of a new forest crop by natural or artificial regeneration.

The clearcut system is primarily used in the Boreal Forest. Only the southern extremes of the Boreal Forest are within the range of the white-tailed deer. The clearcut system is less commonly used in the Great Lakes-St. Lawrence Forest where it is usually only applied in the intolerant hardwood working groups such as poplars (*Populus* spp.) and white birch (*Betula papyrifera*). Jack pine (*Pinus banksiana*) and spruce (*Picea* spp.) in the Great Lakes-St. Lawrence Forest are also managed using the clearcut system. Although 85% of Ontario's annual timber harvest is produced under this system of forest management, in most of the deer range it is not widely used. An exception is the deer range in jack pine and spruce in the boreal forest of northwestern Ontario.

Clearcuts can be of various shapes and sizes. The most common form is an irregular pattern which is broken by topography, forest type, and immature age classes. Contiguous cuts are not usually larger than 150 ha. Size may be reduced and a cutting pattern may be established to protect fragile sites or to retain a standing seed source for natural regeneration. Strip and block clearcuts are also used in the clearcut silvicultural system. With each of these patterns, the uncut strips or blocks are themselves clearcut after the successful establishment of regeneration on the strips or blocks which were clearcut in the first operation, usually about 5-7 years later.

The clearcut silvicultural system usually involves site preparation to ensure regeneration success, and tending of the new forest crop to perpetuate or create an even-aged forest.

Clearcut systems have much potential to produce good deer habitat on summer range. However, clearcuts that destroy too much winter shelter may produce abundant forage that is inaccessible to deer during winters with deep snow. Small cuts (1-10 ha) in winter yards will produce pockets of browse but larger cuts will be detrimental if conifers that allow deer to access food are removed. The shape of the cut and characteristics of residual forest edges (i.e. coniferous shelter trees) will determine the size of cut that is most beneficial for winter yards. In general, clearcutting of conifer in winter concentration areas is to be avoided. On summer range, the same sized clearcut may be beneficial. Small cuts of up to 100 ha will benefit deer on summer range although on the larger cuts, forage supplies will likely be extremely abundant during the regeneration to sapling stages but relatively scarce during the polewood and sawtimber stages.
In northwestern Ontario deer concentrate in winter in areas of 100-300 km^2 in size. These areas can be maintained or enhanced using dispersed harvest blocks with cut sizes of 30-60 ha. No more than 30% of a yard should be harvested before cut overs have regenerated to 6 m in height.

3.2 Shelterwood System

The shelterwood silvicultural system, like the clear cut silvicultural system, is an even-aged system of forest management in which harvest operations, site preparation, regeneration and tending operations are carried out at different times. The primary difference between the two systems is the temporary retention for harvest, of trees which provide the seed source and cover

conditions necessary for the successful germination and establishment of natural or artificial regeneration in the shelterwood silvicultural system. After successful regeneration, the residual crop is removed in a single cut or series of cuts.

The shelterwood silvicultural system is most commonly applied in yellow birch (*Betula alleghaniensis*), white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*) forests on shallow till soils in the Great Lakes-St. Lawrence Forest. The system is also commonly prescribed for even-aged sugar maple forests. About 1/3 of the Great Lakes- St. Lawrence Forest is harvested under this system of forest management and overall it accounts for approximately 5% of Ontario's annual harvest.

There are two forms of the shelterwood silvicultural system currently in use, strip and uniform shelterwood. The strip shelterwood system involves clearcutting strips 20-40 m in width. The adjoining alternate strips which remain provide the seed source for natural regeneration by wind dispersal of seed. The uniform shelterwood system involves cutting uniformly over a whole stand, reducing stand density by approximately 60%, and leaving individual trees or small groups of trees uniformly dispersed over the cutting area as the seed source for natural regeneration. For each form of the system, the residual mature forest is removed in a second, and possibly a third, harvest operation 5-15 years later.

Strip shelterwood has a beneficial effect on deer forage since it disturbs the forest, producing a variety of plants which deer need. If residual winter shelter trees are too scarce, if the strips are too wide, or the strips are not sufficiently cleared of waste, deer movements and access may be impeded. In most cases deer habitat is improved if the strips are about 30-40 m wide. The exact width, however, is flexible and local managers may modify the prescriptions to suit needs in each area. In a winter area some strips of conifer must be maintained at all times. The final cut should not be made until regenerating conifer is intercepting snow which is usually when conifers are 5 to 10 m high.

Uniform shelterwood is usually not as good as strip shelterwood since it produces less diversity. The result can be a short period of abundant food followed by a longer period of low food supplies similar to clearcutting but residual cover is closer to food supplies in shelterwood cuts. In this system, the size of the cut and the amount of mature and immature forest left standing are critical. On winter ranges, if only a few conifer shelter trees remain, the resulting forest may not allow deer to use the area. In winter areas, the final cuts cannot be made until regenerating conifer has grown sufficiently to intercept snow. Uniform shelterwood can be applied in different ways. Depending on species and site conditions, there may be sufficient flexibility to adapt the prescription to meet deer and timber needs.

3.3 Selection System

The selection system is an uneven-aged silvicultural system where mature and undesirable trees are removed individually or in small groups over the whole area. Regeneration is generally natural. This system is well suited only to tree species which are readily able to establish on an

unprepared seedbed, and which are shade tolerant. Forest economics have historically dictated that the tree species and trees involved be of relatively high value (e.g. sawlogs or veneer), since the costs of harvest operations must be spread over a lower yield per hectare. The system is more commonly used in uneven-aged tolerant hardwood stands of the Great Lakes-St. Lawrence Forest. The selection silvicultural system perpetuates an uneven-aged forest, with trees of different ages growing singly or in small groups. Approximately 10% of Ontario's annual harvest is produced under this system of forest management.

Selected trees are carefully marked and then removed, either as individuals or in small groups, at repeated short intervals of time, usually 15-25 years. The trees selected for removal include mature trees, defective trees with poor growth potential, and immature trees in strong competition with other trees of greater potential. Openings created during harvest operations fill in by the crown expansion of residual trees, or by the development of existing seedlings on the forest floor, or both. Tending and improvement operations are critical to the maintenance of crop quality and growing conditions.

Single tree selection limits plant diversity to shade tolerant species. However, it is the preferred system for regenerating American beech (*Fagus grandifolia*), a primary mast producer. Group selection will result in an increase in plant diversity compared to single tree selection. Moderately tolerant, commercial species such as yellow birch, black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), oaks (*Quercus* spp.) and red maple (*Acer rubrum*) in addition to numerous non-commercial forage species will develop after group selection harvest.

Uneven-aged hardwood stands provide a diversity of summer food.

The selection system is designed to produce new regeneration which should benefit deer by providing food. Often, the size of the clearing is less than 0.1 ha in this system. However, unless logging removes trees from an area at least 0.4 to 0.8 ha in size, the deer will benefit only marginally or for a short period of time. On summer range, selection cutting will not affect habitat negatively but it may not enhance habitat either since there is relatively little forest disturbance. Pole or sawtimber forest have little deer forage naturally. Large tracts of hardwoods managed under the selection system with a high component of older (10 cm and larger) trees (pole or sawtimber) provide less forage than a young forest. If the residual basal area is about 12 m^2/ha after cutting, good browse conditions will be created. However, if a higher basal area is maintained (i.e. >18 m^2/ha), the quantity of browse produced will be much lower. On winter range, if logging removes too many conifer trees, a detrimental effect may occur if deer are unable to move freely among resting and feeding sites.

Food in pure hardwood stands is often not available to deer during winters with deep snow.

3.4 Landscape Patterns and Stand Development

In forested areas, the production of deer forage is strongly influenced by the type and age of the forests. The amount of forage available to deer (within about 2 m of the ground) during both winter and summer, is related primarily to the amount of light which reaches the forest floor. Therefore, those structural aspects of forest cover which affect canopy closure are the primary determinants of forage supply. In central Ontario, forage supply is further modified by stand composition since some plant species like balsam fir, beech, bracken fern (*Pteridium aquilinum*), etc., are clearly avoided by deer as food (Voigt *et al.* 1992, Broadfoot *et al.* 1994). In northwestern Ontario, balsam fir (*Abies balsamea*) has luxurious growths of arboreal lichens, principally Usnea spp. which is highly preferred by deer. The amount of understory woody browse has been correlated with the age structure of the forest (Hurst *et al.* 1979, Joyce 1986, Moen *et al.* 1986). A useful division of age class or development stages is: pre-sapling (stands dominated by trees < 2 cm dbh); sapling (2-9 cm dbh); immature (polewood-sized trees 10-24 cm dbh); mature (sawlog-sized trees 25-49 cm dbh); and large sawtimber (>50 cm dbh) (Broadfoot *et al.* 1994). Average dry weight estimates (kg/ha) of current annual growth of woody browse for these 5 stages show a typical pattern in a wide variety of forest types. Averages for open (stocking < 0.6) intolerant hardwood stands show the following mean values: pre-sapling (80 kg/ha); sapling (30 kg/ha); immature (15 kg/ha); mature (40 kg/ha); large sawtimber (50 kg/ha).

Measurements in Ontario by the Cooperative Deer Study show considerable variation from these values depending on two major influences - logging and deer. Logging can alter stand stocking rate and thus canopy closure. This increases the amount of sunlight reaching the ground, thus increasing the amount of woody browse (Wiggers *et al.* 1978, Cooperrider and Behrend 1980, Harlow 1984, Whitlaw *et al.* 1993). Extensive deer browsing can remove much of the woody browse. Thus forest stage analysis can be useful for large area evaluation of potential forage production but local areas may require more detailed ground truthing. Forest Resource Inventory (FRI) data can be converted to forest stage (Broadfoot *et al.* 1994). However, to give a general approximation over larger areas, since logging or intensive deer browsing occurs over much of the deer range, most local sites will require ground truthing (see **Field Inventory Techniques for Measuring Winter Deer Browse Supply and Consumption**, Broadfoot and Voigt (1996a).

During summer months, both deciduous and coniferous species provide cover as a result of the canopy closure and vertical distribution of trees (Demarchi and Bunnell 1993). During the winter, the major cover is provided by conifer species. Although the value of different conifer species varies because of their crown shapes and leaf characteristics, the key variable is crown closure. Coniferous trees enhance winter habitat by intercepting snowfall which allows deer to conserve energy and retain mobility and access to food supplies (Mattfeld 1974, Hanley and Rose 1987). In northwestern Ontario, balsam fir is an important cover species. Although balsam die and fall down after spruce budworm outbreaks, balsam regenerates rapidly and can provide good cover during winter.

In summary, forest stage and canopy closure are the most important determinants of the value of the forest to deer due to the influences they exert on the accessibility of food supplies. Seasonally, deer requirements change as do the areas used by deer. Thus, forest management that alters age structure and canopy closure of the forest will have different effects on deer on winter versus summer range.

Since the effects of silvicultural systems on winter versus summer deer ranges may be greatly different, logging operations can be beneficial or detrimental to deer habitat. In Ontario, logging will enhance most deer summer habitat since it partially or completely opens the forest canopy which encourages regeneration of deer food. Winter habitat will also be enhanced unless conifer removal is too extensive. Generally, logging results in a forest with more pioneer or early succession species.

During the summer months early succession species, especially deciduous, are most beneficial to deer. It is doubtful that the type of forest management practised in Ontario's Great Lakes-St. Lawrence Forest ever results in too much cutting for deer on summer range. Harvest of the tolerant hardwood forest employing a single tree selection silvicultural system results in less site disturbance, smaller stand openings and subsequently less regeneration of browse than other methods.

Browse close to conifer cover is critical in winter yards.

On winter concentration areas, the production of preferred woody browse is very important to improve or maintain winter habitat. The major problem is that much of the deer forage may become inaccessible with deep snow. The solution is an interspersion of snow-intercepting conifers and deer forage. Large areas of pure conifer are often frequented by yarding deer because of the easy mobility and thermal cover advantages. However, the canopy closure allows little or no sunlight to encourage understory growth. In some traditional deer yards, such areas provide very little food (less than 4-5 kg/ha) and long winters have detrimental effects

on deer. Much better winter habitat can be provided by encouraging deer forage growth while maintaining only sufficient conifer to allow deer to maintain a trail network and provide adequate thermal cover. The amount of conifer required depends on snow depths, and the species and age of the conifers. Good winter habitat is comprised of clusters of 3-4 hemlocks, cedars (*Thuja occidentalis*), or pines (*Pinus spp.*) with branches touching. These clusters should be spaced 10-30 metres apart throughout the yard. This would be better than extensive areas of 100% conifer crown closure. This conifer arrangement is a special case for a mixed forest. In that conifers occur in clusters which effectively intercept snow. Mixed forests with widely dispersed individual conifers do not have a significant snow interception function and hence make poor winter habitat for deer (Verme 1965). Species like balsam fir, pines and spruces may require a higher stocking than hemlock to intercept as much snow as hemlocks or cedars. White pine and red pine (*Pinus resinosa*) evenly spaced so that branches do not touch often have little effect on snow depth. That kind of forest structure will likely be unsuitable as winter range even though the average crown closure may be more than 60%.

considerably in cover species, browse species, winter severity and deer use patterns across the range of deer in Ontario. It is most important that local managers be knowledgeable of this variation of the carrying capacity of their yards. Variable local conditions of climate, forest history and soil type preclude a single set of detailed prescriptions and thus local conditions should be taken into account in the application of these guidelines. If required, procedures should be determined from the literature cited section of this document, or from local foresters or agricultural representatives. The three most important features of a successful yard are traditional use, cover, and browse.

Winter yards require a good interspersion of cover and food at both the landscape (above) and the stand levels (below).

4.0 Recommended Forest Management Guidelines

4.1 Landscape and Seasonal Habitat Considerations

4.1.1 Winter Habitat

Winter concentration areas (yards) vary

Traditional Use: Deer show strong traditional use of winter concentration areas and are virtually impossible to change in their migration habits. Within the principal range of deer in Ontario, traditional yards should represent 10-15% of the summer range area. A greater percentage may be required in WMU's to which many deer migrate from surrounding units, especially in areas with high populations and severe winters.

Lesser percentages may be required on southern units where winter conditions are less restrictive to deer and on northern units where deer numbers are low. Lesser percentages may also be found on WMU's with a past history of conifer logging, agricultural clearing or residential development. Winter range conditions are an important limiting factor to deer populations in Ontario. The permanent loss of suitable yarding conditions particularly within large, important yards showing strong traditional use should be avoided at all costs.

Scheduling: Winter logging operations can be extremely beneficial to deer where edible treetops are felled by cutters and fresh trails are broken by skidding equipment. For this reason, harvest operations may be scheduled during the yarding period, to the extent that it is possible and practical. Similarly, in constructing new access roads for logging within yards, winter roads are preferred over all-weather roads.

Regeneration: Many of the traditional yards have an abundance of older conifer but a scarcity of younger conifer stands and conifer regeneration. Provision of browse is often silviculturally easy but regeneration of conifers may be difficult. Both hemlock and white cedar are preferred cover and preferred browse species for deer but these species are difficult to regenerate to high stocking and they are slow to outgrow the reach of deer. In the interest of long-term conifer replacement, it may be necessary to accept temporary sub-optimum conditions for winter deer habitat in order to provide the necessary conditions for conifer regeneration. Caution must be exercised that the tradition of use of that yard is not lost. The best solution may be to provide adequate stocking of other species such as red spruce, white pine, white spruce and balsam fir if hemlock cannot be regenerated. Hemlock and cedar may be regenerated in peripheral or adjacent areas and eventually provide cover. In northwestern Ontario, black spruce, jack pine and balsam fir are important winter cover.

4.1.2 Summer Habitat

Local conditions of climate, forest history and soil type preclude a single set of detailed prescriptions for all summer habitat. If required, procedures to maintain or create summer habitat should be determined from the literature cited section of this document, or from local foresters or agricultural representatives.

Summer range has a major influence on deer productivity and the ability of deer to survive winter effects because deer develop fat (energy) reserves while on summer range.

Summer range affects productivity of deer herds.

Because forage is produced, harvest operations will be beneficial to deer regardless of the silvicultural methods used. Restrictions on logging are unlikely to be necessary on summer range to meet deer management goals. Since deer thrive in early succession forests on summer range, silvicultural systems which produce more early succession forests will enhance summer range.

Summer range can be enhanced by small, heavier and dispersed cutting as compared to large clearcuts and light selection cuts. Cuts of this type produce the early successional types favoured by deer, greater edge effects and diverse habitat.

In most of Ontario, deer range openings, clearings, fields and early succession forest stages make up at least 10-15% of the area. That percentage will provide adequate summer range if widely distributed. The provision of permanent openings on only 5% of the area will be beneficial to deer and many other wildlife species. Openings of 1 ha (ranging from 0.2-4 ha, maximum width 100 m) provide benefits when distributed throughout the area. The seeding of roads, landings and site prepared areas with suitable grasses and forbs can enhance summer range by prolonging the longevity of openings and by providing early spring grazing for deer. Suitable species for seeding include the cool-season forages such as clover, red fesque and birdsfoot trefoil.

Besides the soft mast (e.g. raspberry *Rubus spp.*) found in heavy cutovers, hard mast (i.e. beech and acorn) can be valuable to deer during seed years. Selection cuts can enhance autumn food supply where suitable mast producers, including potential producers, are retained or released. The best seed producers are large, full-crowned, and vigorous trees with a dominant position in the canopy. Often the best producers are only 50-75 years old. Direct sunlight on the crown is an important factor in seed production, and suitable mast trees can be released by selection cuts in the same way as potential timber producing trees.

4.2 Stand Level

4.2.1 Cover

Hemlock and cedar are the best interceptors of snow and typically grow in association with preferred browse species. In the absence of hemlock or cedar, pine and other conifers may be used by deer for yarding purposes. The amount of conifer should allow deer to move throughout the yard and should provide shelter in bedding areas. Deer yards should have a mix of understocked conifers or mixed woods where browse is abundant, interspersed with heavily stocked and relatively pure conifer. This arrangement allows deer to move among feeding and bedding areas

and provides refuge areas during winter storms. Known migration and travel routes and suitable bedding areas such as hemlock ridges and “knobs” should be avoided when deciding road locations. Tree removal should be limited to leave a residual stand that provides an 80% crown closure. Higher stocking levels are preferred where the cover species are other than hemlock or cedar, and in yards where good conifer is already scarce. Outside of bedding areas and travel corridors, conifer stands should be reduced in stocking, in order to encourage browse production. In hemlock or cedar stands, an average conifer crown closure of 60% is adequate, or a patchwork of small openings may be created to achieve the same effect. The average stocking should be approximately 60% based on trees 10 m or higher. In mixed wood stands where the conifer content is low, it is desirable to retain all of the conifers and to confine tree removal to the hardwood component. This objective is especially appropriate where the silvicultural prescription is geared towards regenerating hardwoods rather than conifer.

4.2.2 Browse

The recommended amount of browse that is accessible to deer should average 20 kg/ha of current annual growth (dry weight) of suitable species, between 0.5 and 2.0 m in height. Diversity of browse is required and at least three suitable species should be available. Suitable species include cedar, hemlock, viburnums (*Virburnum spp.*), red maple, striped maple (*Acer pennsylvanicum*), mountain maple (*Acer spicatum*), red oak (*Quercus rubra*), sugar maple, dogwood (*Cornus spp.*), beaked hazel (*Corylus cornuta*), birch (*Betula* spp.), cherry (*Prunus spp.*), ground yew (*Taxus canadensis*) and white pine. To be accessible to deer, browse should be within 30 m of suitable cover in yards where snow depths exceed 50 cm, or as far as 100 m or more in southern yards with less snow or on south-facing slopes. Arboreal lichens, where available, may provide a portion of the required food supply.

Conifers may be cut to foster growth of winter food to the extent that deer access to food is not prevented in average winters. Food supplies will diminish sharply when crown closure exceeds 80% and access to food supplies will be low when crown closure is less than 60%. The species of conifer (and crown shape) and their distribution will determine the optimal crown closure to ensure mobility of deer and access to food. Winter ground or aerial surveys should be done to monitor deer mobility and food supplies.

In areas where annual browse consumption exceeds current annual growth, a year-to-year decline in forage will occur and remedial management should be undertaken. At least one or more of 3 management actions should occur: (1) improve habitat by increasing browse production; (2) improve access to browse via a trail network or restoration of conifer; (3) reduce the deer herd. These provisions apply to long-term winter habitat maintenance during average winters.

Habitat deterioration from over browsing during severe winters when there is a shortage of accessible food should be avoided. Remedial management should consist of: (1) establishing a trail network to make browse more accessible; and/or (2)

Trail networks help deer move among food and shelter areas.

cutting of hardwoods in central Ontario and cutting individual lichen-laden dead conifers in northwestern Ontario to provide immediate food and future browse production; and/or (3) provision of emergency food. (See Guidelines for Winter Feeding of Deer in Ontario OMNR 1997d).

4.2.3 Mast Production

Management of beech and oak trees on summer ranges within 1-2 km of winter concentration areas should be encouraged to perpetuate and maintain mast production. In northwestern Ontario, bur oak is a significant mast producer.

On summer range where oaks and beeches occur in significant numbers, forest management should be geared to maintaining continuous mast production over the long term.

Winter logging can provide immediate food and future browse production.

Even-aged silviculture (shelterwood or clearcut) can be used to promote red oak since it is of intermediate shade tolerance. Single-tree selection cuts can be used for beech regeneration where these species occur in significant areas. This may be at the expense of herbaceous and woody forage locally.

Trees with large crowns should be retained since they are more likely to produce seed. Strong mast production is also characteristic of older trees and is stimulated by exposure to sunlight, such as may occur along roads or adjacent to openings. Large mast crops can be produced by oaks on shallow soil ridges during difficult growing seasons.

4.2.4 Cedar Yards

Winter yards comprised primarily of cedar require special management. Cedar is a shallow-rooted long-lived species that grows well on 2 major site types: (1) organic soils usually associated with lowlands; (2) limestone sites on uplands. Few management guidelines are available for upland sites. Three problems occur: (1) high crown closure and high deer use

result in very low food supplies of 1-4 kg/ha; (2) cedar regeneration after cutting can be very poor without special treatment because other species (e.g. balsam fir) invade the cut or deer browsing prevents growth of small cedars; (3) severe disturbance to the stand can elevate the water table which limits regeneration.

Cedar cuts may require a precut or postcut removal of undesirable species. Very large cedar stands can be strip or patch cut under the shelterwood system on a 90-120 year rotation with 2 or 3 cuts depending on regeneration and growth. Patches may be 0.1 to 0.2 ha in size.

In cedar stands, with low or moderate numbers of deer, regeneration may occur but elsewhere intense browsing may make cedar planting necessary. Burning or mechanical disturbance may be necessary for cedar regeneration. Protection of individual trees with barriers may be needed to allow cedars to grow beyond the reach of deer and be recruited to the canopy.

4.2.5 Hemlock Yards

Winter concentration areas where hemlock is the dominant conifer species require special management. Hemlock should receive special consideration since it is an excellent snow interceptor and good winter food for deer. Hemlock trees are very long-lived and respond to release even when very old.

Two problems often occur in hemlock forests which require special management: (1) food supplies are low in stands with high crown closure stands where deer have concentrated for many winters;

Hemlock or cedar can provide excellent winter cover but often a poor supply of food.

(2) regeneration under hemlock in wintering areas is difficult to establish. Good seedbed conditions, including adequate moisture as well as sunlight, are critical for regeneration and growth.

Uneven-aged hemlock stands with greater than 80% crown closure should be selectively cut (using group selection) to encourage forage if supplies are below recommended amounts (see section 4.2.2). Crown closure should average 60-70% by creating linked patches of hemlock with branches touching. This is approximately equivalent to a basal area of 30 m^2/ha of hemlock.

Mature even-aged hemlock stands should be partially cut to achieve 3 objectives: (1) increased availability or production of forage; (2) maintenance of sufficient conifer shelter; and (3) regeneration of hemlock to replace future loss of mature trees.

Stands to be cut on poor to moderately drained sites with relatively fine textured soils should have 45-50% residual crown closure where regeneration is desired. Scarification after cutting and removal of competing hardwoods, especially maples, is recommended. At least 50% of the area

should be scarified. Advanced hardwood regeneration should be removed. Seeding is recommended at the rate of 0.6 kg/ha. Spring seeding requires 90 days stratification (a technique for preparing seeds) but fall seeding requires no stratification. In high deer density areas, success is jeopardized unless steps are taken to deter deer.

Stands to be cut on dry sites, or stands that are over-mature, or where grass invasion is probable require 2 cuts. The first cut should reduce crown closure to 70-80%, with scarification and hardwood removal as described above. After 8-12 years crown closure can be reduced to 50%. In winter concentration areas, a final cut (such as in a 3 cut shelterwood system) may occur if regeneration of hemlock is good enough to intercept snow (i.e. 60% crown closure by trees greater than 5 m high).

Strip shelterwood cuts of 20% removal (cut 1 strip, leave 4 strips) with north-south oriented strips of 20-30 m will retain shelter values and promote regeneration in the cut strip. The leave period between cuts is dependent upon regeneration on the cut strip achieving “free-to-grow” status. Scarification and seeding or planting may be necessary to encourage regeneration but in high deer density areas, “escape” of hemlock may be prevented. This system has advantages if it is economically viable for commercial harvest (i.e. markets exist for hemlock products). Renewal and maintenance treatments are also easier to conduct.

Where hemlock regeneration is subject to failure, for example, in a winter concentration area, attempts should be made to: (1) maintain overhead canopy for as long as possible; (2) maintain 60% crown closure and encourage hardwoods for browse production; and (3) establish new areas of cover to replace the old stand. New cover may have to be established with conifer species that are not likely to be eaten by deer such as white and red spruce.

4.3 Site Level

4.3.1 Browse and Forage

Browse plots from 0.5 to 2 ha in size should be scattered throughout the yard to distribute deer over a wider area and provide food to all groups of deer. Very good sites may regenerate too quickly to herbaceous plants and grasses which can compete with woody browse. Select sites with trees which will promote suckering if there is no advance regeneration. Pile and burn slash to provide maximum area of regeneration. Hand-cut plots produce more food/ha but bull-dozing may be more feasible if hand cutting is impractical.

Browse plot production should be in association with nearby conifer shelter to permit deer access, but a trail network linking bedding areas and browse plots may be required. A packed snow base should be established in January before snow depths become excessive. In late February and March these trails are more easily maintained.

Re-cutting of browse plots may be necessary in 7-10 years. If browse plots escape the reach of deer in less time, either deer numbers are too low for food supplies or the plot location is poorly chosen. Yard management plans should be reviewed.

4.3.2 Cool-Season (Spring and Fall) Forage Production

Cool-season forages should be promoted whenever possible on summer range because of their value during spring and autumn. Logging trails and log landings are the usual places that are seeded.

White Dutch and red clovers are preferred species that should be used to enhance suitable sites. Inoculated seed should be sowed on good sites. Grass-clover mixtures may be required to establish ground cover on poor sites.

Grasses and legumes should be seeded at a rate of at least 0.6 kg/ha; rates as high as 2.0 kg/ha will produce a better vegetation cover. Fertilizers may be required to establish cover depending on soil and site conditions.

Cool-season forages should be sown in late winter (on snow) or early spring if ground conditions are known. Alternatively, late August to early September seeding should be attempted. Fertilizers can also maintain a desirable forage crop if applied every 3-5 years.

4.3.3 Permanent Openings

A permanent opening contains a plant community consisting of a variety of grasses, annuals, forbs, and may have a limited number of shrubs. These permanent openings are distinctly different from the temporary openings created to encourage the return of second growth forest. Regenerating forest stands, marshes, bogs, and outcrops have not been considered to be permanent openings for the purpose of wildlife management, but they may serve similar functions temporarily. Abandoned beaver ponds, if maintained in a dry state, can produce the vegetation community desired in a permanent opening.

Openings in the interior of forested areas and adjacent to winter concentration areas should receive higher priority than in other areas. On summer range in farmland sufficient openings will be provided by normal agricultural practices.

Openings should provide mainly spring and fall food. (See Cool-Season Forage Production).

Since creation and maintenance of openings is expensive, management for openings should be in areas where natural openings are uncommon.

Sites created by other development such as powerline or pipeline rights-of-way, or log-landings should receive priority for treatment. Idle fields with unsuitable forage or shrub invasion should receive priority before creation of new openings expressly for deer.

The enhancement or creation of permanent openings should consider the following factors: (1) the most diverse plant communities are found at the junction of several forest types; (2) sites that were formerly open often have remnant plant communities that respond quickly to release; (3) costs are often lower in sparse or low quality stands such as oak, birch, poor hard maple sites or off-site aspen; (4) irregularly-shaped openings with east-west layout on southern exposures adjacent to heavy cover have the potential to meet many year-round needs of deer.

The enhancement or creation of openings should employ techniques that are the most economical for long-term maintenance. Consideration should be given to using one or more of the following: (1) commercial timber sales; (2) bulldozers; (3) roller choppers; (4) tillers, ploughs and disks; (5) spring burning.

The use of fertilizers or herbicides and/or seeding should be evaluated if native plant regeneration will be unsuitable or short-lived. Late summer or autumn mowing will create new growth tips and alter plant communities to the benefit of deer and other wildlife such as ruffed grouse (*Bonasa umbellus*). Mowing removes mature unpalatable forage, as well as weeds and brush. Pasture mixtures will produce new palatable growth after mowing.

Openings with primarily native forage species should produce seasonally diverse forage; openings created by seeding should have predominately cool-season forages such as rye and legumes (clovers).

Openings of 2 ha (with a maximum width of 100 m) are recommended.

5.0 Application of the Guidelines

These guidelines are to be applied in the Great Lakes-St. Lawrence Forest where deer are the featured species with the exception in local situations where deer and moose (*Alces alces*) populations overlap and moose are declared the featured species. Proper planning at the landscape and stand levels is necessary to apply these guidelines.

Forest management planning on Crown lands in Ontario is governed by the *Forest Management Planning Manual*. The planning process is comprised of three interrelated levels which describe forest operations in varying levels of detail:

- At the Forest Management Plan (FMP) level, broad objectives and strategies for a 20 year term are described and specific operations for the first five years are identified. At this level landscape requirements for winter and summer deer habitat are considered.

- Areas are scheduled for operations annually in an Annual Work Schedule (AWS). A Forest Operation Prescription (FOP) is prepared for each area of operations that is outlined in the Annual Work Schedule. The FOP verifies actual site conditions and prescribes the treatment package that will be used on that site, such as selection, shelterwood or clear cutting.

- Operational design (on-site planning), which is conducted at the field level, is not specifically prescribed in the FMP manual. At this level detailed operational decisions are made, such as the individual trees to be harvested or retained.

The guidelines are to be applied in relation to the particular habitat requirements of deer on the forest management unit. In considering those requirements, the following steps should be followed in developing the Forest Management Plan:

Step 1. Organize Background Information

Both winter and summer range should be identified for the forest management unit (MU) and assessed in the context of the wider planning unit of which the MU is part.

Planning teams will consult with the local wildlife manager who will determine the need to maintain or enhance habitat for deer on the forest management unit. The manager will make that judgment on the basis of an evaluation of the deer population targets for the relevant wildlife management unit(s), and translate those habitat requirements into management objectives for the forest management unit.

Population targets are established through Ontario's deer management system so that deer numbers do not exceed carrying capacity of the wildlife management unit. (Figure 6 illustrates how these deer guidelines are integrated with the management system for deer in Ontario.) The Ontario Deer Model (Broadfoot and Voigt 1992) and the habitat evaluation techniques (Broadfoot *et al.* 1994, Broadfoot and Voigt 1996b) can be used by the local wildlife manager to establish targets for the wildlife management unit (Voigt 1992). An evaluation of the current carrying capacity of winter range and the supply of summer forage can be conducted using the habitat supply model developed by Broadfoot *et al.* (1994) and Broadfoot and Voigt (1996a). After these evaluations, the planning team will be advised by the wildlife manager of the need to maintain or improve winter or summer habitat on the unit.

Step 2. Determine Management Direction

The preferred alternative for forest management in terms of deer habitat and other forest management objectives is selected from an analysis of forest management alternatives using for example the **Strategic Forest Management Model** (Davis, 1996).

Step 3. Select Areas for Operations

Areas are selected for operations on the basis of a set of selection criteria. These selection criteria may include criteria which address deer habitat needs as described in these guidelines.

Step 4. Determine Prescriptions for Areas for Operations

For most areas of operations the silvicultural ground rules, developed in accordance with MNR's silvicultural guides, will prescribe management operations, such as the forest harvest system to be employed.

Critical habitat areas, such as winter yards and associated browse areas, are identified as Areas of Concern (AOCs) in the forest management plan and specific operational prescriptions are produced.

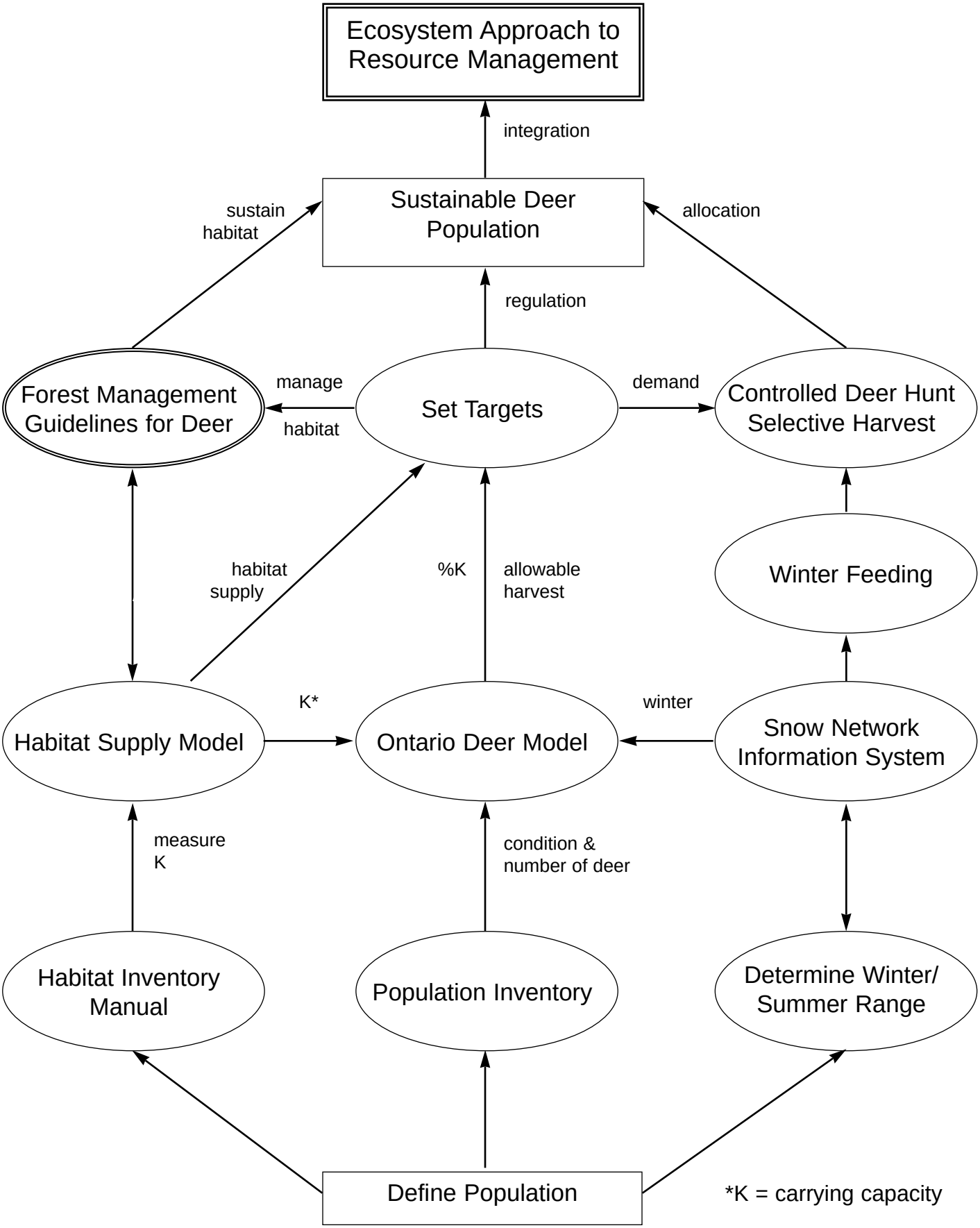

Fig. 6 The integration of the Forest Management Guidelines for Deer and the management system for deer in Ontario.

6.0 Future Directions

The amount and distribution of both cover and browse availability is a function of the composition of the forest within deer range in the province which in turn is dependent on the amount and frequency of disturbances in the forest. Over most of the deer range in Ontario, particularly throughout central Region, the primary agent of disturbance is forest harvesting for commercial purposes. Forest harvesting through the use of various silvicultural systems improves the amount of browse production and is the primary source for creating early successional forests. The amount and distribution of forest harvesting is dependent on two factors, demand for forest products and supply. Recent advances in analytical techniques for both demand and supply provide an opportunity to examine the future potential for forest harvesting as a means of creating and maintaining suitable habitat conditions for deer.

The analysis of current and projected trends in demand and supply of forest products has been examined for each of the MNR administrative regions and provides a general speculative “picture” of the future trends for the creation and maintenance of deer habitat. The primary area of forested deer range is in central Ontario and the Great Lakes-St. Lawrence Forest of northwestern Ontario.

An assessment of Ontario’s forest resources (OMNR 1997c) provides long term estimates of timber supply and demand.

In the central Region over the next 20 years the demand for softwoods is expected to decline while demand for hardwoods is expected to increase. On crown land the supply for softwoods is expected to be constant until the middle of the next century. Thus, the expectation is the amount of conifer cover for deer should remain near the levels currently available. The supply of hardwoods will remain constant over the next 20 years after which it is expected to decline until the middle of the next century. The combination of increased demand for hardwoods and a flat supply should translate into harvesting of hardwoods at the same or increased rates above current levels . Thus, browse production should be maintained at or above current rates. Since a significant amount of the supply for forest products in the region is supplied from private land a major contribution for both the retention of cover in winter yards and browse production will be supplied on private land. Any further expansion of supply of hardwoods may require improvements in the quality of hardwood stands through increased stand improvement activities which if carried out will also improve the supply of browse for deer.

In northwestern Ontario there is expected to be increased demand for both softwoods and hardwoods. The supply of softwoods is expected to decline over the next 50 years while the supply of hardwoods is expected to remain constant. Although this analysis does not distinguish between the Great Lakes-St. Lawrence Forest and the Boreal Forest within northwestern Ontario, similar trends can be expected in both areas. Thus, in terms of cover and browse production within the northwestern deer range there could be a general reduction in

the availability of conifer cover and maintenance of browse production at current levels. Careful planning will be required to ensure that conifer cover is maintained in deer wintering areas.

6.1 Ecological Land Use Planning and Setting Targets

The future vision of land use planning in Ontario consists of ecological land use plans for large, ecologically based planning areas, accompanied by operational planning for smaller areas and management units.

Ecological land use planning will: (1) integrate direction from relevant provincial policies, (2) establish broad objectives and management standards for the key natural resources such as white-tailed deer within the planning area, and (3) allocate land and natural resources among competing uses. These ecological plans will provide a clear basis for operational planning at the local forest management unit level.

Ecological land use plans will provide a context to ensure that local operational planning decisions will contribute to sustainable resource use and the conservation of biodiversity.

An important component of ecological land use plans will be to establish objectives for the desired future forest condition expected under natural disturbance regimes. With respect to deer, population targets should be set based upon habitat supply and user demand. These targets should be compatible with the desired future forest condition and established in relation to the anticipated demands for other resources.

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